ECONOMICS, MANAGEMENT & BUSINESS 2025

SEARCHING FOR SOLUTIONS IN TIMES OF GLOBAL INSTABILITY AND UNCERTAINTY

Róbert Štefko - Richard Fedorko - Eva Benková (Eds.)

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CONTENTS

Preface 17

1. Economics

Innovation Economics in Healthcare: How the Dental Implant Industry Navigated Global Market Disruptions and Created New Business Models (1980-2025)
Umar Dacca, *Slawomir* Banaszak, and *Ariel* Fuchs 19

Factors Influencing the Internationalization of Businesses in the Construction Industry in Slovakia
Mariana Dubravská 29

Foreign Investment, Legal Barriers, and Housing Policy: Transforming the Slovak Real Estate Market
Julius Golej and *Daniela* Špirkova 38

Employment Preferences of Slovak Economics Students in Domestic and Foreign Labour Markets
Tamara Hrušovská, *Tomáš* Koreň, *Matúš* Kubák , and *Jozef* Nemec 49

Analysis of the Cross-Border Mergers and Acquisitions Activity within EEA
Stela Kolesárová, *Alexandra* Chapčáková, *Juraj* Smatana, and *Vladislav* Stanko 55

Analysis of Performance Indicators of Small and Medium-sized Enterprises in the European Union
Jaroslav Korečko and *Ján* Vravec 64

Subsidies as a Tool for Increasing the Competitiveness of Slovak Farms
Ivana Kravčáková Vozárová, *Rastislav* Kotulič, and *Omar* Mohamad Abdulhafiz Mhemed 73

Underexplored Factors of Fiscal Outcomes in the Slovak Local Public Sector: Gender Standpoint
Lenka Maličká and *Dominika* Jusková 80

The Analysis of Key Indicators of Europe's Digital Transformation
Mária Matijová and *Beáta* Šofranková 89

Economic and Political Implications of Public Transport Discount Fares in Czechia
Alex Mican 100

Transforming Housing Through the Sharing Economy: The Case of Co-living as an example
Askar Mustafin, *Rastislav* Kotulič, *Galina* Tuguskina, *Natalia* Larionova, and *Valerii* Pureliani 111

Moldova at the Gates of the European Union
Andrea Nagy and *Zsuzsanna* Nagy 120

The Influence of Geopolitical Situations in the Middle East and Iran on the European Construction Sector in Cement and Concrete Production and Imports
Florian Struck and *Mária* Bohdalová 129

Progress in the Competitiveness of the Slovak Republic in the Context of Sustainability
Elena Širá 141

Digital Performance and Sustainable Competitiveness of EU-26 Countries in the Context of a Multidimensional Assessment
Beáta Šofranková, *Mária* Matijová, and *Elena* Širá 149

Flexibility in the Labor Market
Daniela Štellárová, *Marta* Urbaníková, *Tatiana* Bencová, and *Alexandra* Krivošíková 161

Trust in Economic Actors in the Czech Republic
Ilona Švihlíková and *Dana* Junková 168

2. Management

Challenges for Social Responsibility of Organizations in Market Economy Conditions
Nataliia Antoniuk, *Michaela* Harničárová, *Eva* Benková, and *Ľubica* Šarišská 176

An Analytical Perspective on Innovation in Recruitment & Selection of Employees
Jana Cocuľová, *Daniela* Bertová, and *Simona* Minďašová 187

Work Engagement Among Healthcare Professionals: A Comparative Analysis of Key Influencing Factors
Jana Cocuľová and *Veronika* Škerháková 193

Neuroscience in Leadership: An Integrative Framework for Optimizing Human Capital Performance
Kefah-Rakiaa Dabur and *Sławomir* Banaszak 199

Intercultural Communicative Competence Development in the Context of Managerial Foreign Language Education
Lucia Dančišinová 205

Sustainability of Social Service Provision in the Slovak Republic: An Innovative Example of Good Practice
Zuzana Draková 213

Organizational Resilience and Employee Well-being: An Evidence-Based Analysis of Workplace Interventions and Performance Outcomes
Nof Eilon 221

From Efficiency to Stability: Factors of Sustainable Strategic Management in Slovak Business
Patrik Fitala, *Renata* Skýpalová, *Zdeněk* Málek, *Peter* Šedík, *Adam* Klement, and *Milan Jan* Půček 228

Optimizing Managerial Decision-Making Processes in Complex Organizational Systems using Transformative Intelligence-Based Strategic Frameworks
Hila Fuchs 243

Transformative Intelligence in Decision-Making Processes and Policy Implementation Management: An Integrated Framework for Organizational Process Optimization in Complex Systems
Hila Fuchs 249

The Effect of Self-Efficacy and Perceived Career Threats on Attitude Towards Parental Leave
Petia Genkova and *Tim* Speckmann 256

Tax Management and the Effectiveness of Tax Crime Detection
Miroslav Gombár, *Nella* Svetozarovová, and *Anna* Burdová 265

The Fluid Reality Theory of Pygmalion Effect in Management: Integrating the Consciousness Equation and Oxytocin-Mediated Trust
Assaf Ichilov 276

Proactive Agility - Barriers and Capabilities of Companies: Evidence from Slovakia
Andrea Janáková Sujová and *Martin* Halász 282

Generational Perspectives on Employee Well-being
Terezie Krestová, *Nicola* Kubacká, and *Marcela* Papalová 290

Management of Intangible Assets: Aspects of Evaluation and Identification of Digital Assets of an Enterprise
Svitlana Labunska, *Volodymyr* Yermachenko, and *Mykola* Sidak 300

Level of Digitalization of Communication Media with the Public in Selected Cities
Marcel Lincényi, *František* Vojtech, and *Miriam* Slobodníková 314

Transformative Intelligence as a Core Competency for Educational System Management: Integrating Organizational, Technological, and Human Dimensions in 21st Century Leadership
Enrique Messer and *Reuven* Azulay 321

Workforce Stability in Healthcare: Key Predictors of Hospital Nurse Retention
Veronika Mozolová, *Magdaléna* Tupá, and *Monika* Gullerová 327

Strategic Measures to Secure Financing for Schools and Educational Facilities during the Energy Crisis: The Case of the Slovak Republic
Ľubomír Nebeský and *Jana* Barjaková 338

The Impact of Working From Home on the Motivation of Technical and Economic Workers in the Nový Jičín District: Barriers, Motivation and Impacts on Work-life Balance
Lech Nierostek, *Petra* Horváthová, *Tereza* Harabišová, and *Thi* Phuong Thao Diep 349

Deciphering Small Business Performance through Entrepreneurial Resilience: Empirical Findings from Sub-Saharan Africa
Timilehin Olasoji Olubiyi 358

Sports Management in the Dimensions of Managerial Functions
Iveta Petríková Rosinová and *Jana* Korcová 371

Microcredentials and Their Potential for Lifelong Learning and Human Resource Management
Simona Polonyová 380

Do Social Issues Matter? A Survey on Socially Responsible Behaviour of Businesses in the Czech and Slovak Republics
Renata Skýpalová, *Mária* Urbánová, and *Martin* Šikýř 387

Transformation of Traditional Approaches and Practices in Human Resource Management
Nella Svetozarovová, *Anna* Burdová, *Martin* Frohmann, and *Abdalah Yousef Mohamed* Gajem 399

A Theoretical Analysis of Work Environment Factors in Relation to Healthcare Worker Engagement
Veronika Škerháková, *Soňa* Kuchárová, and *Denis* Tirpák 406

Conceptualizing Employee Engagement in Slovak Healthcare: A Basis for Empirical Research
Denis Tirpák, *Veronika* Škerháková, and *Michaela* Harničárová 414

How Artificial Intelligence is Changing the Future of Human Resource Management and the Labour Market
Ľuba Tomčíková, *Daniela* Bertová, and *Jana* Cocuľová 422

Growth and Survival Strategies of Small and Medium-sized Enterprises in Slovakia
František Vráb and *Milan* Fiľa 430

Benefits of Using Key Performance Indicators in Management Process in Industrial Enterprises
Tsanka Zlateva-Petkova 438

Why And How Should Business Models in Industrial Organizations Be Transformed?
Tsanka Zlateva-Petkova 449

3. Business and Marketing

A Gender Perspective on Selected Neuromarketing Attributes to Enhance Sales
Zuzana Birknerova and *Lucia* Zbihlejova 460

Revealing the Neuromarketing Potential of NLP Subconscious Mechanisms in Entrepreneurial Practice
Zuzana Birknerová and *Eva* Benková 468

Advertising Literacy and Implicit Reactions to Brand Benefits:
A Case Study of Research on Implicit Reactions as a Complement to Verbal Feedback
Tamás Darázs 476

The Importance of E-Commerce in Global Enterprises
Juraj Fabus, *Miriam* Garbarova, *Petra* Holla Bachanova, and *Piotr* Gorzelanczyk 487

Visual and Psychographic Features of Advertising Creatives as Predictors of User Attention
on the Meta Platform
Igor Fedorko 495

Emotional Factors as Determinants of Purchasing Decision-Making in E-Commerce
Richard Fedorko, *Barbora* Talašová, *Lenka* Kráľová, and *Štefan* Kráľ 504

The Marketing Power of Customer Reviews in Hospitality Industry
Lujza Gunišová and *Peter* Štarchoň 513

The Impact of Unexpected Changes on the Determinants of Family Business in the Slovak Republic
Martin Halász, *Andrea* Janáková Sujová, and *Mariana* Sedliačiková 519

Analytical View of Online Consumer Behavior in Influencer Marketing within a Post-Pandemic
Market Environment
Jakub Horváth, *Igor* Fedorko, and *Mária* Jusková 529

Verbal Communicative Strategies in Intercultural Business Communication: a Theoretical Perspective
Irina Kozárová 536

An Analytical Examination of Consumer Purchasing Behaviour in the Context
of E-Commerce Sustainability
Lenka Kráľová, *Štefan* Kráľ, *Richard* Fedorko, and *Bianka* Herichová 543

The Use of Neuromarketing Tools in Evaluating the Effectiveness of Advertisements
in E-commerce Environments
Veronika Loumová, *Mária* Tomášová, and *Radovan* Bačík 550

The Effect of Omnichannel Logistics Service Quality on Customer Loyalty
M.A.R.D. Manatunga, *T.S.L.W.* Gunawardana, *D.M.T.* Madushanka, and *S.A.M.H.* Sudasinghe 559

Global Challenges and Digital Solutions: Communicating with Green Consumers in the Digital Era
Renáta Miklenčičová and *Michal* Kubovics 569

Analysis of Brand Awareness Level and Its Relationship with the Determinants of Brand Equity
Mária Oleárová and *Radovan* Bačík 577

Compulsive Buying in the Context of Socio-Demographic Characteristics
Ivana Ondrijová and *Róbert* Štefko 587

Marketing Tools for Increasing the Export Potential of Agricultural Enterprises
Nataliia Parkhomenko and *Lucia* Vilcekova 595

Gender Perspective on Perception of Healthy Food Advertisement by Entrepreneurs
Dagmara Ratnayake Kaščáková 605

Marketing Research in the Age of Industry 5.0: Insights from a Bibliometric Analysis
Martin Rigelský 614

The Impact of Loyalty Programs on Consumer Behavior: A Multivariate Analysis from Croatia
Marko Šostar, *Sapthasree Bharathanveettil* Thamban, and *Ante* Jozić 624

Neuromarketing as a Tool for Optimizing Multimedia Communication in the Tourism Sector
Róbert Štefko, *Nella* Svetozarovová, *Ľudovít* Nastišin, and *Marianna* Vrábová 645

Neuromarketing Insights into Visual Attention and Perception of Real vs. AI-Generated Images
Anna Tomková and *Dávid* Miško 654

Social Marketing and its Importance in Times of Global Instability and Uncertainty
Lukas Vartiak, *Iveta* Ubreziova, and *Miroslav* Skoda 665

Silence or Music? Consumer Preferences during Grocery Shopping and Their Implications for Marketing Practice
Peter Vaško, *Jakub* Berčík, *Elena* Horská, and *Patrik* Jurčišin 673

4. Finance

Beyond Linear Models: A Polynomial-Russell Interaction Framework for Predicting Stock Market Sensitivity to Financial Reporting Delays
Avraham Bookra and *Ariel* Fuchs 680

Analyzing the Accounting of Heritage Assets in the Public Sector: A Review of Research Trends
Daniela Feschiyan and *Radka* Andasarova 688

AI-driven Selection of Criteria for Measuring the Financial Performance of Enterprises
Jarmila Horváthová, *Martina* Mokrišová, and *Polina* Orikhan 696

Consequences of the Underestimated Role of Branches on the Effectiveness of the Greek Banks
Pantelis F. Kyrmizoglou 705

Fundamental Analysis and Optimal Portfolio of Companies Operating in the Semiconductor Sector
Magdaléna Musilová, *Ľudomír* Šlahor, and *Monika* Zatrochová 710

Financial-Economic Analysis in Smart Economy
Marek Nagy and *Katarina* Valaskova 720

The Impact of the Recognition of Deferred Tax Assets and Liabilities on the Usefulness of Financial Information
Nikolay Oresharov 735

The Role of Artificial Intelligence in Enhancing Financial Accounting Systems: An Applied Study on Startups
Nazahan Qahatan Sarhan 744

Analyzing Market Efficiency in the Israeli Stock Market
Kfir Saroussi 754

Examining the Impact of Financial Situation on Tax Discipline and Tax Evasion
René Vagaský and *Miroslav* Gombár 761

Analytical View of the Performance Limits of Small and Medium-Sized Enterprises in Slovakia
Ján Vravec and *Jaroslav* Korečko 774

5. Regional Development Management

Smart City Governance – a Cross-Regional Evolution Analysis of Patterns and Convergence Dynamics
Nir Abudraham, *Hujerat* Eslam, and *Alexander* Hait 783

Pre-pandemic Challenges and Socio-economic Disparities in the Prešov Region
Jaroslav Gonos, *Katarína* Čulková, *Jozef* Nemec, and *Anna* Tomková 790

The Role of the Solidarity Economy in Rural Areas
Katalin Lipták 805

Regional Impact of Public Support with a Special Regard to Investment Incentives in the Czech Republic
Martin Lukavec, *Hana* Černá Silovská, *Lucie* Jarešová, *Lucie* Burianová, and *Veronika* Špírková 812

Current State of Research on Administrative Capacity in Cohesion Policy: Topics and Unresolved Issues
Martina Michalíková and *Dagmar* Cagáňová 821

Development of Municipalities under the Influence of Fiscal Imbalance in Slovakia
Mária Murray Svidroňová and *Janka* Holíková 831

The Development of the Standard of Living in Slovakia
Mária Pleshanov 841

Analysis of Electromobility Development in the Slovak Republic from a Regional Perspective
Martin Rovňák, *Peter* Adamišin, *Matúš* Bakoň, *Simona* Minďašová, and *František* Chovanec 849

The Concepts of Regional Innovation Ecosystems
Silvia Ručinská and *Lenka* Jakubócová 857

6. Tourism, Hotel Management and Spa Industry

Educational Indicators as Determinants of Motivation for Participation in Tourism: An Analysis of Selected European Union Countries
Tomáš Bačinský 867

Investigating Generation Z's Preferences in Sustainable Tourism in Slovakia
Janka Beresecká and *Martina* Hudecová 876

Case Study of Marketing Tools and Strategies in DMOs in Slovakia: Current Status and Practice
Hana Bieliková, *Viktória* Bíziková, and *Norbert* Beták 883

Efforts to Implement Environmental Principles in Tourism Enterprises in Slovakia
Tünde Dzurov Vargová, *Daniela* Matušíková, and *Ivana* Šaffová 892

Marketing Strategies for the Valorisation of Cultural Heritage in Slovakia
Jaroslava Gburová, *Michal* Lukáč, *Martin* Halmo, and *Gabriela* Pajtinková Bartáková 901

Possibilities and Limitations of Innovative Marketing Communication in the Context of Slovak Towns and Municipalities
Denisa Jánošová and *Alexandra* Ďurovová 908

A Comparison of Hilton Hotel Reviews on Booking and Google in the V4 Countries
Stela Kolesárová and *Kristína* Šambronská 916

Differences in the Perception of Sustainable Tourism from the Perspective of Generations X, Y and Z
Erika Kormaníková, *Anna* Šenková, and *Gabriela* Strachanová 926

Financial Performance and Resilience of Slovak Spa Companies: A Comparative Analysis Before, During, and After the COVID-19 Pandemic
Martina Košíková, *Petra* Vašaničová, *Sylvia* Jenčová, *Marta* Miškufová, and *Kateryna* Melnyk 936

Perceptions of City Image Among Millennials: The Case of Prague, Vienna, and Budapest
Ivica Linderová, *Petr* Scholz, and *Hana* Kotoučková 947

Ensuring Digital Accessibility Under the European Accessibility Act: Legal Obligations for E-Commerce Platforms and Travel Agencies
Hana Magurová and *Eva* Tinaková 955

Digital Technology Preferences in Transport Services
Daniela Matušíková, *Tünde* Dzurov Vargová, and *Ivana* Šaffová 965

Travel Behavior Across Generations: Evidence from Slovak Women
Kateryna Melnyk, *Petra* Vašaničová, *Martina* Košíková, *Sylvia* Jenčová, and *Marta* Miškufová 975

Regeneration through SMART Tourism in Central European Countries
Ludmila Novacká and *Matěj* Pejsar 982

Cultural Tourism in the Perspective of Wellness:
Towards a Model of Smart Wellness Destination Cultural Driven
Tonino Pencarelli and *Mauro* Dini 993

Environmental Management and Eco-labeling:
Perceptions of Managers and Owners in the Lodging Industry
Petr Scholz and *Ivica* Linderová 1005

Aspects of Digital Nomadism at the Current Travel Market:
Preferences of Digital Nomadism Tourists
Ivana Šaffová, *Daniela* Matušíková, and *Tünde* Dzurov Vargová 1014

Analysis of Vacationers' Satisfaction with Air Transport Services in the Context of Tourism
Kristína Šambronská and *Stela* Kolesárová 1021

Stakeholders´ Perception of Pilgrimage Tourism Development in the Prešov Region
Anna Šenková, *Erika* Kormaníková, and *Dávid* Hnát 1029

7. Green Economy and Sustainable Entrepreneurship

Challenges of Adopting Circular Economy Business Models in Sri Lankan Manufacturing Companies
D.L.M.N.K. Ariyasena 1038

When Values Meet Knowledge: Mediating and Moderating Effects of University-Sourced Knowledge on Sustainability Performance
Michal Erben, *Zoltan* Rozsa, and *Luboš* Smrčka 1046

The Role of Quality Management in Supporting the Circular Economy Transition:
A Case Study of Closed-Loop Production in the Polish Textile Industry
Małgorzata Fiałkowska-Filipek, *Monika* Florian, and *Promporn* Wangwacharakul 1056

Forecasting of the Energy Intensity in Agricultural Sector
Štefan Haščík and *Renáta* Benda Prokeinová 1065

Digital Challenges Shaping a New Generation of Entrepreneurs
Emília Huttmanová, *Alexandra* Chapčáková, *Juraj* Smatana, and *Tomáš* Bálint 1075

Regional Disparities in the Green Transformation Process across the European Union
Emília Huttmanová and *Radoslav* Mikča 1084

Greening the Entrepreneurial Path: Insights into the Development of Sustainable Start-ups
Flóra Anna Juhász, *Ni Made* Estiyanti, and *Domician* Máté 1093

Consumer Values: Exploring the Relationship Between Consumer Materialism and Circular Economy Principles
Dávid Miško and *Ivana* Ondrijová 1102

Importance of Sustainable Approaches in Gastronomy from the Consumer Perspective
Roman Novotný, *Peter* Adamišin, and *Katarína* Švarná 1113

Generational Differences in the Acceptance of Eco-product Communication in Times of Global Crisis: Bibliometric Analysis of Research Trends
Tabita Pavel and *Ana* Zaušková 1126

Testing the Environmental Kuznets Curve Hypothesis under the EU Net-Zero Agenda
Igor Petruška and *Jana* Chovancová 1136

Climate Risk and Regulation: The Way to EU Taxonomy Reporting
Tomáš Smolárik and *Mária* Bohdalová 1146

ESG Reporting from the Czech and Estonian SMEs' Perspective
Jiří Strouhal, *Josef* Horák, *Anett* Resik, *Vaiva* Kiaupaite-Grušniene, and *Paavo* Siimann 1153

Reducing Emissions through the Use of Renewable Energy and the Application of Environmental Taxes
Juraj Válek and *Jana* Kušnírová 1163

8. Quantitative Methods and Applied Informatics in Management and Business

A Novel Hybrid IBA-OSCD Approach for Multi-Criteria Inventory Classification
Ognjen Anđelić, *Pavle* Milošević, *Zoran* Rakićević, *Miroslav* Hudec, and *Milica* Zukanović 1175

AI in Action: Real-World Projects Improving Work Processes
Lasse Berntzen 1184

Digital Workforce Development: From Individual Adaptability to Organizational Innovation in Human Capital Management
Nof Eilon, *Ariel* Fuchs, *Sławomir* Banaszak, and *Hila* Fuchs 1192

Cloud-Based Augmented Reality in Mobile Heritage Applications for Tour Platform Development
Solomiia Fedushko and *Natalia* Kryvinska 1202

Multiple Nonlinear Regression and Quantile Regression Analysis of Sustainable Height of Tax Evasion in the EU Socioeconomic Area
Miroslav Gombár, *Alena* Vagaská, and *Simona* Minďašová 1210

A Hybrid Model of Interpolative Boolean Algebra and Ordinal Sum of Conjunctive and Disjunctive Functions for Evaluation Semantically Connected Attributes
Miroslav Hudec, *Pavle* Milošević, *František* Zapletal, *Milica* Zukanović, *Eva* Rakovská, and *Lívia* Krajčíková 1220

Efficiency of Slovak Hospitals: Data Envelopment Analysis
Sylvia Jenčová, *Marta* Miškufová, *Igor* Petruška, and *Stanislav* Letkovský 1230

Preventive Diagnostics of Financial Statements Data Empirical Analysis
Ladislav Kabát *and Agnesa* Víghová 1240

Organizational Management in Educational Systems: Leadership in the 21st Century using an Integration of Psychological Flexibility, AI-Assisted Assessment and Innovative Thinking
Enrique Messer 1253

Digital Performance of Businesses in EU Countries - a Prerequisite for Success in an Era of Instability
Martina Mokrišová and *Jarmila* Horváthová 1260

Digital Native Markets: A Fluid Reality Framework for Business Strategy in Virtual-Physical Consumer Ecosystems
Ran Mor 1268

Thriving in the Midst of Uncertainty: Strategically Mitigating HR and Payroll Risks through Digital Transformation
Otakar Němec, *Filip* Bušina, and *Pavlína* Charouzová 1277

Optimization of Tourist Routes Using Traveling Salesman Problem Algorithms
Yuriy Syerov, *Iryna* Ivanochko, and *Michal* Greguš jr. 1290

Preface

Global instability and uncertainty - economic, political, social, technological, and several other areas - deeply affect individuals, businesses, and public institutions. Unpredictable developments complicate decision-making processes and demand new approaches grounded in flexibility, resilience, and innovation. Searching for solutions in such conditions is not a passive endeavour but an active, strategic, and creative process that seeks to anticipate risks, adapt to change, and identify sustainable pathways forward. Global instability manifests itself through market volatility, trade tensions, geopolitical conflicts, shifting labour markets, and the growing complexity of decision-making processes. In such an environment, organisations, institutions, and individuals are confronted with new challenges, risks, and opportunities that require innovative, flexible, and knowledge-based approaches.

The present volume of conference proceedings is published on the occasion of the international scientific conference Economics, Management & Business 2025 - Searching for Solutions in Times of Global Instability and Uncertainty, which responds directly to these contemporary developments. The conference was organised on the occasion of the 21st anniversary of the establishment of the Faculty of Management and Business at the University of Prešov, which has more than two decades of experience in creating platforms for international scientific exchange. Throughout this period, the faculty has achieved significant results in education and research, strengthening its position among leading social science institutions in Slovakia. Its scientific activities are supported by specialised research laboratories, including laboratories focused on neuromarketing, neuro–human resources management, and related fields, and numerous national and international research projects, contributing to the advancement of modern management and business knowledge.

In recognition of its scientific output and research quality, the faculty has received the status of Excellent Research Workplace annually over the past four years and has repeatedly ranked among the top three institutions in the social sciences in Slovakia.

The thematic focus of the conference reflects pressing contemporary challenges. The primary ambition of the conference is to contribute to the development of theoretical knowledge as well as experience-based insights in modern economics, management, and business practice. It aims to foster meaningful interaction between academics and practitioners and to encourage the creation and strengthening of international research partnerships. The conference brought together participants from universities and institutions in more than twenty countries across four continents, underlining its truly global character.

We believe that the contributions published in this proceedings volume will offer valuable perspectives, stimulate further research, and support informed decision-making in times of global uncertainty. We hope that readers will find the insights presented here both inspiring and practically relevant.

Prof. Ing. Dr. Róbert Štefko, Ph.D.

Dean
Chairman of International Scientific Committee

1. Economics

Innovation Economics in Healthcare: How the Dental Implant Industry Navigated Global Market Disruptions and Created New Business Models (1980-2025)

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Abstract

Research Background: Healthcare technology markets occupy a unique position in the global economy, combining innovation dynamics of technology sectors with the stability demands of essential services. Understanding how healthcare industries navigate disruption while maintaining innovation trajectories offers critical insights for business strategy and economic policy in times of global instability.
Purpose of the Article: This paper examines the transformation of the dental implant industry from a niche medical technology into a $6.2 billion global market, analyzing how key players developed resilient business models capable of weathering multiple economic crises while expanding accessibility across diverse markets from 1980-2025.
Methods: Using longitudinal analysis combining patent data, market statistics, industry archives, and stakeholder interviews spanning 45 years, this study traces industry evolution through multiple economic disruptions including the 1980s recession, 2008 financial crisis, and COVID-19 pandemic. We employ theoretical frameworks from innovation economics and organizational adaptation to understand strategic responses to uncertainty.
Findings and Added Value: Analysis reveals three distinct adaptation strategies that enabled consistent growth despite economic crises: (1) Scientific legitimacy leveraging - converting clinical research into market credibility and regulatory approval; (2) Ecosystem orchestration - building integrated networks of manufacturers, practitioners, and payment systems; (3) Market democratization through technology - using digital innovation to reduce costs and expand accessibility while maintaining premium positioning. The industry achieved a 17,600% ROI over 40 years while expanding accessibility from 1% to 35% of the population.
The study provides evidence-based frameworks for healthcare technology commercialization that demonstrate how breakthrough healthcare technologies can achieve sustainable commercial success while contributing to broader objectives of healthcare improvement and accessibility enhancement. These strategic frameworks offer actionable insights for managers, policymakers, and entrepreneurs navigating similar challenges in contemporary healthcare innovation.

Keywords: Healthcare innovation, Business model adaptation, Medical technology commercialization, Crisis management, Global market strategy

JEL classification: A10; J01; J11

1. Introduction

Healthcare technology markets occupy a unique position in the global economy, combining the innovation dynamics of technology sectors with the stability demands of essential services (Arrow, 1963; Newhouse, 1992). Unlike purely discretionary consumer technologies, medical devices address fundamental human needs that persist regardless of economic conditions, yet their adoption patterns reflect complex interactions between clinical efficacy, regulatory approval, professional acceptance,

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and economic accessibility (Gelijns & Rosenberg, 1994). In an era of unprecedented global instability, understanding how industries navigate disruption while maintaining innovation trajectories offers critical insights for business strategy and economic policy.

The medical device industry is subject to many of the same economic forces that affect all highly innovative industries, with device producers needing to make reasonable profits while remaining vigilant of competitive strategies and technological advances (Institute of Medicine, 1991). However, the industry faces unique challenges due to what has been termed "polyintervention" - the complex web of public policies that wrap around virtually every stage of the innovative process to accomplish various public goals (Foote, 1986).

The dental implant industry provides an ideal lens for examining these dynamics because it straddles the boundary between essential healthcare and elective enhancement, serving both medical necessity and lifestyle aspiration. This dual nature has created distinctive market opportunities and challenges, requiring companies to develop sophisticated strategies for addressing diverse customer segments, payment models, and cultural contexts while maintaining scientific credibility and regulatory compliance.

The transformation from scientific discovery to global market leadership represents a comprehensive case study in healthcare technology commercialization. The industry's evolution from Per-Ingvar Brånemark's accidental discovery of osseointegration in 1952 to a $6.2 billion global market demonstrates how breakthrough medical innovations can achieve sustained commercial success through strategic adaptation to multiple economic crises.

Business model innovation has emerged as a critical capability for healthcare companies navigating uncertainty and managing the complex stakeholder relationships that characterize modern healthcare delivery (Javanmardi et al., 2024). The ability to adapt business models during crises - whether through creating new revenue streams, securing liquidity, or leveraging digital transformation - has proven essential for survival and growth in healthcare markets (Saebi et al., 2017).

The COVID-19 pandemic has provided a natural experiment in healthcare business model adaptation, forcing companies to rapidly reconfigure their operations while maintaining service delivery (Lyng et al., 2021). This context offers valuable insights into how healthcare organizations balance adaptation and innovation for resilience, particularly in technology-intensive sectors where both clinical efficacy and commercial viability must be maintained.

Contemporary research on healthcare innovation emphasizes the importance of dynamic capabilities and organizational agility in responding to environmental challenges (Biswas et al., 2021). The dental implant industry's experience across multiple economic cycles provides evidence for how sustained investment in scientific legitimacy, ecosystem development, and market democratization can create competitive advantages that persist through various forms of market disruption.

This study contributes to the broader literature on healthcare innovation economics by examining how a single industry successfully navigated 45 years of economic volatility while simultaneously advancing clinical outcomes and expanding market accessibility. The analysis reveals strategic patterns that may inform policy and practice in other healthcare technology sectors facing similar challenges.

2. Methods

2.1 Research Design

This study employs a longitudinal case study methodology to examine the evolution of the dental implant industry from 1980-2025. The research design integrates multiple data sources to construct a comprehensive analysis of business model adaptation strategies during periods of economic disruption, following established approaches in healthcare innovation research (Collins et al., 2016).

The methodology builds upon frameworks from innovation economics that examine how companies develop and maintain competitive advantages in technology-intensive industries characterized by high uncertainty and complex regulatory environments (Gelijns & Rosenberg, 1994). The approach recognizes that medical device innovation differs significantly from pharmaceutical innovation in terms of company size, R&D processes, and regulatory pathways (Roberts, 1988).

2.2 Data Collection

Primary Data Sources

- Industry archives and company documents spanning 1980-2025
- Patent databases and intellectual property records
- Regulatory filing documents and FDA approval records
- Financial reports and market analysis data
- Conference proceedings and industry publications

Stakeholder Interviews

- Semi-structured interviews with industry executives, clinical practitioners, and regulatory experts
- Historical interviews from industry publications and academic journals
- Documentary evidence from key innovators and company founders

Market Data

- Sales figures, market share data, and pricing evolution
- Adoption rates across different geographic markets and demographic segments
- Insurance coverage patterns and reimbursement policy changes

2.3 Analytical Framework

The analysis employs theoretical frameworks from several domains:

Innovation Economics: Drawing from literature on technological innovation patterns, market entry strategies, and competitive dynamics in healthcare technology markets (Arrow, 1963; Institute of Medicine, 1991).

Business Model Innovation: Utilizing frameworks for understanding how companies adapt their value propositions, revenue models, and stakeholder relationships during periods of uncertainty (Javanmardi et al., 2024; Saebi et al., 2017).

Crisis Management Theory: Applying concepts from organizational adaptation and resilience research to understand how healthcare companies maintain performance during economic disruptions (Lyng et al., 2021; Biswas et al., 2021).

2.4 Data Analysis

The analysis follows a structured approach to identify patterns across multiple economic cycles:

Temporal Analysis: Examining industry evolution across three distinct periods:

- Market creation phase (1980s-1990s)
- Industry consolidation phase (1990s-2010s)
- Digital transformation phase (2010s-present)

Cross-Case Comparison: Analyzing strategic responses of major industry players (Nobel Biocare, Straumann, Zimmer Biomet, emerging competitors) to identify common patterns and distinctive approaches.

Economic Impact Assessment: Measuring industry performance metrics during specific crisis periods (1980s recession, 2008 financial crisis, COVID-19 pandemic) to understand resilience mechanisms.

2.5 Validation Approaches

Data Triangulation: Cross-referencing multiple data sources to verify key findings and ensure accuracy of historical claims.

Expert Review: Validating interpretations with industry experts and academic researchers familiar with medical device commercialization processes.

Archival Verification: Confirming historical claims through multiple independent sources and official records where available.

This methodological approach enables comprehensive analysis of how a healthcare technology industry developed sustainable competitive advantages while navigating multiple forms of economic

disruption over a 45-year period. The framework provides a foundation for understanding strategic patterns that may be applicable to other healthcare innovation contexts.

3. Results

3.1 Market Creation Through Scientific Innovation (1980s-1990s)

The commercialization of osseointegration technology illustrates how breakthrough scientific discoveries require sophisticated business strategies to achieve market success. Brånemark's approach prioritized scientific credibility over rapid market entry, investing 25 years in research before beginning clinical trials. This extended validation period served multiple strategic purposes that became evident in retrospect.

Scientific Legitimacy Foundation

The extensive clinical documentation created an intellectual property foundation extending beyond basic patents. By the time competitors entered the market, Brånemark's team had established scientific protocols, clinical guidelines, and treatment standards that became industry benchmarks. This scientific legitimacy proved crucial for long-term market acceptance, validating principles from healthcare innovation literature about the importance of clinical evidence in medical device adoption (Roberts, 1988).

Economic Returns from Scientific Patience

- Research investment (1952-1985): $2.3 million
- Annual revenue by 1985: $15 million
- ROI after 33 years: 2,100%
- Long-term ROI over 40 years: 17,600%

Professional Ecosystem Development

Initial professional resistance was overcome through systematic education and training programs. The number of trained practitioners grew from 12 dentists globally in 1982 to 12,400 active doctors by 1995. This ecosystem development created switching costs and network effects that provided sustainable competitive protection, demonstrating how healthcare technology adoption depends on professional acceptance and training infrastructure.

3.2 Competitive Strategy and Patent Navigation

The entry of competitors like Straumann and 3i illustrates how patent landscapes can create innovation incentives that ultimately benefit end users. Rather than merely circumventing existing patents, successful competitors developed genuinely superior technologies while establishing independent intellectual property protection.

Straumann's Surface Technology Innovation

- SLA surface development cost: $12 million (1987-1991)
- Clinical improvement: 40% faster healing times
- Revenue from SLA patents through 2005: $340 million
- Market share achieved by 2000: 23%

3i's External Hex Connection

- Development investment: $3.2 million over 18 months
- First year sales: $8.7 million
- North American market share by 1995: 35%

These examples demonstrate how competitive pressure drove continuous innovation while expanding overall market opportunity, supporting economic theories about competition-driven technological advancement in healthcare markets (Gelijns & Rosenberg, 1994).

3.3 Industry Consolidation and Global Expansion (1990s-2010s)

The consolidation around three major players—Straumann, Nobel Biocare, and Zimmer Biomet—reflected distinct strategic approaches to building sustainable competitive advantages in a rapidly expanding global market.

Strategic Acquisition Patterns (1995-2005):

- Nobel Biocare: 23 acquisitions, $340 million investment, 39% global market share
- Straumann: 11 acquisitions, $180 million investment, 24% global market share
- Combined global presence: 67 countries

Zimmer's Orthopedic Synergies:

Zimmer's background in orthopedic implants provided significant advantages in materials science, surgical instrumentation, and regulatory navigation. Their market entry strategy leveraged:

- 23% manufacturing cost savings through shared titanium technology
- 40% savings in surgical tool development
- Investment of $95 million (2003-2006) generating $127 million revenue by 2007

3.4 Digital Transformation and Market Democratization (2010s-Present)

The integration of digital technologies represents one of the most significant disruptions in the industry's history, fundamentally altering competitive dynamics, value chains, and customer relationships.

Digital Platform Development:

- NobelClinician software development: $45 million (2004-2009)
- User growth: 340 doctors (2009) to 8,700 doctors (2015)
- Software revenue by 2015: $89 million annually

Market Democratization Impact:

The entry of lower-cost competitors, particularly from Asia, fundamentally altered market dynamics:

- European average price (2010): $650 per implant
- Osstem competitive price: $180 per implant
- Market response: 35% price reduction from established players
- Result: 67% total market growth (2010-2015)

3.5 Crisis Response and Adaptation

The industry's response to the COVID-19 pandemic demonstrates organizational agility and innovation capacity developed over decades of crisis navigation.

COVID-19 Pandemic Response:

- Initial impact: 87-91% decrease in procedures (April-May 2020)
- Digital transformation acceleration: Complete digital consultation systems developed in 6 weeks
- Recovery timeline: Return to 95% of 2019 sales levels by Q4 2020
- Growth acceleration: 23% growth above 2019 levels in 2021

Same-Day Treatment Innovation:

- Technology adoption: 2% (2015) to 31% (2023) of procedures performed same-day
- Economic impact: 67% increase in clinic profit margins
- Patient satisfaction improvement: 94% vs. 78% for traditional treatment

3.6 Framework for Medical Technology Commercialization

Analysis reveals a four-stage commercialization model that characterizes successful healthcare technology development:

Stage 1: Scientific Legitimacy Establishment (Years 1-10) Foundation through rigorous clinical research, peer-reviewed publication, and professional validation creates sustainable competitive advantages persisting beyond patent expiration.

Stage 2: Professional Ecosystem Development (Years 5-15) Building comprehensive professional ecosystems encompassing education, training, support services, and relationship management creates switching costs and network effects.

Stage 3: Market Infrastructure Creation (Years 10-20) Development of supporting infrastructure including financing systems, insurance coverage, regulatory frameworks, and patient education programs accelerates market expansion.

Stage 4: Platform Evolution and Democratization (Years 15-25) Evolution toward platform business models integrating multiple stakeholders and value streams while enabling market democratization through cost reduction and accessibility improvement.

This framework demonstrates how healthcare technology companies can build sustainable competitive advantages while navigating multiple forms of economic disruption, supporting broader theories about innovation patterns in regulated industries (Javanmardi et al., 2024).

4. Discussion

4.1 Theoretical Contributions to Healthcare Innovation Economics

The dental implant industry's 45-year evolution provides compelling evidence for several key theoretical propositions about healthcare technology commercialization. The industry's success in building sustainable competitive advantages while navigating multiple economic crises demonstrates that healthcare markets exhibit unique characteristics that differentiate them from other technology sectors.

The concept of "scientific legitimacy leveraging" emerges as a distinctive healthcare innovation strategy. Unlike traditional technology markets where rapid market entry often provides first-mover advantages, healthcare technology success requires extensive clinical validation periods that create intellectual property foundations extending far beyond basic patents. This finding supports Arrow's (1963) observations about uncertainty in healthcare markets while extending understanding of how companies can transform uncertainty into competitive advantage.

The four-stage commercialization model identified in this study provides a framework for understanding how healthcare technologies evolve from scientific discoveries to global markets. This model addresses gaps in existing innovation literature that often assume linear relationships between R&D investment and commercial success (Gelijns & Rosenberg, 1994). The extended timeframes and complex stakeholder relationships characteristic of healthcare technology commercialization require fundamentally different strategic approaches than those successful in other technology sectors.

4.2 Business Model Innovation in Healthcare Technology

The study reveals sophisticated business model adaptation strategies that enabled sustained performance across multiple economic cycles. The identification of three core adaptation strategies - scientific legitimacy leveraging, ecosystem orchestration, and market democratization - provides evidence for dynamic capability development in healthcare technology companies.

The ecosystem orchestration strategy demonstrates how healthcare technology companies must navigate complex stakeholder relationships involving clinicians, patients, regulators, and payment systems. This finding aligns with recent research on business model innovation in healthcare that emphasizes the importance of stakeholder integration and value network development (Javanmardi, et al., 2024). The dental implant industry's success in building comprehensive professional ecosystems created switching costs and network effects that provided sustainable competitive protection.

Market democratization through technology represents a particularly significant finding. The industry's ability to simultaneously reduce costs and expand accessibility while maintaining premium positioning challenges traditional assumptions about healthcare technology pricing strategies. This pattern suggests that digital transformation can enable new forms of value creation that benefit both companies and patients, supporting theories about technology-enabled healthcare delivery innovation (Saebi et al., 2017).

4.3 Crisis Management and Organizational Resilience

The industry's performance during multiple economic crises provides insights into organizational resilience mechanisms in healthcare technology sectors. The COVID-19 pandemic response, in particular, demonstrates how companies with strong scientific foundations and professional ecosystems can rapidly adapt to external shocks while maintaining service delivery.

The acceleration of digital transformation during the pandemic illustrates how crisis conditions can catalyze innovation processes that might otherwise require years to implement. The development of complete digital consultation systems in six weeks, compared to planned five-year timelines, supports literature on crisis-driven innovation and organizational adaptability (Lyng et al., 2021).

The industry's ability to achieve record growth levels (23% above 2019) within one year of the pandemic's onset demonstrates the resilience value of diversified business models and strong professional relationships. This finding contributes to understanding of how healthcare organizations balance adaptation and innovation during periods of extreme uncertainty (Biswas et al., 2021).

4.4 Policy Implications and Market Development

The study's findings have significant implications for healthcare policy and market development strategies. The demonstration that extended scientific validation periods can create sustainable competitive advantages suggests that regulatory frameworks requiring rigorous clinical evidence may actually benefit long-term industry development rather than hindering innovation.

The success of market democratization strategies provides evidence that healthcare technology accessibility can be improved through business innovation rather than only regulatory intervention. The industry's expansion from 1% to 35% population accessibility demonstrates how market forces can drive healthcare improvement when appropriate incentive structures are in place.

The role of professional ecosystem development in market creation suggests that healthcare policy should consider education and training infrastructure as components of innovation policy. The industry's investment in professional education created network effects that accelerated adoption while ensuring appropriate clinical implementation.

4.5 Limitations and Future Research Directions

While this study provides comprehensive analysis of one healthcare technology sector, several limitations should be acknowledged. The dental implant industry's characteristics - elective procedures, direct payment models, and relatively straightforward technology - may limit generalizability to other healthcare technology sectors with different stakeholder structures and payment mechanisms.

Future Research Priorities

- **Cross-sectoral analysis:** Comparative studies examining whether the four-stage commercialization model applies to other healthcare technology sectors such as diagnostics, therapeutics, or digital health platforms.
- **Geographic variation:** Investigation of how cultural and regulatory differences across international markets affect healthcare technology adoption patterns and business model effectiveness.
- **Digital transformation impact:** Longitudinal analysis of how digital technologies continue to reshape healthcare technology business models and competitive dynamics.
- **Stakeholder ecosystem evolution:** Research on how changing healthcare delivery models (value-based care, direct-pay medicine, telehealth) affect healthcare technology commercialization strategies.

4.6 Practical Implications for Healthcare Innovation

The findings offer actionable insights for healthcare technology entrepreneurs, established companies, and investors. The importance of scientific legitimacy establishment suggests that companies should invest in rigorous clinical validation even when market pressures favor rapid commercialization. The long-term competitive advantages created through clinical evidence development justify extended development timelines and higher initial costs.

The ecosystem orchestration strategy provides guidance for companies seeking to build sustainable market positions. Investment in professional education, training programs, and support services creates switching costs and network effects that provide protection against competitive entry. These investments should be viewed as essential infrastructure rather than optional marketing activities.

The market democratization findings suggest that digital transformation can enable new forms of value creation that simultaneously reduce costs and expand accessibility. Companies should consider how digital technologies can be leveraged not only for operational efficiency but also for fundamental business model innovation that creates shared value for multiple stakeholders.

4.7 Contribution to Healthcare Economics Literature

This study contributes to healthcare economics literature by providing evidence for how healthcare technology industries can achieve sustainable commercial success while advancing clinical outcomes and expanding accessibility. The demonstration that market forces can drive both innovation and accessibility challenges perspectives that view these objectives as inherently conflicting.

The identification of specific strategic patterns that enable resilience during economic crises provides frameworks that may be applicable to other healthcare sectors facing similar challenges. The evidence that scientific legitimacy, ecosystem development, and market democratization can create sustainable competitive advantages offers strategic guidance for healthcare technology companies navigating uncertain market conditions.

The research demonstrates that healthcare technology commercialization follows distinctive patterns that differ from other technology sectors, contributing to understanding of how regulatory environments, professional stakeholder relationships, and clinical evidence requirements shape innovation trajectories in healthcare markets.

Conclusions

This comprehensive analysis of the dental implant industry's evolution from 1980-2025 provides evidence-based insights into how healthcare technology industries can achieve sustained commercial success while advancing clinical outcomes and expanding market accessibility. The transformation from a niche scientific discovery to a $6.2 billion global market demonstrates strategic patterns that offer valuable guidance for healthcare innovation policy and practice.

Key Strategic Contributions:

The identification of three core adaptation strategies - scientific legitimacy leveraging, ecosystem orchestration, and market democratization - provides a framework for understanding competitive advantage development in healthcare technology markets. These strategies enabled consistent industry growth despite multiple economic crises, achieving a 17,600% ROI over 40 years while expanding accessibility from 1% to 35% of the population.

The four-stage commercialization model revealed through this analysis offers practical guidance for healthcare technology development timelines and investment priorities. The model demonstrates how extended scientific validation periods (10+ years) can create sustainable competitive advantages that persist long after patent expiration, challenging conventional assumptions about first-mover advantages in technology markets.

Business Model Innovation Insights:

The study provides evidence that healthcare technology companies can simultaneously reduce costs and expand accessibility while maintaining premium positioning through digital transformation and strategic ecosystem development. The industry's response to multiple crises demonstrates how established professional relationships and scientific credibility create resilience mechanisms that enable rapid adaptation to external shocks.

The COVID-19 pandemic response illustrates how crisis conditions can accelerate innovation processes, with companies achieving digital transformations in weeks that were originally planned for years. This finding supports theories about crisis-driven innovation while providing practical examples of organizational agility in healthcare technology contexts.

Policy and Market Development Implications:

The research demonstrates that rigorous regulatory requirements for clinical evidence may actually benefit long-term industry development by creating differentiation opportunities and

sustainable competitive advantages. This finding has implications for healthcare policy debates about balancing innovation incentives with patient safety requirements.

The success of market democratization strategies provides evidence that healthcare technology accessibility can be improved through business innovation rather than only regulatory intervention. The industry's expansion demonstrates how market forces can drive healthcare improvement when appropriate incentive structures are in place.

Theoretical Contributions:

The study extends existing healthcare innovation theory by demonstrating how uncertainty in healthcare markets can be transformed into competitive advantage through strategic scientific validation and ecosystem development. The findings support Arrow's (1963) observations about healthcare market characteristics while providing evidence for specific strategic responses to market uncertainty.

The research contributes to business model innovation literature by identifying healthcare-specific adaptation patterns that differ from other technology sectors. The importance of professional stakeholder relationships and clinical evidence in healthcare technology adoption creates distinctive commercialization challenges that require specialized strategic approaches.

Practical Applications:

For healthcare technology entrepreneurs and companies, the research provides evidence that investment in scientific legitimacy and professional ecosystem development creates sustainable competitive advantages that justify extended development timelines and higher initial costs. The strategic frameworks identified offer guidance for navigating complex regulatory environments and professional stakeholder relationships.

For policymakers, the findings suggest that healthcare innovation policy should consider education and training infrastructure as components of innovation ecosystem development. The industry's success in building professional ecosystems created network effects that accelerated appropriate clinical adoption while maintaining patient safety standards.

Future Research Directions:

The study opens several avenues for future research, including cross-sectoral analysis of healthcare technology commercialization patterns, investigation of geographic and cultural variations in adoption patterns, and longitudinal analysis of digital transformation impacts on healthcare technology business models.

Final Implications:

Most significantly, the research demonstrates that healthcare technology industries can create shared value for multiple stakeholders - achieving commercial success while advancing clinical outcomes and expanding accessibility. This finding challenges perspectives that view these objectives as inherently conflicting and provides evidence for how market-based approaches can contribute to healthcare system improvement.

The dental implant industry's 45-year journey from scientific discovery to global market leadership illustrates the potential for healthcare innovation to create sustainable competitive advantages while serving broader social objectives. The strategic frameworks and lessons identified provide actionable guidance for navigating similar challenges in contemporary healthcare innovation contexts, contributing to both academic understanding and practical application of healthcare technology commercialization principles.

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Factors Influencing the Internationalization of Businesses in the Construction Industry in Slovakia

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Abstract

Research background: Internationalization is a key process for companies, enabling them to expand their field of activity beyond the domestic market. This process is influenced by a number of factors, such as economic and political conditions, technological progress, availability of capital, and the ability of a company to adapt to foreign markets. Slovakia is a small, open economy with a high degree of involvement in international trade.
Purpose of the article: Proponed paper offers analysis of the factors influencing the internationalization of business in the construction industry in Slovakia.
Methods: The research part focuses on analyzing the current state of internationalization in a selected industry. It also includes an assessment of development trends in selected areas of internationalization of these companies. Based on the information obtained about the forms and reasons for foreign trade activities interdependencies within this ongoing process have been identified.
Findings & Value added: Based on the processing of available data and a survey conducted among construction companies operating in Slovakia, it can be concluded that the purpose of the article has been fulfilled. The paper identified and analyzed key factors influencing the internationalization activities of companies operating in the construction sector in Slovakia.

Keywords: Internationalization, Construction sector, Slovakia

JEL classification: F02, F06

1. Introduction

The tendency to build international relations and trade is as old as humanity itself. Therefore, it would not make sense to analyze the entire history of trade and economic relations in detail. In this chapter, we will focus on modern history and the development of international relations.

According to Jones (2005), the beginnings of modern internationalization date back to the 19th century, when we see the first formation of modern international trade relations, mainly in the context of colonization and industrialization. The colonial campaigns of European powers led to the creation of new trade routes and relations, mainly with Africa and Asia. The spread of industrial technologies also laid the foundation for the later development of international relations.

In the ever-changing conditions of the current century, globalization and the expansion of international business have become determining factors for companies seeking growth and success. Expansion into international markets requires a systematic and well-planned approach. Internationalization is not a one-time event, but a complex process consisting of several phases, from initial market research to full integration into foreign markets. Each phase has its own specifics, demands, and challenges that companies must face. Most companies go through various stages of internationalization (Buck, 2004).

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Figure 1. Stages of internationalization
Source: El Idrissi (2023)

1.1 Internationalization

Internationalization is the oldest trend in the global economy. It is defined as the process of removing barriers between countries and creating mutual relationships, one of its current manifestations being the increased mobility of production factors and manufacturing output in the global economy (Hečková, Chapčáková ,2021).

Internationalization is part of many theories of business and greatly influences the decision-making process regarding business activities. Thanks to internationalization, companies become international or even global, as they conduct business in different business environments and outside their home country.

Thompson (2021) views internationalization as the process of adapting a product, service, or operational offering for entry and growth in international markets. He sees globalization as a possible end goal, but internationalization is the process through which a company can get there. Internationalization requires a thorough understanding of cultural differences, traditions, and different market preferences.

This concept was also addressed by authors in the last century. Among the classic and recognized definitions is this one from the well-known British economist J. Dunning (1988): Internationalization refers to the process by which companies increase their involvement in international markets.

Internationalization offers companies the opportunity to strengthen their position, achieve organic growth, and better utilize their corporate capital. It is clear that internationalization can bring many benefits to companies, but here too, there are two sides to every coin: positive and negative. The positive and negative aspects of business internationalization according to Mura (2010) can be summarized in a comprehensive form, as shown in Table 1.

Table 1. Positives and negatives of business internationalization

Positives of business internationalization	Negatives of business internationalization
Deepening the international division of labor	Increased intensity of competition
Blurring of national borders	Higher losses in the event of business failure in foreign markets than in the domestic business environment
Removing barriers to trade	The demise of entities that failed to adapt
Better utilization of corporate resources	Higher investment requirements for internationalization compared to domestic business
Growth and profit potential of the company	
An opportunity to gain experience in international business	
The opportunity to diversify business risk	
An opportunity to gain know-how	
The chance to get new customers, new markets	

Source: Mura (2010)

1.2 Factors influencing the internationalization of business

The process of business internationalization is very fragile, unstable, and dynamic. It can be influenced by a number of factors, which can be divided into several criteria. Whether internal, external, push, pull, technological, or other factors, they all contribute to companies' decision-making and their internationalization strategy.

Internal factors can be defined as those directly related to the capabilities and characteristics of a given company. There are many internal variables that influence the international activities of companies. Wach (2014) states that internal internationalization factors are rooted in the view of resources and points to three basic groups of factors, such as internal resources, capabilities and competencies, and business knowledge and experience.

Zahra and George (2002) conducted research into the internal determinants of international business and presented a set of three factors with the greatest impact on internationalization at the company level based on a view of resources, namely:

- top management team, especially experience working abroad, the origin of the founders, foreign education, and their vision of the global development of the organization,
- internal resources, especially unique ones such as expenditure on research and development activities and the company's reputation
- company specifics such as size and age, location, legal form, testing business environment, financial strength, and pro-development orientation.

External business factors are those that a company cannot influence and that arise from external conditions. Taking into account the research of several authors, we can divide external factors into the following groups:

- Economic – economic factors that influence the internationalization of companies include two groups of variables – demand (exchange rate, external demand) and cost variables (prices, salaries or wages, interest rates).
- Demographic – these include, for example, the size or structure of the population, urbanization, education, and lifestyle. These factors influence the behavior and needs of end consumers, which is why they are also important for companies when considering entering a given foreign market.
- Political and legal – in particular, the stability of political and legal conditions is considered an important stimulus for internationalization. Great emphasis is also placed on the extent to which governments can control or restrict the actions of foreign investors, as well as attract or even discourage foreign-owned companies from entering a given market (Belniak, 2015).

The second division is the division of internationalization factors according to their motivational influence. Here we distinguish between push and pull factors that influence the internationalization process of companies and their corporate strategy. There are several driving forces that motivate companies to enter foreign markets. These forces can be divided into pull (attractive) and push (pressing) forces.

Pull forces are proactive forces that attract companies to foreign markets and international expansion. They are usually associated with the attractiveness or better conditions of foreign markets. Pull factors are generally perceived as positive or opportunistic drivers of internationalization. For example, a new international market may have an emerging middle class with increased purchasing power, which represents a potential opportunity for a company. Attractive factors generally include market size, economic and social conditions, and characteristics of the foreign market (Francis, 2024).

On the other hand, push factors are reactive forces that "push" a company towards foreign markets. These are often internal or domestic unfavorable conditions that motivate or force the company to expand. Push factors are often considered negative, but this may not always be the case. In general, they can include resources, management expertise, corporate culture, and environmental factors (Evans et al., 2008).

2. Methods

The material used in the preparation of the Paper and the fulfilment of its objectives consists of primary and secondary sources. The primary sources of information are information obtained through own research activities—questionnaire survey. The survey focused on owners, their representatives, or managers who have knowledge about how the company works. We summarize the research sample as:

a construction company based in Slovakia that has the scope, interconnectedness, or experience with the foreign market.

The aim of the questionnaire was to gain deeper insights into the factors influencing the internationalization of business in the construction industry, to identify barriers and motivations for companies entering foreign markets, and to verify the hypotheses formulated in the theoretical part of the thesis. Given the nature of our data and the need to identify possible monotonic relationships without having to meet strict assumptions about data distribution, Spearman's coefficient was the most appropriate choice. Spearman's correlation coefficient is a non-parametric statistical method used to measure the strength and direction of a monotonic relationship between two variables.

3. Results

The construction industry is characterized by its stable presence in the Slovak economy, has high potential for expansion into foreign markets, and is very sensitive to global economic factors. This makes it an interesting candidate for analysis of internationalization development and potential.

According to the SITA agency (2023), construction is a strong and irreplaceable segment of the economy, as well as a barometer of the functioning of the economy. The reputation of the Slovak construction industry has been very good for decades. Construction is irreplaceable for the state in fulfilling social, economic, and political tasks, i.e., when it comes to housing, civil, and engineering infrastructure. As reported by TASR (2018), construction is important for Slovakia because it is low in import demand and independent of the economic cycle, meaning that if a crisis or other financial problems arise in other parts of the economy, construction can significantly stabilize it. It further states that the construction industry brings the largest volume of subsidies from European Union (EU) funds and other funds to Slovakia.

The Slovak construction industry is primarily focused on the domestic market. Domestic production remains stable at around 90%. However, on a positive note, 2023 saw a higher increase in foreign construction contracts, up by 1.88%. This trend may indicate the expansion of Slovak construction companies abroad, which may be a response to economic conditions or new opportunities outside Slovakia (see Figure 2).

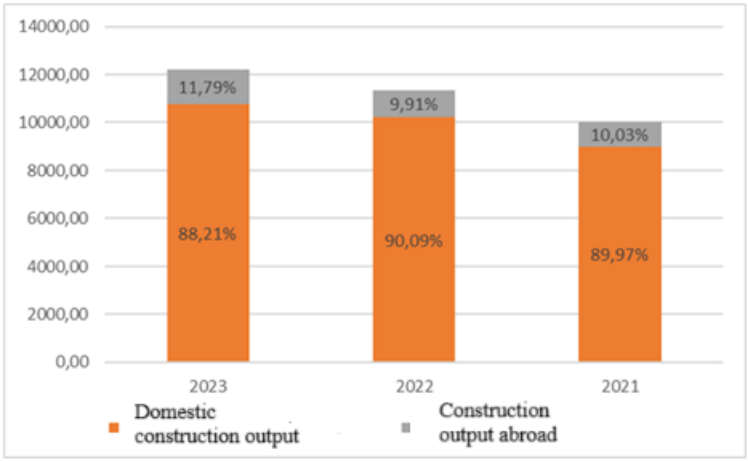


Figure 2. Share of domestic and foreign construction output for 2021–2023 (%)
Source: own processing according the Slovak Statistical Office (2025)

Figure 3 shows the volume of construction services exports in thousands of euros for the years 2019 to 2022. The blue curve shows the total volume of exports from Slovakia. The data is then supplemented by the five largest export partners for this period, which are the Czech Republic, Poland, Italy, Germany, and Austria, in that order. The years 2019 to 2021 are characterized by a significant decline in exports. The year 2021 is the most critical due to the pandemic. We see a similar trend in the Czech Republic (orange curve), which has long been the most important partner in the export of construction services. After a sharp decline in 2019–2021, exports recovered slightly in 2022.

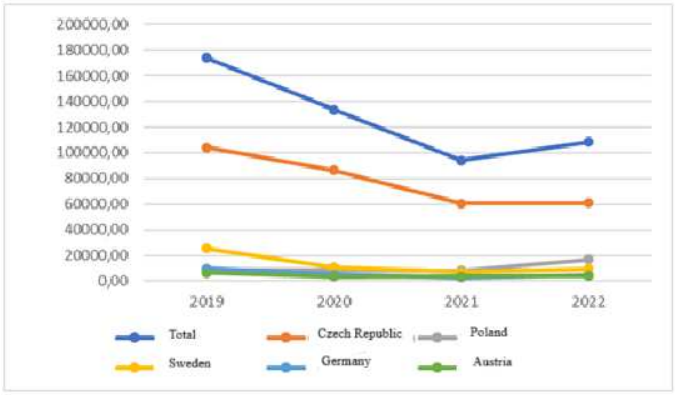


Figure 3. Exports of construction services for 2019–2022 (thousands of euros)
Source: own processing according the Slovak Statistical Office (2025)

The most significant growth was recorded in Poland (gray curve), where we see an increase in the volume of construction services exports. Other countries, such as Austria, Italy, and Germany, show relatively stable values, but at a lower level.

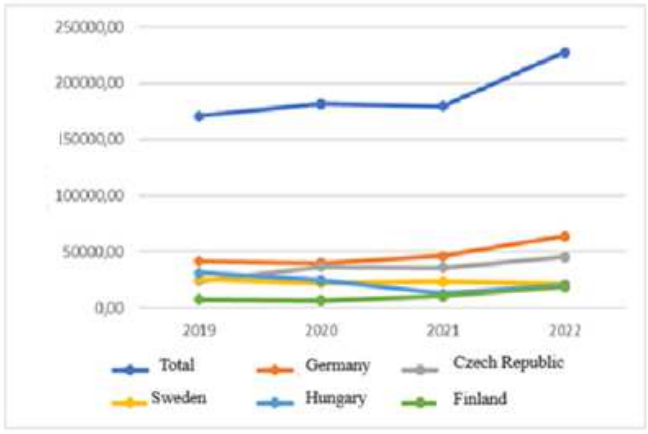


Figure 4. Imports of construction services for 2019–2022 (thousands of euros)
Source: own processing according the Slovak Statistical Office (2025)

Figure 4 shows the volume of imports of construction services in thousands of euros for the years 2019 to 2022. Here we see a slightly different trend than for exports. The total import volume was relatively stable for the first three years under review. The year 2021 saw only a slight decline. We also see a post-pandemic increase in this case, with a significant increase in 2022. The largest import partner is Germany. The Czech Republic is again close behind. Sweden (yellow curve) and Hungary (blue curve) show slight fluctuations in values without a significant trend. Finland (green curve) recorded growth in 2022, which may indicate new cooperation with the Slovak construction sector.

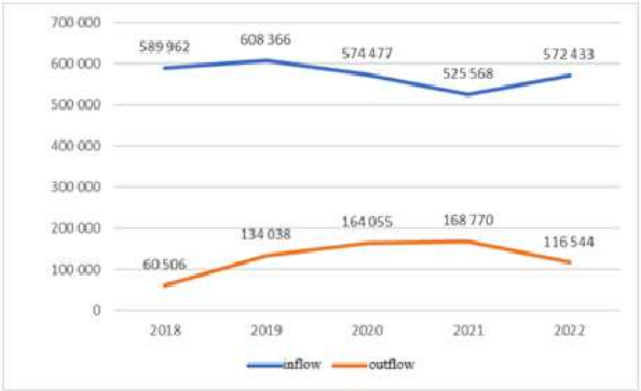


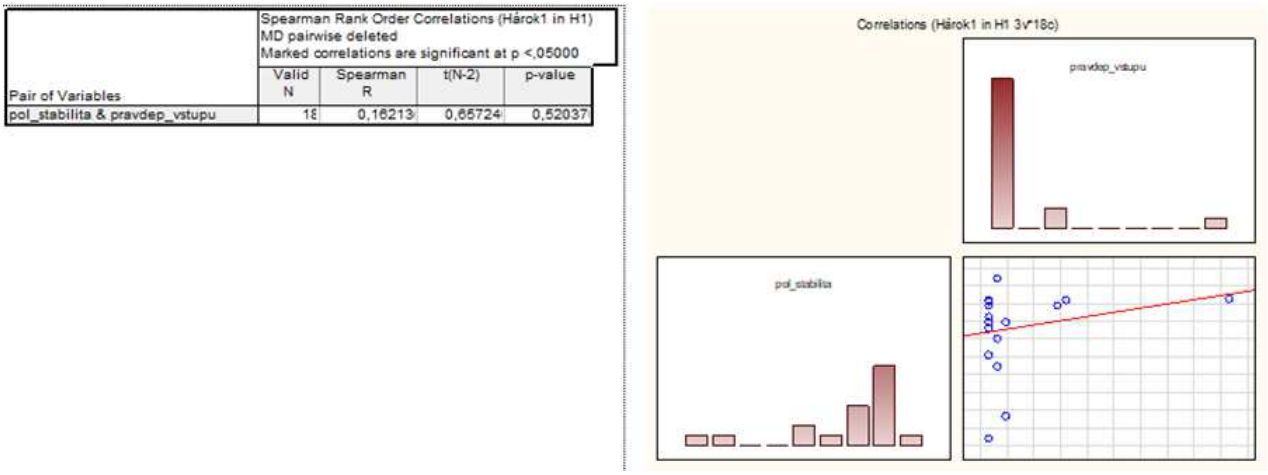
Figure 5. Inflow and outflow of FDI in construction for 2018–2022 (thousands of euros)
Source: own processing according the National Bank of Slovakia (2023)

Another way to analyze the internationalization of construction in Slovakia is through foreign direct investment. Figire 5 shows the inflow and outflow of FDI in the Slovak construction industry from 2018 to 2022 in thousands of euros. If we look at incoming FDI, we see a peak in 2019 of EUR 608,366 thousand. Conversely, the lowest value is understandably in 2021, at EUR 525,568 thousand. We can also see the post-pandemic economic recovery in this indicator, where in 2022 the volume rose to approximately the pre-pandemic level of EUR 572,433 thousand. FDI outflows showed a different trend during the years under review. For the period 2018–2021, we see an increase in outflows to other countries. The peak is reached in 2021, at EUR 168,770 thousand. After the pandemic in 2022, there was a significant decline in outflows of up to EUR 52,226 thousand. As far as FDI flows are concerned, the amount coming into Slovakia is much greater than the amount Slovakia sends out.

Another factor influencing the internationalization of the Slovak construction industry is definitely the movement of labor to and from the country. This indicator is important given the dependence of the construction industry on labor, its impact on the international competitiveness of Slovak companies, and it also serves as an indicator of market attractiveness. The largest number of Slovak construction workers leave to work in the Czech Republic, with as many as 5,711 doing so in 2019. 5,569 Slovaks left to work for foreign construction companies other than Czech ones. 160 people from abroad worked in Slovakia in the construction sector, of which 10 were migrant workers and 150 were refugees. We can see that a large number of Slovaks are leaving to work abroad, which significantly weakens the sector. On the contrary, there are far fewer foreign workers coming to Slovakia. As a result of these phenomena, the Slovak construction industry is struggling with a labor shortage.

As part of the statistical analysis, the questionnaire has been elaborated and sent to 208 companies operating in the construction industry in Slovakia, hypotheses were set and then subsequently verified. The aim of the questionnaire was to gain deeper insight into the factors influencing the internationalization of business in the construction industry, identify obstacles and motivations for companies entering foreign markets, and verify the hypotheses formulated in the theoretical part of the thesis. The set hypotheses discussed the statistically significant correlation between:

- political stability of countries and the likelihood of market entry



Spearman Rank Order Correlations (Hárok1 in H1)
MD pairwise deleted
Marked correlations are significant at p <,05000

Pair of Variables	Valid N	Spearman R	t(N-2)	p-value
pol_stabilita & pravdep_vstupu	18	0,16213	0,65724	0,52037

Figure 6. Evaluation of statistically significant relationship between political stability and market entry
Source: own processing

The study examined 18 countries identified on the basis of a questionnaire and their calculated probability of business entry. The resulting p-value is 0.52, which means that we cannot reject the null hypothesis and therefore there is no statistically significant correlation between the variables (Figure 6).

- financial strength of companies and their ability to expand

Pair of Variables	Valid N	Spearman R	t(N-2)	p-value
fin_sila_trzby & schopn_expandovat	50	0,952185	11,79129	0,000000

Spearman Rank Order Correlations (Hárok1 in H2)
MD pairwise deleted
Marked correlations are significant at p <,05000

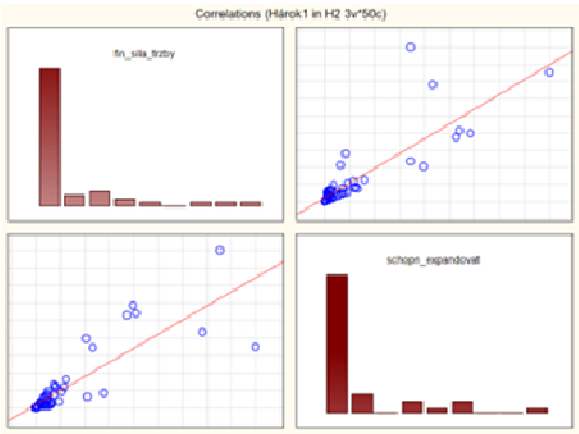


Figure 7. Evaluation of statistically significant relationship between financial strength and ability to expand
Source: own processing

The p-value is 0.00. We can therefore say that there is a significant correlation between the variables – the financial strength of the company and its ability to expand into international markets (Figure 7).

- development of construction material prices and willingness to expand abroad

Pair of Variables	Valid N	Spearman R	t(N-2)	p-value
zmena_trzieb_zahranicie & zmena_materialy	5	0,200000	0,288675	0,8000

Spearman Rank Order Correlations (Hárok1 in H
MD pairwise deleted
Marked correlations are significant at p <,05000

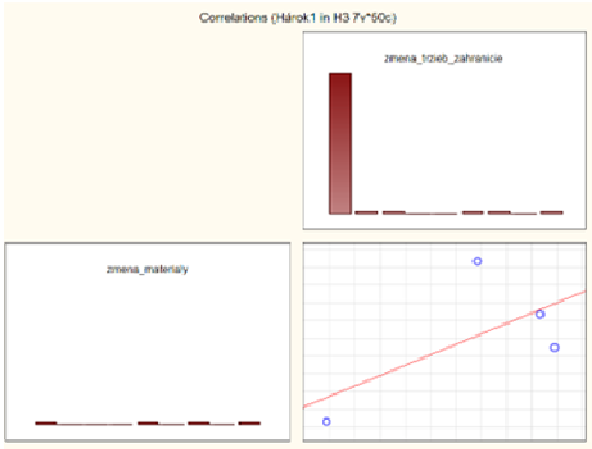


Figure 8. Evaluation of statistically significant relationship between material prices and expanding
Source: own processing

The resulting p-value is 0.8. Based on the test result with a p-value of 0.8, we do not reject the null hypothesis. No statistically significant correlation was found between the development of construction material prices and the willingness of construction companies to expand abroad (Figure 8).

4. Discussion

The development of the Slovak construction sector over the last two decades indicates its sensitivity to economic and political factors, with significant declines caused by the global financial crisis, shortfalls in EU funds, the COVID-19 pandemic, and geopolitical uncertainty resulting from the war in Ukraine. Despite these challenges, the sector is showing signs of recovery and expansion abroad. An analysis of the construction industry in the context of internationalization has shown that it is a stable and important sector of the Slovak economy with high potential for future expansion into foreign markets.

Conclusion

Internationalization currently affects an increasing number of companies from all sectors, including construction. Due to competitive pressure, domestic market saturation, or the need to expand their customer base, the number of companies with links to foreign markets is slowly increasing. Companies in the construction industry are seeking to expand beyond their borders through trade in construction materials, the implementation of projects abroad, investments, and various forms of cooperation with foreign partners. Even though the trend curve for the number of construction companies connected to foreign markets is slowly rising, there is still huge room for improvement in this sector.

Acknowledgements

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Foreign Investment, Legal Barriers, and Housing Policy: Transforming the Slovak Real Estate Market

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Abstract

Research background: Since the political and economic transition of the early 1990s, the Slovak real estate market has undergone significant transformation. Key drivers include foreign direct investment (FDI), changes in property-legal relations, and housing policy reforms. However, persistent issues such as an undersized rental housing sector and unresolved property rights continue to constrain market development.
Purpose of the article: This paper explores the evolution of the Slovak real estate market, focusing on the structural impacts of economic reforms, foreign investment, and policy decisions. Special attention is given to the consequences of housing privatization and the limited development of rental housing.
Methods: A longitudinal, mixed-methods approach was employed, combining macroeconomic and sectoral analyses. Data were drawn from Eurostat, the World Bank, and national sources. Key methods included trend analysis, regional comparisons within the Visegrad Four (V4), and assessments of policy impact and institutional change.
Findings & Value added: The research highlights how FDI, particularly in the automotive sector, has spurred housing demand in industrial regions while contributing to regional disparities. The rapid privatization of housing stock significantly reduced rental availability, constraining housing mobility and affordability. Unresolved property ownership, especially in state-owned assets, continues to impede investment and development. The study offers a comprehensive assessment of the Slovak real estate market's transformation, emphasizing the need for policy reform to enhance rental housing provision, legal clarity, and equitable market development. These findings provide valuable insights for policymakers, urban planners, and investors in post-transition economies.

Keywords: Slovakia, Housing market, Real estate market, Housing development, FDI

JEL classification: F23, R31, R38,

1. Introduction

Slovakia is one of the Visegrad Four (V4) countries (Table 1), whose other countries are the Czech Republic, Hungary and Poland. Over the last 30 years, they have significantly transformed their economies (Fig. 1), which has had significant implications for the real estate market.

Table 1. Geographic information on Visegrad countries (2022)

Country	Surface in kilometers square	Population
Czechia	88,891	10,670,000
Hungary	93,050	9,643,000
Poland	314,400	36,820,000
Slovakia	49,039	5,432,000
Total	**565,630**	**62,565,000**

Source: authors, 2025

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Figure 1. Gross domestic product (GDP) per capita (current million US$) - Slovak Republic, Czechia, Poland, Hungary
Source: World Bank (2025)

During the transition period, the Visegrad Four (V4) governments implemented key legislative reforms across several domains, including the Commercial Code, tax regulations, property registration, and territorial and municipal governance. These reforms significantly stimulated business activity in the real estate sector and enhanced the attractiveness of the V4 economies to foreign direct investment (FDI) (Fig. 2).

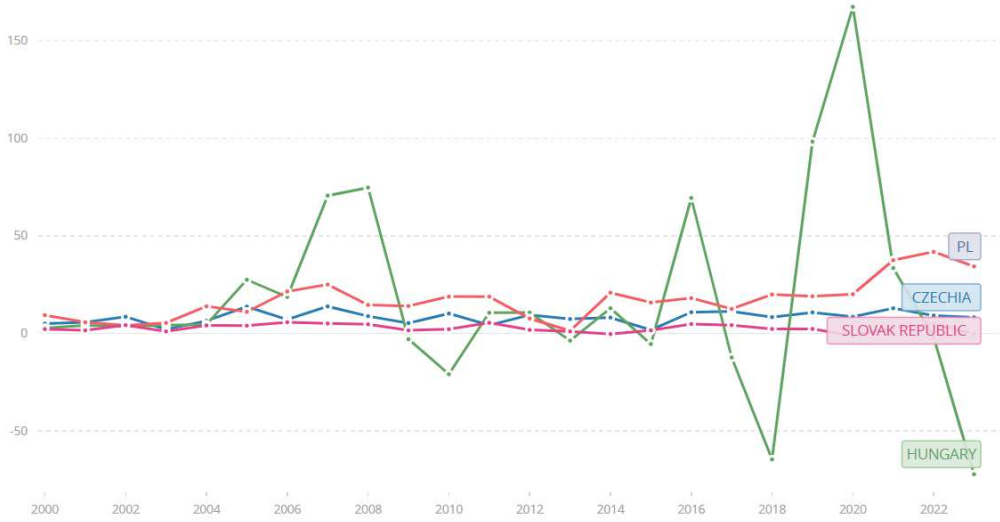

Figure 2. Foreign direct investment, net inflows (% of GDP) - Slovak Republic, Czechia, Poland, Hungary
Source: World Bank (2025)

A pivotal moment in Slovakia's investment landscape occurred in the year 2000, marking a breakthrough in its privatization strategy and its openness to foreign capital. By the end of that year, the stock of foreign direct investment had surged to approximately USD 6.49 billion (EUR 5.9 billion)—nearly double the amount recorded in 1999. This sharp increase underscores how institutional and legislative modernization catalyzed investor confidence, especially among international financial institutions and the banking sector. Slovakia's strategic geographic location, low labor costs, and highly skilled workforce were also decisive factors in attracting foreign capital.

FDI inflows carry considerable macroeconomic significance for host countries. In the short term, they provide essential external financing to offset current account deficits, contributing to currency stability or even appreciation (Altomonte & Resmini, 2001). Over the long term, FDI serves as a vital conduit for the diffusion of new technologies and managerial practices. The early post-transition years

saw the V4 countries enjoy heightened investor interest due to their comparatively higher levels of economic and political stability, accelerated reform efforts, superior economic performance, and advanced development relative to other post-socialist economies.

Scholarly interest in this transformation has coalesced around two principal research streams. One group of experts has concentrated on the role of FDI in economic development (e.g., Pavlínek, 2021; Kosztowniak, 2016; Táncošová, 2019; and Lizińska et al., 2022), while another has focused on the evolution of the real estate market and property price dynamics (Kishor, 2022; Yakubovsky & Zhuk, 2024; Jakimowicz & Kulesza, 2018; and Belej, M and Kulesza, 2020).

2. FDI as a driver of Housing Market development in Slovakia

One of the primary drivers of Slovakia's real estate market—both historically and today—has been substantial foreign investment in the automotive industry (Fig. 3), which remains one of the country's most vital economic sectors. As of 2023, the automotive industry contributes approximately 10.4% to Slovakia's GDP and directly employs around 255,000 individuals (Statistical Office of the Slovak Republic, 2024), underscoring its pivotal role in the national economy.

Slovakia has earned global recognition as one of the leading per capita producers of automobiles, with 198 vehicles manufactured per 1,000 inhabitants, making it the world leader in this metric. Current major foreign investors include Jaguar Land Rover and Volvo, each employing between 4,000 and 5,000 people as of 2023 (Statistical Office of the Slovak Republic, 2024). Moreover, the expansion of the automotive supply chain is expected to generate an additional 22,000 indirect jobs across subcontracting and service sectors.

Since 2000, Slovakia has attracted significant automotive investments from a range of global car manufacturers. These investments have not only advanced industrial development but also exerted a transformative influence on the real estate market, particularly through increased demand for housing in regions hosting automotive plants.

Figure 3. Selected foreign direct investment in Slovakia from 2000 to the present
Source: authors (2025)

The following summary outlines key foreign investments in Slovakia's automotive sector from 2000 to 2024. These data are based on public investment reports, corporate disclosures, and national statistical sources. Where precise figures were unavailable, estimates were derived using incremental trends and reported investment plans.

1. Volkswagen Slovakia

Since the 1990s, Volkswagen has served as a cornerstone of Slovakia's automotive industry. By 2023, its cumulative investments—including expansions, modernization, research and development, logistics, and infrastructure—had exceeded USD 6.05 billion (EUR 5.5 billion) (Statistical Office of the Slovak Republic, 2024).

2. PSA Peugeot Citroën (now Stellantis)

In 2003, PSA began construction of its plant in Trnava with an initial investment of approximately USD 770 million (EUR 700 million). Subsequent expansions and modernizations have raised the total investment to USD 1.32 billion (EUR 1.2 billion).

3. Kia Motors Slovakia

Kia launched its operations in Žilina in 2004, committing an initial USD 1.1 billion (EUR 1.0 billion). Over the years, further investments—particularly in production line expansions—have brought the cumulative total to approximately USD 2.2 billion (EUR 2.0 billion).

4. Jaguar Land Rover

In 2015, Jaguar Land Rover announced a major investment to establish a new manufacturing plant in Nitra. The initial commitment was around USD 1.54 billion (EUR 1.4 billion), with ongoing plans for further capital inflows.

5. Volvo

In 2022, Volvo declared its intention to build a new production facility near Košice, with an estimated initial investment of USD 1.32 billion (EUR 1.2 billion). The plant is expected to be fully operational by 2026.

Table 2 presents a summary of these cumulative investments. According to the authors' consolidated estimates, the total value of automotive industry investments in Slovakia from 2000 to 2024 is approximately USD 12.43 billion (EUR 11.3 billion). This figure encompasses not only factory construction and expansions but also modernization initiatives and research and development activities.

These substantial capital inflows have profoundly influenced Slovakia's economic landscape—driving employment, improving infrastructure, and accelerating growth in both industrial and real estate markets. As a result, Slovakia has emerged as one of Europe's leading automotive hubs.

Table 2. Total investment in the automotive industry from 2000 to the present

Automotive company	Amount of investment (in billions of USD)
Volkswagen Slovakia	6.05
PSA Peugeot Citroën (Stellantis)	1.32
Kia Motors Slovakia	2.2
Jaguar Land Rover	1.54
Volvo	1.32
Total	**12.43**

Source: authors, 2025

The automotive industry significantly influences Slovakia's real estate market through its substantial contributions to GDP, employment, and regional development. As illustrated in Table 2, major investments from companies such as Volkswagen, Kia, and Jaguar Land Rover have generated tens of thousands of direct and indirect jobs. These developments have, in turn, created considerable demand for both residential and commercial real estate—particularly in regions hosting automotive production facilities.

Regional Housing Demand

Cities like Bratislava, Trnava, Žilina, and Nitra have experienced a marked increase in housing demand, especially for rental properties. This surge is largely driven by the need to accommodate factory workers, subcontractors, and professional staff affiliated with automotive plants.

Corporate Housing Requirements

High-profile employers such as Jaguar Land Rover have also spurred demand for premium housing tailored to expatriate managers and specialized personnel. These professionals typically seek centrally located apartments equipped with parking, high-end amenities, and modern furnishings.

Infrastructure and Urban Development

The scale of automotive investments has necessitated substantial upgrades to infrastructure, including roads, public utilities, and transportation networks. These improvements not only support

industrial operations but also enhance the attractiveness of surrounding areas for further residential and commercial development.

In sum, the automotive industry's capital inflows serve as a powerful catalyst for real estate expansion in Slovakia, particularly in municipalities adjacent to major industrial zones. This sectoral synergy continues to play a pivotal role in shaping the spatial and economic landscape of the country (Statistical Office of the Slovak Republic, 2024).

3. Role of the Property Market

In advanced market economies, the real estate market plays a critical role in the allocation and redistribution of land resources, contributing significantly to overall economic prosperity. It serves as a mechanism for accessing real estate assets and offers a wide range of opportunities and choices regarding location, property type, lease conditions, and terms of occupancy across different economic sectors. Consequently, the real estate market is closely interconnected with manufacturing, construction, labor mobility, and broader national economic performance.

Given its deep integration with the functioning of the economy, any imbalance in the development of the real estate sector poses substantial risks to the financial system and economic stability. In mature economies, this systemic importance encourages institutional investors to commit capital to development projects. However, such a conducive economic and institutional environment is still underdeveloped in many post-transition countries, including Slovakia.

Following the political and economic transformation in Slovakia after 1990, significant reforms in property rights legislation were introduced to rectify injustices rooted in the 1948–1989 period. According to Machajdikova (2011), the process required legal mechanisms not only to address historical grievances but also to resolve inconsistencies between de jure and de facto ownership. To this end, the Act on the Regulation of Property Relations concerning Land and Other Agricultural Property was enacted. The Land Act of 1991 defined the categories of persons entitled to property restitution and established a timeframe for submitting supporting documentation. It also introduced the concept of land consolidation—encompassing the merging, subdivision, and legal regularization of land holdings—to reestablish coherent ownership rights.

Among the various components of the real estate market, housing is particularly significant, both economically and socially. It reflects broader patterns of social change and deprivation, and is inherently spatial in nature (Ivanicka, 2004). When making housing investment decisions, households consider multiple factors, including employment opportunities, household income, interest rates on housing loans, labor market status, and existing debt levels (Spirkova, 2018).

Since the early 2000s, the development of Slovakia’s housing market has been strongly influenced by sustained GDP growth, particularly in the industrial, construction, and agricultural sectors. In these areas, economic performance outpaced overall national output. Rising real wages, combined with low interest rates, also contributed to increased household consumption and greater accessibility to credit. These conditions supported both housing demand and broader patterns of consumption through debt-financed living standards.The transformation of Slovakia’s social and political system after 1990, coupled with housing policy reforms, facilitated the introduction of new housing finance mechanisms and significantly improved access to owner-occupied housing—primarily through property purchases and new construction. However, the extensive and often poorly managed privatization of the housing stock between 1992 and 2006 had profound consequences for the structure of the housing market, particularly the rental sector.

During this period, Slovakia experienced a sharp decline in the availability of municipal rental housing. According to historical records from the Ministry of Transport and Construction of the Slovak Republic (2024) and the Statistical Office of the Slovak Republic (2024), the share of municipally owned rental dwellings plummeted from 26.75% in 1991 to just 2.66% in 2006. In contrast, private homeownership surged from 51.13% to 92.21% over the same timeframe, highlighting the dramatic shift toward privatized housing. This data was compiled and analyzed by the authors using reported housing figures and cross-referenced with official annual reports on construction and privatization. Their calculations reflect the structural transformation of housing tenure in Slovakia resulting directly from privatization policies.

In total, approximately 340,000 flats were privatized between 1992 and 2006, leading to a marked reduction in the rental housing stock and reshaping the national housing market (Spirkova et al.,

2017). The long-term effects of this process continue to influence housing accessibility and mobility, particularly for lower-income and younger population groups.

The rental housing sector in the Slovak Republic is significantly undersized compared to the developed countries of Europe (as illustrated in Fig. 4). The shortage of rental housing was and is a consequence of

- the implementation of the inappropriate concept of privatisation of housing,
- problems of economic transformation (slow transformation of the housing sector) - rent deregulation was slow to avoid disturbing social peace,
- inappropriate incentive system for the development of rental housing (no incentives for private rental housing and an unsustainable subsidy system for social housing),
- the lack of tax breaks and favourable credit conditions, especially from commercial banks,
- the absence of non-profit developers on a larger scale, although the legislative preconditions for this are in place.

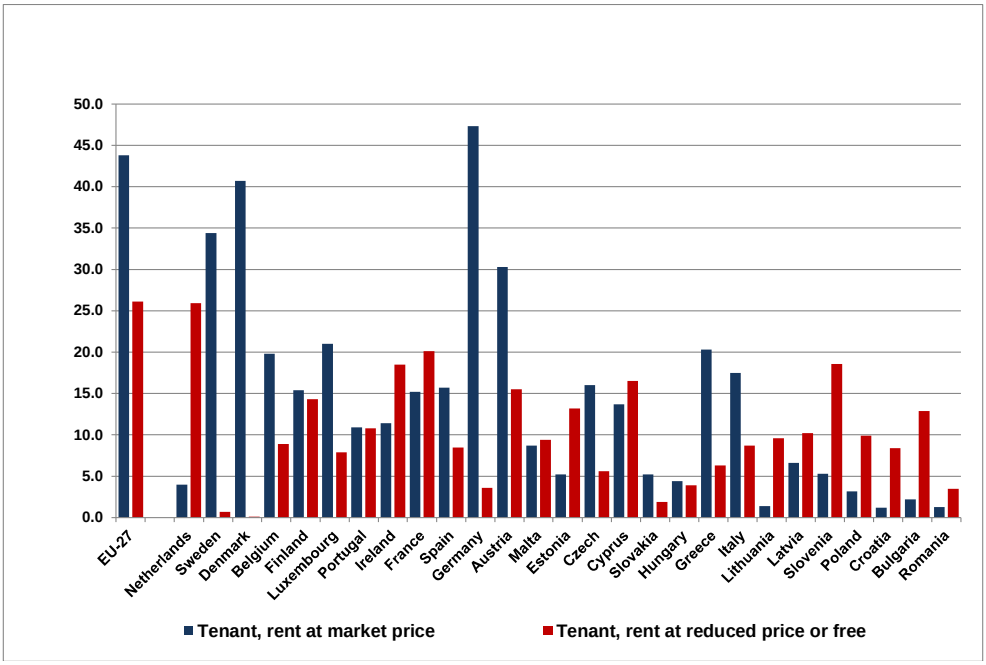

Figure 4. Population share by tenure status in %
Source: Eurostat (2023)

According to Eurostat (2023), rental housing accounts for only 5.2% of Slovakia's total housing stock, with reduced-price or subsidized rentals representing just 1.9%. These figures are markedly below the European Union average, underscoring a significant disparity in housing accessibility across the region. The acute shortage and increasing unaffordability of rental housing have made this issue a growing concern in public discourse and policy debates. Notably, the situation has shown little to no improvement in recent years, despite rising demand.

In addition to supply-side constraints, unresolved property relations pose a substantial barrier to real estate market development in Slovakia. There is currently no unified, comprehensive database covering property ownership across the entire country—only fragmented regional records exist. This lack of transparency primarily affects state-owned properties. In cases where buildings are state-owned but the underlying land has unresolved legal status, complications arise during restitution proceedings. Such legal ambiguities not only delay the settlement of property rights but also hinder investment and create barriers to financial compensation and further development.

4. Methodology and methods

This study employs a comprehensive research design grounded in extensive longitudinal analysis of the real estate market in Slovakia and the broader Visegrad Four (V4) region—comprising the Czech Republic, Poland, Hungary, and Slovakia. The scope spans the political and economic

transformation period from 1989 to the present day (2025). The methodology is structured to investigate both macroeconomic trends and microeconomic specifics that influence Slovakia's housing and real estate sectors, with an emphasis on the country's unique post-transition challenges and structural evolution.

The selected methodological approach is justified by its ability to integrate historical, political, and economic dimensions, thereby providing a holistic understanding of the real estate market's development. The longitudinal aspect enables a deep exploration of systemic transformations such as privatization, legislative reform, and the influx of foreign direct investment (FDI). It captures the critical interplay between policy decisions and market dynamics—an essential factor for contextualizing housing affordability, rental market undersizing, and unresolved property ownership issues.

Additionally, the use of macroeconomic indicators—such as GDP growth and FDI inflows—is complemented by qualitative assessments of legislative and institutional frameworks. The triangulation of multiple credible data sources enhances the robustness and credibility of the study's findings.

Data Sources and Description

This research draws on secondary data collected from reputable national and international institutions to ensure validity and comparability. The key data sources include:

Eurostat – Provides harmonized data on housing tenure, population statistics, and broader economic indicators across EU member states.

World Bank – Supplies longitudinal data on GDP per capita and foreign direct investment inflows.

OECD National Accounts – Offers standardized macroeconomic statistics consistent with international accounting frameworks.

Statistical Office of the Slovak Republic – Delivers region-specific data on housing stock, real estate prices, and demographic trends.

Ministry of Transport and Construction of the Slovak Republic – Contributes data on housing construction, rental housing availability, and legislative reforms.

The compiled dataset includes macro-level variables such as GDP per capita, FDI as a percentage of GDP, and housing construction rates, along with micro-level indicators like housing tenure structure and regional disparities in housing access.

Data Analysis Techniques

The study applies a combination of descriptive and inferential methods to analyze historical patterns, evaluate causal relationships, and forecast potential developments in the Slovak real estate market. The principal analytical techniques are as follows:

Trend Analysis – Examination of long-term data on GDP growth, FDI inflows, and housing construction to identify key inflection points and structural shifts.

Comparative Analysis – Benchmarking Slovakia's housing market against other V4 countries to assess relative performance and distinctive challenges.

Policy Impact Assessment – Evaluation of legislative reforms and their effects on housing access and market stability through case examples and conceptual frameworks.

Sector-Specific Analysis – Focused assessment of how Slovakia's automotive industry, as a major FDI recipient, affects housing demand in regional labor markets.

Quantitative Modeling – Use of basic statistical tools to explore relationships between variables such as household income, credit availability, and housing affordability.

This multi-pronged analytical strategy enables a nuanced interpretation of the real estate market's structural dynamics and policy-driven outcomes.

Discussion on Data and Analysis

The methodological robustness of this study lies in its interdisciplinary approach and reliance on diverse, high-quality data sources. By combining macroeconomic trends with sector-specific insights, the analysis captures the complex interdependencies that characterize Slovakia's real estate market. The study identifies persistent structural issues—including the undersupply of rental housing, fragmented property legislation, and FDI-driven regional disparities—that continue to shape housing

accessibility and affordability. Furthermore, the longitudinal and comparative dimensions of the analysis contextualize these findings within the broader trajectory of post-socialist transformation in the V4 region.

5. Results

Political reforms following the Velvet Revolution in 1989 necessitated wide-ranging adjustments to public administration structures and the implementation of new legislative frameworks. One of the key legal instruments introduced was the **Land Act of 1991**, which aimed to resolve longstanding property rights issues and address historical injustices rooted in the 1948–1989 period (Machajdikova et al., 2011; Ivanicka et al., 2004). Since the establishment of the independent Slovak Republic in 1993, significant changes have been enacted in the housing sector. As in other areas of the economy, housing policy transitioned from a centrally planned rationing system to a market-based framework, emphasizing private ownership and liberalization (Spirkova et al., 2017).

Improvements in the market environment became evident in the mid-2000s through increased housing construction. In 2005, **2.76 apartments per 1,000 inhabitants** were completed—a notable achievement driven by a surge in demand for owner-occupied housing. This high demand was fueled not only by strong economic growth and rising household incomes but also by evolving demographic patterns. The highest number of housing starts—20,592 units—was recorded in 2006, while 14,863 units were completed in 2005, marking the peak of new residential development.

The entry of foreign investors into Slovakia's financial market further catalyzed this growth, fostering innovation in housing finance. Commercial banks began prioritizing investment loans, project financing, and mortgage products aimed at owner-occupied housing construction. While this expanded homeownership, it also contributed to a decline in interest among developers for constructing rental housing, thereby exacerbating supply shortages in the rental sector.

As a result, while the market for luxury housing gradually became saturated, a severe shortage emerged in the segment serving middle-income households, young families, and new employees—particularly in regions experiencing industrial expansion. This imbalance drove subletting prices up by 10–30% in specific localities. For instance, executives from multinational firms like Jaguar Land Rover typically seek high-quality, centrally located, fully furnished apartments with secure parking—further straining supply in urban cores. The demand for two-room apartments is especially intense, often attracting 5 to 20 prospective tenants per unit, highlighting a critical mismatch between supply and demand.

The underdevelopment of the rental housing sector, both public and private, poses a significant barrier to labor mobility and may even contribute to elevated regional unemployment. The availability of rental units, particularly those with regulated rents or affordable market rates, remains acutely limited. According to the 2021 Census of Population, Houses, and Apartments, Slovakia had **2,235,586 dwellings**, of which **1,833,150 were occupied**, representing **82% occupancy**. However, the majority are owner-occupied, with rental options scarce and increasingly unaffordable.

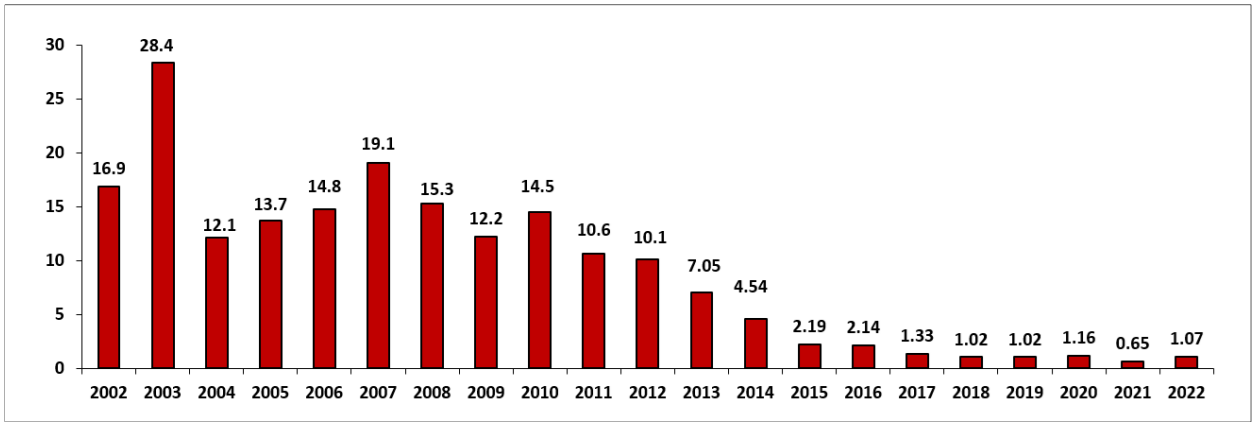

Figure 5. Number of completed dwellings in municipal ownership (rental housing) and their share (%) in the total number of completed dwellings between 2002 and 2022
Source: Ministry of Transport and Construction of the Slovak Republic (2024)

In recent years, rental housing has become a prominent and recurring issue in public discourse, primarily due to the declining affordability of homeownership for a growing segment of the population. One of the primary drivers of this trend is the rapid escalation of housing prices, which continues to outpace income growth and credit accessibility, further limiting options for low- and middle-income groups.

6. Discussion

A key institutional factor influencing the development and effective functioning of the real estate market is the presence of housing organizations. These entities form part of the broader institutional framework and play a crucial role in ensuring housing availability and affordability—particularly in countries where rental housing represents a substantial segment of the housing market. Notable examples include the Netherlands, Sweden, France, and Austria, where rental housing is supported by a robust tradition of non-profit housing organizations (Spirkova et al., 2018). In these countries, non-profit housing providers have historically emerged to address the housing needs of middle- and, more critically, lower-income populations. Their organizational forms are diverse and include limited liability companies, joint-stock corporations, housing cooperatives, foundations, and public benefit institutions. The development of this sector is typically driven by multi-level initiatives—from grassroots movements to external stakeholders and government policies.

Although Slovakia has established the **legal and regulatory framework** necessary for the formation of such organizations, the sector remains underdeveloped. There continues to be a notable **lack of initiative or interest** in founding non-profit housing bodies. This resistance may stem from uncertainty about the viability of these entities or concerns from private developers about potential competition. Nevertheless, such organizations could serve as **innovative development actors** - not only addressing the chronic shortage of rental housing for lower-income groups but also meeting the demand from higher-income demographics, such as expatriate managers employed by multinational firms operating in Slovakia.

Despite Slovakia's well-structured **subsidy mechanisms** to support rental housing construction, through instruments such as the State Housing Development Fund (ŠFRB) and direct grants from the Ministry of Transport and Construction, the emphasis on rental housing has diminished in recent years. Legislation such as **Act No. 443/2010 Coll.** (on subsidies for housing development and social housing) and the Ministry's 2019 decree outlining eligible subsidies and cost limits for rental housing construction remain underutilized.

International experience demonstrates the effectiveness of non-profit housing models in stabilizing rental markets and expanding affordable housing access. In Slovakia, a substantial portion of the population earns regular but insufficient income to meet the costs of high-quality housing. Moreover, **regional disparities in economic development** have led to significant differences in housing affordability across the country. These disparities disproportionately impact lower- and middle-income groups, exacerbating social inequality. The housing market, as currently structured, does not adequately meet the needs of all income groups, and is unlikely to do so in the foreseeable future. In this context, **non-profit housing organizations** could play a transformative role in mitigating housing inequality. They offer a viable solution for various vulnerable groups, including young people, senior citizens, and mobile workers, who require affordable rental options, whether on a temporary or longer-term basis.

Conclusion

This article highlights several critical implications for the real estate market in Slovakia, driven by historical, economic, and policy-related factors:

Impact of Housing Privatization. The large-scale privatization of housing stock (1992–2006) led to a significant reduction in rental housing availability, shifting the market toward owner-occupied properties. This change has restricted mobility and affordability, especially for lower-income and younger populations.

Undersized Rental Market. With only 5.2% of housing stock designated for rental purposes (Eurostat, 2023), Slovakia's rental market is among the smallest in Europe. The lack of rental housing limits workforce mobility, deters foreign investments requiring employee accommodations, and contributes to regional housing disparities.

Unresolved Property Relations. Unclear property ownership, especially in cases involving state-owned properties or land, hampers real estate development. These legal ambiguities often delay projects, discourage private investment, and create inefficiencies in property transactions.

Influence of Economic Growth and FDI. The influx of foreign direct investment, particularly in the automotive sector, has boosted housing demand in industrial hubs like Bratislava, Trnava, and Nitra. While this creates opportunities for real estate development, it has also driven up property prices, exacerbating affordability issues.

Regional Disparities. Economic and infrastructure development concentrated in specific regions has widened the gap between urban and rural areas. Property values and housing accessibility differ significantly, with urban centers experiencing overburdened markets and rural areas facing underutilization.

Need for Policy Reforms. The current housing policies lack adequate incentives for rental housing development and fail to address affordability challenges. Strengthening tax breaks, offering subsidies for non-profit developers, and fostering public-private partnerships could improve market balance.

Workforce Housing Challenges. The mismatch between housing availability and industrial growth has created a gap in mid-tier and rental housing for employees. This shortage risks limiting Slovakia's attractiveness as a destination for further FDI.

The research underscores the interconnectedness of economic policies, housing development, and property market dynamics in Slovakia. Addressing these challenges requires comprehensive reforms, targeted investments in the rental sector, and solutions to unresolved property rights to create a balanced and efficient real estate market.

Acknowledgements

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Employment Preferences of Slovak Economics Students in Domestic and Foreign Labour Markets

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Abstract

Research background: Youth employment remains a key priority on the European Union's political agenda, particularly following the 2008 financial crisis. Despite numerous policy interventions, such as the European Youth Guarantee and vocational training subsidies, young adults continue to face complex challenges during the transition from education to employment. These challenges are formed not only by educational attainment but also by socioeconomic, regional, and cultural factors.
Purpose of the article: Paper map the employment preferences of Slovak university students with economic specialization, focusing on their inclination to work domestically or abroad. The study investigates how individual expectations, social background, and regional context influence decisions regarding employment location.
Methods: The study is based on a quantitative research design using an online questionnaire survey administered to 283 students aged 17–26 from four Slovak universities. The collected data were analyzed using descriptive statistics and binary logistic regression to assess the impact of selected factors on students' preferences for working abroad.
Findings & Value added: The analysis reveals that nearly 40% of respondents prefer employment abroad, driven primarily by perceived lack of career opportunities and professional development in Slovakia. Key predictors of foreign employment preference include skepticism about job availability in one's field, limited career growth, lack of valuable experience domestically, and willingness to relocate. Students from wealthier families are significantly less inclined to seek employment abroad. The study contributes to the understanding of push and pull factors that define employment decisions among young graduates.

Keywords: youth employment, labour migration, school-to-work transition

JEL classification: J61, R23

1. Introduction

The European Union's political agenda has consistently prioritized youth employment, and a focus significantly intensified following the financial crisis of 2008. The European Youth Guarantee stands as a core policy initiative addressing various facets of the "School to Work Transition" for young individuals aged 15–29. While the EU has implemented numerous educational measures and vocational training subsidies to facilitate labour market integration for graduates, these interventions represent only a fraction of the challenges young adults face in their job search (Simões et al., 2022). Education and professional skills are paramount, as increasing educational attainment generally correlates with a reduced likelihood of unemployment. However, an individual's career outlook is also formed by parental, social, and regional factors, often influenced by globalization and persistent structural disparities (Tosun, Arco-Tirado et al., 2019; Štefánik, 2018).

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Despite policy efforts, youth employment in Europe remains uneven across regions, especially in Central and Eastern European countries, where socio-economic fragmentation continues to influence labour market outcomes (Tosun, Hörisch & Marques, 2019). Slovakia is emblematic of these challenges, facing persistent regional disparities and a notable outflow of young, skilled individuals who seek better prospects abroad (Kahanec & Mýtna Kureková, 2016; Richterová et al., 2014). Furthermore, the prevalence of dual labour markets in several European countries, including Slovakia, limits the availability of stable, high-quality entry-level jobs, discouraging long-term career planning among graduates (Cabrales, Dolado, & Mora, 2017). Such migration reflects not only perceived shortcomings in the domestic labour market, such as limited opportunities for advancement or innovation, but also a wider inconsstency between young people's expectations and the realities they encounter after graduation (Drbohlav & Hárs, 2018).

This study explores the factors influencing Slovak university students' employment preferences, particularly their inclination toward working abroad versus domestically. Building on previous theoretical work, we consider how individual expectations, social origin, and regional affiliation define their decisions. We argue that the School to Work Transition process cannot be fully understood without considering institutional, economic, and cultural factors that operate both nationally and internationally. Through a quantitative analysis of responses from 283 students in economic disciplines at four Slovak universities, this paper adds to the literature on youth labour mobility, perceived career security, and the drivers of cross-border employment intentions.

2. Data and Methods

The analytical component of this study is based on a quantitative research design utilizing an online questionnaire survey. The survey was disseminated to respondents via the Kahoot.it and Docs.google.com platforms. The target population comprised young individuals aged 17 to 26 currently enrolled in higher education institutions with an economic specialization in Slovakia. Specifically, participants were drawn from the Technical University of Košice, Matej Bel University in Banská Bystrica, Comenius University in Bratislava, and the University of Žilina.

A total of 283 relevant responses were collected through the questionnaire, with a relatively balanced gender distribution: 139 male respondents (49.12%) and 144 female respondents (50.88%). The survey instrument was divided into two main sections. The first section gathered socio-demographic information pertinent to the respondents' socioeconomic status, including gender, place of study, place of residence, social status, household income, household security, among others. The second section focused on young people's employment preferences. Data were collected on preferred employment location, desired professional field, perceived obstacles in the Slovak labour market, and perceived benefits of working in Slovakia, among other relevant aspects.

The data analysis proceeds in two main stages. Firstly we use descriptive statistical analysis to summarize general employment preferences. This includes preferences for employment location (city vs. village), preferences for working in Slovakia vs. Abroad. Further we apply binary logistic regression to model the likelihood of preferring employment abroad based on a set of explanatory variables. These include professional factors (perceived availability of jobs in one's field, opportunities for career growth), economic and infrastructural conditions (salary levels, quality of public services, willingness to relocate), and control variables (region of residence, family income).

3. Results

The initial descriptive analysis (3.1 Empirical Summary) focuses on preferred employment location, a key aspect given the globalized labour market. For very question, two hypothetical scenarios concerning employment were presented to respondents. Further, regression analysis (3.2 Regresion Analysis) identify the factors influencing respondents' decisions to work abroad.

3.1 Empirical Summary

First question investigates the job location preferences of students, specifically their willingness to accept higher-paying work in a capital city versus lower-paying work in a smaller village (Table 1).

Table 1. Scenario 1: Employment in Bratislava vs. Employment in a smaller town/village

You have just completed your university studies. You have two options:	Count	Percentage
Accept a job in Bratislava or near Bratislava	175	61.84%
Accept a job in a small town/village where the salary is 25% lower and 30 km from a larger city	100	35.34%
No response	8	2.83%
Total	283	100,00 %

Source: Own processing based on questionnaire data

Secondly, respondents were confronted by two choices, examining respondents' preferences between accepting a job in a regional city/its immediate vicinity and accepting a job in a small village/town with a 25% lower salary and a greater distance from a larger city.

Table 2. Scenario 2: Employment in a regional capital vs. employment in a smaller town/village

You have just completed your university studies. You have two options:	Count	Percentage
Accept a job in a regional city or its immediate surroundings (within 10 km)	254	89,75 %
Accept a job in a small town/village where the salary is 25% lower and 30 km from a larger city	28	9,89 %
No response	1	0,35 %
Total	283	100,00 %

Source: Own processing based on questionnaire data

In the second scenario, a substantial majority (89.75%) preferred employment in a regional capital or its immediate vicinity (within 10 km). Only approximately 10% were willing to accept lower-paid work further from a regional or larger city. This indicates that young people generally seek higher-paying jobs after graduation to secure their future and access a wider range of professional and private opportunities. The shift in percentages compared to the first question suggests a general preference for larger cities due to better career prospects, though a notable segment still prioritized staying in their home region over Bratislava, even at the cost of lower remuneration.

The third question, central to our analysis, explored the preference for working domestically or abroad. Respondents choices are in the Table 3.

Table 3. Scenario 3: Employment in Slovakia vs. employment abroad

You have just completed your university studies. You have two options:	Count	Percentage
Employment in Slovakia	172	60.78%
Employment abroad	111	39.22%
Total	283	100.00%

Source: Own processing based on questionnaire data

Nearly 40% of respondents expressed a preference for working abroad. This finding suggests a potential dissatisfaction with current working conditions or opportunities within Slovakia. It implies that foreign employment is highly attractive to a significant portion of the respondents, likely due to higher salaries or enhanced career advancement opportunities. Conversely, 60.78% preferred working domestically, possibly motivated by closer family ties, absence of language barriers, and a general sense of comfort within their home country.

The fourth question examined whether respondents preferred working in Slovakia or in a neighboring EU country (Austria, Czech Republic, Poland, Hungary). Respondents preferences are in the Table 4.

Table 4. Scenario 4: Employment in Slovakia vs. employment in neighboring country

Work in Slovakia or a neighboring EU country	Count	Percentage
Work at home (SK)	164	57,95%
Work in a neighboring country	119	42,05%
Total	283	100,00%

Source: Own processing based on questionnaire data

The distribution of responses shifted slightly, with the demand for foreign work increasing by almost 3%. Approximately 58% preferred working in Slovakia, while 42% opted for a neighboring EU state. This suggests that when considering international employment, respondents frequently favor countries geographically and culturally close to Slovakia, such as the Czech Republic or Austria, due to linguistic and cultural similarities, as well as proximity to family.

3.2 Regression Analysis

The primary objective of the regression analysis was to identify the factors influencing respondents' decisions to work abroad. We deploy binary logistic regression where each coefficient β indicates the strength and direction of the association between the respective independent variable and the likelihood of preferring employment abroad. Regression model has following specification:

$$\left(\frac{Pr\,(Employement\ abroad\,)}{1-Pr\,(Employement\ abroad)}\right) = \beta_0 + \beta_1 Work\ in\ the\ field_i + \beta_2 Career\ growth_i + \beta_3 Valuable\ work\ experience_i + \beta_4 Cost\ of\ living_i + \beta_5 Public\ services_i + \beta_6 Salaries_i + \beta_7 Relocation\ for\ work_i + \beta_8 Poor\ infrastructure_{\ i} + \beta_9 Region\ of\ residence_i + \beta_{10} Family\ income_i$$

where the log-odds of preferring employment abroad are expressed as a linear function of several explanatory variables. These include professional factors such as the opportunity to work in one's field, prospects for career growth, and gaining valuable work experience, as well as economic and infrastructural considerations like cost of living, quality of public services, salary levels, willingness to relocate for work, and perceptions of poor infrastructure. Additionally, the respondent's region of residence and family income are included as control variables. Regresson analysis results are in Table 5.

Table 5. Regression analysis

Variable	Group	B	S.E.	Wald	Sig.	Exp(B)
Intercept		-1.9621	1.0006	3.845	0.0499	0.140
Work in the field	Yes	Reference value				
	No	1.2173	0.4321	7.935	0.00485	3.379
Career growth	Yes	Reference value				
	No	1.4574	0.37	15.525	<0.001	4.293
Valuable work experience	Yes	Reference value				
	No	1.0569	0.3906	7.321	0.00682	2.877
Cost of living	Yes	Reference value				
	No	0.2655	0.3774	0.495	0.48183	1.304
Public services	Yes	Reference value				
	No	-0.7313	0.4008	3.332	0.06807	0.481
Salaries	Yes	Reference value				
	No	0.1898	0.4763	0.158	0.69027	1.209
Relocation for work	Yes	Reference value				
	No	0.8273	0.3485	5.635	0.0176	2.287
Poor infrastructure	Yes	Reference value				
	No	0.6066	0.3491	3.017	0.08232	1.834
Region of residence	Central Slovakia	Reference value				
	Western Slovakia	1.1687	0.609	3.686	0.05497	3.219
	Eastern Slovakia	1.2044	0.4954	5.904	0.01508	3.335
Family income	€0 - €800	Reference value				
	€801 - €1500	0.8879	0.7713	1.325	0.24991	0.412
	€1501+	-1.825	0.7472	5.971	0.01452	0.162

Source: Own processing based on questionnaire data

Regression analysis reveals thay several factors significantly influence students' preferences for employment abroad. The analysis shows that students who do not believe they will find a job in their field of study in Slovakia are 3.38 times more likely to prefer working abroad compared to those who believe they will. Similarly, respondents who do not see suitable opportunities for career

growth in Slovakia are over four times more likely to choose employment abroad. The perception that valuable work experience cannot be gained in Slovakia also significantly increases the likelihood of seeking work abroad, raising the odds by almost 2.88 times. Another significant factor is willingness to relocate for work, students who do not consider relocation within Slovakia a barrier are 2.29 times more likely to prefer employment abroad. Moreover, those who do not consider poor infrastructure as a major barrier are 1.83 times more likely to seek work abroad. Regional differences were also significant, students from Eastern and Western Slovakia are more likely to prefer employment abroad compared to those from Central Slovakia. Finally, students from families with the highest income bracket (€1501+) are significantly less likely to prefer employment abroad, with odds reduced by 84% compared to those from the lowest income group. Regression analysis findings suggest that perceived limitations in the domestic labor market (lack of professional opportunities, career stagnation, and weak infrastructure) are key push factors in students' decisions to seek employment abroad.

4. Discussion

Study found that a significant portion of Slovak university students specializing in economics are inclined to seek employment abroad, driven largely by structural shortcomings within the domestic labour market. The logistic regression analysis confirms that perceptions of limited job availability, lack of career advancement opportunities, and insufficient prospects for gaining valuable work experience in Slovakia serve as strong push factors. These findings are consistent with existing research on youth employment in Europe, where the misalignment between graduate expectations and national labour market realities remains a recurring issue (Tosun et al., 2019; Simões et al., 2022).

An important contribution of this study is its identification of how regional and socioeconomic differences influence employment decisions. Students from Eastern and Western Slovakia showed a higher tendency to consider foreign employment than those from Central Slovakia, which likely reflects regional disparities in economic development and infrastructure. Additionally, the finding that students from higher-income families are less inclined to work abroad may relate to stronger social capital and better access to domestic opportunities. This supports theories suggesting that mobility is not solely a function of ambition but also of perceived necessity (Cabrales et al., 2017).

Furthermore, students expressed a clear preference for employment in larger urban areas over rural regions, accentuationg the importance of urban infrastructure, professional networks, and quality of life in location preferences. This urban bias mirrors extensive European patterns, where cities act as magnets for young talent but simultaneously contribute to regional imbalances.

Conclusion

The results of the study identify the urgency of addressing structural and regional inequalities within the Slovak labour market to improve graduate retention. Policies aimed at increasing the attractiveness of domestic employment opportunities should focus on expanding career development programs, enhancing regional infrastructure, and supporting innovation outside of major urban centers. In particular, targeted support for economically weaker regions may reduce the need for young talent to seek better conditions abroad.

If unaddressed, the current dynamics may reinforce existing trends of brain drain, especially among highly educated youth with strong foreign language skills and international aspirations. Given the cultural and geographic proximity of many EU labour markets, Slovakia remains vulnerable to continued outmigration unless systemic improvements are made. Strengthening links between higher education, regional development, and the labour market should be a core element of future policy strategies to retain qualified graduates and promote inclusive economic growth.

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Analysis of the Cross-Border Mergers and Acquisitions Activity within EEA

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Abstract

Research background: Mergers and acquisitions are a common designation of transactions related to the purchase and sale of companies, parts of companies, assets, shares and business units. Creation of national or international companies linked to the capital brings benefits not only to the stakeholders but also, to a certain extent, to the whole organization and its further sustainability.
Purpose of the article: Since 1990s, the popularity of mergers and acquisitions (M&As) and cross-border M&As has greatly increased thanks to globalization and technological development. The purpose of the paper is to analyze the volume of the realized cross-border M&As within EEA in the monitored period.
Methods: Correspondence analysis was used to acquire the results and define the volume of the implemented cross-border M&As within EEA divided into five intervals.
Findings & Value added: The results of the analysis show that, among the purchasing companies, the lowest implemented M&A volumes were recorded in Malta, Cyprus, Poland and Greece, while the largest volumes in Germany and France. In the group of the purchased companies, the lowest volume of mergers and acquisitions was recorded in Malta and Slovenia, the highest in Luxembourg. These results indicate the necessity to examine and analyze the reasons for these outcomes in further, country-specific detail.

Keywords: Cross-border merger, Cross-border acquisition, EEA, Correspondence analysis

JEL classification: F15, F21, F23

1. Introduction

Cross-border mergers and acquisitions have become the dominant form of foreign direct investment in the world economy over the past three decades (Erel et al., 2022). Progressive globalization is an important factor in the growing importance of cross-border mergers and acquisitions, which can be perceived as one of the main forms of integration that enables companies to create synergies, gain economies of scale, reduce costs, increase market power, and create an overall competitive advantage (Bhagat et al., 2011; Hečková et al., 2016).

Various studies describe M&As transactions to describe the theoretical motives of cross-border M&As as follows: acquisition of production capacity, specific market experience of target enterprises, strategic motives of cross-border trading companies within the oligopoly, and the ability of some multinationals to better control or manage specific countries (Hyun and Kim, 2010). The following section will examine the theoretical framework of the issue at hand, which will serve as a base for the subsequent analysis of the cross-border M&A activity in European Economic Area, particularly during the period of 1998-2022, when M&As had undergone a turbulent, active era.

Raff et al. (2007) and Neary (2007) classify merger and acquisition motives into the following groups:

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- companies with a high Tobin Q-index are those which have the best technology and seek opportunities to expand their share capital;
- efficiency gains increase as takeovers increase economies of scale or bring other synergies in the form of tax incentives;
- strategic increments increase when cross-border mergers and acquisitions change the structure of the market, the competitive position, and the level of profit by creating monopolies or oligopolies;
- building "empires" allows to diversify and hedge against shocks in the particular sector;
- managers may be motivated by managerial compensations or their own decisions.

Mergers and acquisitions are a common designation of transactions related to the purchase and sale of companies, parts of companies, assets, shares and business units. Creation of national or international companies linked to the capital brings benefits not only to the stakeholders but also, to a certain extent, to the whole organization and its further sustainability (Trąpczyński et al., 2018; Frankovský et al., 2019).

The four most commonly used indicators of acquisition performance are: (1) cumulative abnormal returns, (2) divestment data, (3) managers' assessments, and (4) expert informants' assessments (Schoenberg 2006).

The acquisition of companies by means of mergers and acquisitions is considered to be a dynamic process (Georgopoulos et al. 2008) and, at the same time, one of the most risky capital interconnection processes undertaken by companies (Boubakri et al., 2012; Alexandrou et al., 2014).

According to Sharma and Raat (2016), the motivation for mergers and acquisitions varies considerably, depending on the particular business, the industry, the current economic environment and other influencing factors. De Pamphilis (2015) states that the main advantage of cross-border mergers and acquisitions is the provision of foreign market access, while domestic mergers and acquisitions reduce the competitive pressure on the domestic market.

A favorable regulatory environment, a more stable political background in the host country, low foreign tax rates, cultural differences, geographical and country-level governance differences are considered important motives for cross-border M&As (Šoltés and Gavurová, 2014). Zhu et al. (2014) consider strategic market entry as the main motivation for cross-border mergers and acquisitions. Mergers and acquisitions are seen as a fast way to enter a new market in a new country and the authors state that the acquirer enters the market across borders by acquiring an already established trading company. In this way, the acquirer can use distribution channels, a proven brand name, a qualified workforce, management experience and local knowledge. Cross-border mergers and acquisitions give companies access to resources that may not be available in their domestic economy, thus enhancing their ability to be competitive (Rani et al., 2016).

Mergers and acquisitions can reduce operating and transaction costs, improve efficiency and improve resource dependency management. They are primarily driven by the interest of the trading company management itself (Guadalupe et al., 2012). The Central and Eastern European markets are becoming increasingly attractive to merger or acquisition connections as they offer high profit margins, low wages and cheap labor costs Eurostat (2016). In addition, there are specific and very favorable conditions for investment in the last countries to have joined the Union. Recent research by Chapčáková et al. (2022) demonstrates that the deepening of European integration, the expansion of the European Union, and the creation of the European Monetary Union (EMU) have significantly contributed to the increase in cross-border M&A activity within the European area. The introduction of the euro, liberalization of trade and investment regimes, and regulatory harmonization have created a more homogeneous business environment, facilitating capital reallocation through cross-border mergers and acquisitions.

2. Methodology and Structure of Used Data

The main aim of the paper is to analyze the volume of implemented cross-border mergers and acquisitions divided according to the European Union countries in the monitored period of 1998-2022. The analysis is divided into two parts. In the first part we monitor those Member States of the European Union, which initiated implementation of cross-border mergers and acquisitions most frequently, and the volume of their implementation. In the second part we analyze those Member

States of the European Union which were most often targeted by cross-border mergers and acquisitions, and in what volume they were carried out. We conducted the analysis for the aforementioned period of 1998-2022.

In both parts of the analysis, we focused on an identification of the countries where M&As were similar in their volumes. Correspondence analysis was used to acquire the results and define the volume of the implemented cross-border mergers and acquisitions in the individual Member States of the European Union divided into five intervals.

For the purposes of the analysis, a database containing records of cross-border mergers and acquisitions carried out in the European Economic Area (EEA) and in Turkey, the data of which were taken from the Zephyr database Bureau van Dijk (2023), was used. Our database includes data on mergers and acquisitions carried out from 16 source countries[1] to 25 target countries[2] in the selected production[3] and service[4]sectors. MS Excel and SPSS statistical software were used to process the analysis results.

3. Data Analysis and Results

The analysis focuses on the determination of the volume of cross-border mergers and acquisitions (hereinafter as M&A) by countries within EU during the period of 1998-2022. Figure 1 depicts the evolution of total volume of M&As during this period.

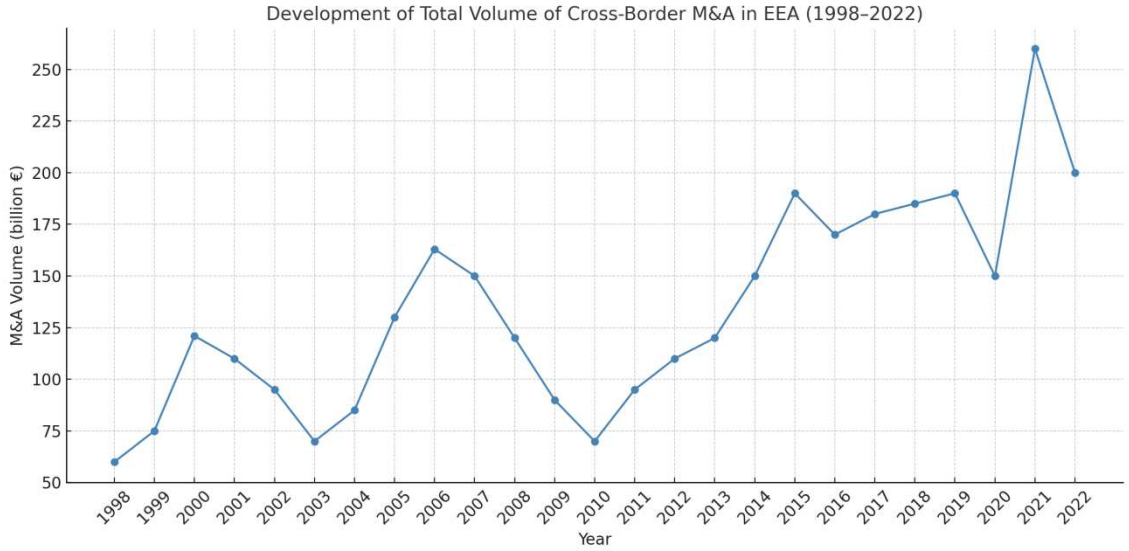

Figure 1. Development of Total Volume of Cross-Border M&A in EEA (1998–2022)
Source: own processing based on Zephyr and Orbit databases (Bureau van Dijk, 2023)

Our analysis is divided into two parts. Firstly, we are interested in the amount of cross-border M&As in the source countries, where the enterprises purchasing other enterprises are based. Secondly, we are interested in the countries, where the purchased enterprises are based. In both cases, we try to identify the countries in which cross-border M&As are similar in their volumes. We use correspondence analysis to reveal the relationship between the countries and the total summary of cross-border mergers and acquisitions during the mentioned period. Correspondence analysis is a

[1] Belgium, Republic of Cyprus, Denmark, Finland, France, Greece, Netherlands, Luxembourg, Republic of Malta, Federal Republic of Germany, Republic of Poland, Portuguese Republic, Republic of Austria, Spain, Italy, United Kingdom

[2] Belgium, Republic of Bulgaria, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Netherlands, Republic of Lithuania, Republic of Latvia, Luxembourg, Hungary, Republic of Malta, Federal Republic of Germany, Portuguese Republic, Republic of Austria, Romania, Slovak Republic, Republic of Slovenia, Spain, Italy, Turkey, United Kingdom

[3] Food, Beverages, Tobacco, Textiles, Clothing, Leather, Chemicals, Rubber, Plastics, Non-Metallic Products, Metals and Metal Products, Machinery, Equipment, Furniture, Recycling, Gas, Water, Electricity, Construction

[4] Transportation, Hotels and Restaurants, Post and Telecommunications, Insurance, Banking

statistical technique that provides a graphical representation of cross-tabulations. It is an exploratory technique designed to analyze data in the pivot tables, while its aim is to reduce dimensionality. It provides a measure of correspondence between rows and columns of a pivot table, and allows studying the relationships between two categorical variables. Correspondence analysis is also useful in cases when the graphical output is clearer than the numeric outputs. Outputs of correspondence analysis are similar in its nature to results of a factor analysis. A correspondence analysis output is represented by a two-dimensional graph, a so-called correspondence map.

We note that evolution of the total volume of cross-border M&As hit its peaks and bottoms. Peaks were reached in the years of 2000, 2006, 2015 and 2021. This development was due to the results of the analyses reported in Bureau van Dijk's annual reports (2000, 2006) from 2000 to 2006 by a gradual deregulation of the market and a simultaneous increase in internet penetration within the area in question, causing the cross-border mergers and acquisitions between 2000 and 2006 record their highest value of the implemented volume in the sectors of Telecommunications, Media and IT. The $2.95 trillion M&A record of 2000 was surpassed in 2006, when 29,000 M&A amounting to $3.8 trillion were carried out worldwide, with an emphasis on EEA, representing a 10% increase over 2000. In the examined European area in 2000, 1,987 mergers and acquisitions worth $121 billion were carried out, and in 2006, 2,527 mergers and acquisitions worth $163 billion were implemented. In addition, in the period of 2000-2006, the stock market trend was increasing, thus significantly improving the financing of investments and, at the same time, achieving a relatively high profitability of trading companies. This was reflected in the increase in capital reallocation through mergers and acquisitions both worldwide and in the European area, with their peak in 2006. Contrarily, minimal values of the cross-border M&A amounts were attained in 2003 and 2010. At the beginning of 2003, the cross-border M&A activity decrease was linked to the “dot-com bubble” (internet stock bubble). The internet stock bubble is a term for a period during which the value of the so-called dot-com internet businesses (using the .com domain) rose sharply. After cooling, the value dropped sharply and many companies went bankrupt.

The latent sources of the financial crisis (Mikušová and Horváthová, 2012) had not yet been made explicit by 2007. The fall in share prices led to a decrease in the value of cross-border M&As transactions. Serious economic instability in 2009 (not only in the Eurozone countries) dampened the acquisition appetite of strategic investors. The global M&A activity fell by 22% to $2.3 trillion in 2009, compared to $2.94 trillion in 2008. The decline in cross-border M&As transactions was significantly affected by a reduction in national GDP of the individual countries, global financial instability, a decline in oil prices, and deterioration in export prospects. After 2015, the EEA M&A market experienced a period of stabilization and moderate growth, with annual volumes ranging from €160–190 billion. The covid-19 pandemic in 2020 led to a temporary decline of 15–20% in transaction value. However, 2021 saw a record surge in M&A activity, driven by low interest rates, accumulated investment capital, and increased activity in private equity and technology sectors. In 2022, the volume dropped by approximately 20–25% due to the impact of the war in Ukraine, inflation, and tightening financial conditions. The findings of Chapčáková et al. (2022) also provide detailed evidence on the direction and volume of cross-border M&A flows. For example, the United Kingdom, France, the Netherlands, and Germany were the most important source countries, with France recording the largest financial volume of outbound M&As (€80.7 billion). On the target side, France, Germany, and Spain attracted the highest volumes of inbound M&As, with France as a target country receiving €56.3 billion in cross-border transactions. These patterns underline the dominant role of large and developed economies in European M&A activity

3.1 Purchasing enterprises – M&As volumes

For purposes of this analysis, we scale the summary of cross-border M&A volumes into 5 intervals. Using binning, we define 5 intervals of cross-border M&A volumes with similar frequencies, which are:

1. (≤ €2,619,000),
2. (€2,620,000 – €8,975,000),
3. (€8,976,000 – €28,000,000),
4. (€28,001,000 – €130,000,000),
5. (€130,001,000 ≤).

Every interval contains about 1,160 observations.

An interesting fact about purchasing enterprises is that only the enterprises from the 16 EU countries are performing cross-border M&A. Table 1 contains details of correspondence analysis. A Chi-square test is designed to analyze categorical data. That means that the data has been counted and divided into categories. Pearson's chi-squared test is a statistical test applied to sets of categorical data to evaluate how likely it is that any observed difference between the sets arose by chance. Categorical data is statistical data consisting of categorical variables (a variable that can take on one of the limited possible values). Pearson's chi-square test p-value is 0.000 (column Sig.), thus we reject the null hypothesis of non-dependence of data and we suppose that there exists the dependence between the data – country of origin and cross-border M&A volume. The first dimension of the analysis captures 67.7% of inertia, and the second dimension captures 19.2% of inertia. Total inertia captured by correspondence analysis is 86.9% (column Proportion of Inertia/Cumulative), thus our model is satisfactory.

Table 1. Correspondence analysis – Purchasing enterprises

Dimension	Singular Value	Inertia	Chi Square	Sig.	Proportion of Inertia		Confidence Singular Value	
					Accounted for	Cumulative	SD	Correlation 2
1	.199	.040			.677	.677	.013	.113
2	.106	.011			.192	.869	.013	
3	.072	.005			.089	.958		
4	.050	.002			.042	1.000		
Total		.058	340.480	.000[a]	1.000	1.000		

a. 60 degrees of freedom

Source: own processing

Figure 2 illustrates correspondence analysis of volume of purchasing cross-border M&A in the respective countries. We note that the lowest volumes of cross-border M&A s(≤ €2,619,000) weakly correspond with the enterprises from Malta, Cyprus, Poland and Greece. Volumes of the cross-border M&A from the second interval (€2,620,000 – €8,975,000) can be found most often in the United Kingdom. Cross-border M&A volumes from the next interval (€8,976,000 – €28,000,000) correspond with the companies from Finland and Denmark. Enterprises from Austria, Italy and Spain implement cross-border M&A most frequently in the volumes from the fourth interval (€28,001,000 – €130,000,000). Enterprises from Germany and France correspond with the cross-border M&As volumes which are higher than €130,001,000.

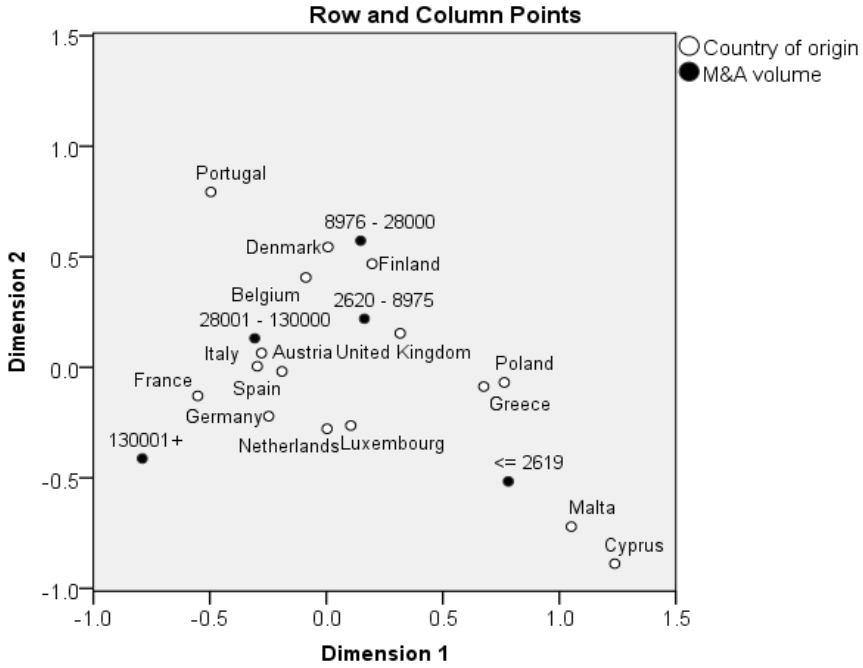

Figure 2. Correspondence analysis – Purchasing enterprises

Source: own processing

3.2 Purchased enterprises – M&A volumes

In terms of the purchased enterprises, we observe cross-border M&A in all counties of EU + Turkey. Table 2 contains properties of correspondence analysis. Pearson's chi-square test p-value is 0.000 (column Sig.), what leads us to rejection of the null hypothesis of non-dependence of data, and we suppose that there exists the dependence between the variables – target country and cross-border M&A volume. Total inertia captured by correspondence analysis is 86.6% (column Proportion of Inertia/Cumulative), thus our model can be seen as satisfactory.

Table 2. Correspondence analysis – Purchased enterprises

Dimension	Singular Value	Inertia	Chi Square	Sig.	Proportion of Inertia		Confidence Singular Value	
					Accounted for	Cumulative	SD	Correlation
								2
1	.258	.066			.729	.729	.015	.093
2	.112	.012			.137	.866	.013	
3	.079	.006			.069	.935		
4	.077	.006			.065	1.000		
Total		.091	530.351	.000a	1.000	1.000		

a. 96 degrees of freedom

Source: own processing

Figure 3 contains correspondence analysis of the volume of cross-border M&A in the target countries.

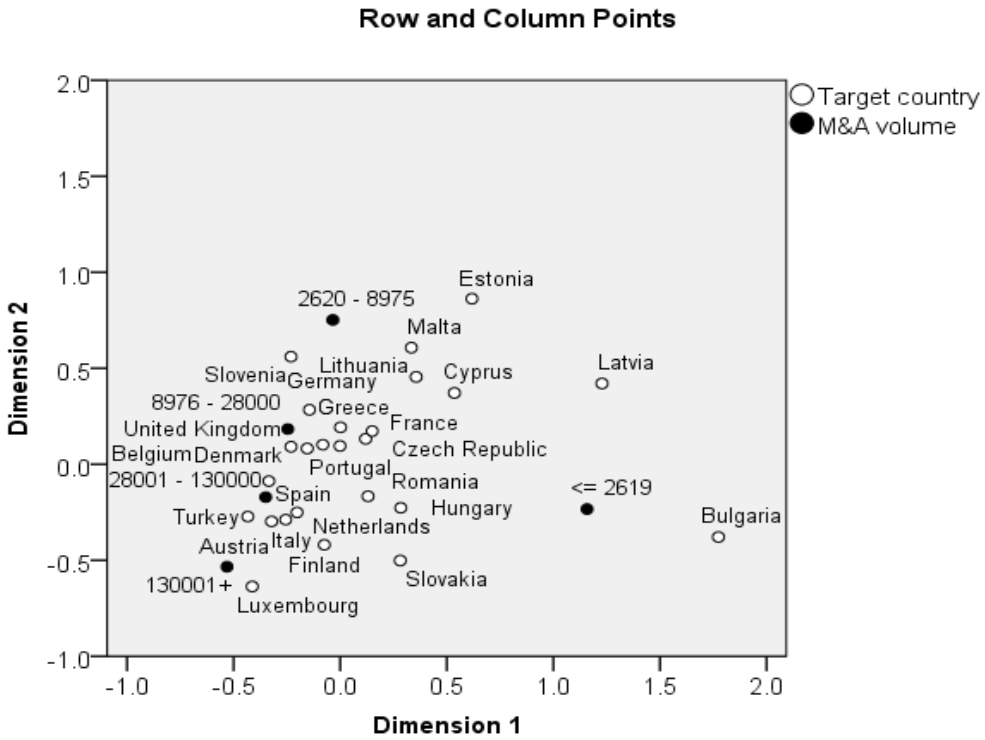

Figure 3. Correspondence analysis – Purchased enterprises

Source: own processing

We observe some clusters formed by the target countries of cross-border M&A and the volumes of M&A. No specific country is strongly associated with cross-border M&A volumes from the first interval (≤ €2,619,000). Cross-border M&A volumes from the next interval (€2,620,000 – €8,975,000) are mostly present in Malta and Slovenia. Cross-border M&A volumes from the third interval (€8,976,000 – €28,000,000) were carried out most frequently in Greece, France, Czech Republic, Portugal, Denmark, Belgium and United Kingdom. Cross-border M&A with the volumes from the

fourth interval (€28,001,000 – €130,000,000) were seen during 1998-2022 in Spain, Turkey, Italy and Netherlands. Cross-border M&A with the volume bigger than €130,001,000 relatively closely corresponds with Luxembourgian enterprises.

4. Discussion and Conclusions

Ease of access, more information, or the unity of standards, norms and rules of the European market have contributed to increased tendencies of M&A investment among EU Member States. The most important reasons for M&As in the period under review were the restructuring of entities, the improvement of the balance of payments, and the acquisition of a larger market share. Mergers and acquisitions are complex and demanding processes, both legally and economically. A merger is preceded by an evaluation of the value of the participating companies, their liabilities, indebtedness, and other determinants that will reveal whether or not the planned merger or acquisition is beneficial. The main objective of the paper, based on correspondence analysis, was to analyze the volume of cross-border mergers in the Member States of the European Area in the period of 1998-2022, which was monitored in the target and the source countries of the European Area. Using correspondence analysis, we have divided the volume of the implemented cross-border mergers and acquisitions into five intervals for which the following values apply: (≤ €2,619,000), (€2,620,000 – €8,975,000), (€8,976,000 – €28,000,000), (€28,001,000 – €130,000,000), and (€130,001,000 ≤).

Based on the results of the analysis, the lowest implemented M&As volumes were recorded in Malta, Cyprus, Poland and Greece among the purchasing companies. Their value was less than or equal to €2,619,000. The largest volumes of mergers and acquisitions were recorded in Germany and France. Their value was over €130,001,000. This stems from the basic assumption that in an economy that is in a growth phase, individual entities are able to accumulate a larger volume of capital resulting from its higher evaluation, which may be the result of an increased consumption of entities on the domestic market, or by increasing the demand on foreign markets (competitiveness increase). Mergers and acquisitions in Germany and France within the countries of the European area were the best option for companies in the reporting period of 1998-2022 to gain a significant market position. In the case of the purchased companies, the highest volume of mergers and acquisitions was in Luxembourg with a value equal to or greater than €130,001,000.

In the period of 1998-2022, the purchased companies were affected by the transformation of economies into a market economy, which led to more intensive redemptions of companies, which could pose a competitive risk in the future (they had not yet been restructured and the production processes had not been streamlined) and a relatively low market valuation at the time, particularly from the perspective of the acquiring country. The lowest volume of mergers and acquisitions was in Malta and Slovenia in the reporting period, amounting to €2,620,000 – €8,975,000. From the results of the analysis we can conclude that neither country achieved the same volume of mergers and acquisitions, which applies both to the target and the source countries. The incentive for businesses to carry out mergers and acquisitions within the European Union is consistent with efforts to strengthen their position in one of the largest common markets. This is mainly related to the uniform compliance with standards and the compatibility of permits between the Member States of the Union, or better awareness of all essential requirements.

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Analysis of Performance Indicators of Small and Medium-sized Enterprises in the European Union

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Abstract

Research background: Small and medium-sized enterprises are key employers in all Member States of the European Union. In Slovakia, they are also crucial for economic performance, job creation, and value-added. For the European industrial strategy of progress and advancement, SMEs represent a key tool for innovation in many sectors across the economy.
Purpose of the article: SMEs were the largest employers in the European Union in 2023. The sectors with the largest number of employees also produced the largest share of value added. The article aims to examine the status and development of selected indicators on small and medium-sized enterprises in the European Union and Slovakia. It will bring new insights, reveal problem areas, and propose solutions in the subject area.
Methods: Secondary data obtained from databases, reports, and studies dealing with the issue of small and medium-sized enterprises will serve as a basis for the analysis of selected indicators for recent years. The result´s comparison in space and time will provide the opportunity to monitor the status and development of SME indicators.
Findings & Value added: SME´s support and financing is a matter of survival for each individual economy and the economy of the entire integration group. It is necessary to focus economic and political efforts on the part of government authorities on their constant encouragement so that they can survive even in times of crisis and ensure stability in economic development and employment.

Keywords: Small and Medium-sized enterprises, European union, Net turnover

JEL classification: E24, E32

1. Introduction

The COVID-19 pandemic profoundly impacted every European country and its economy. While measures to save lives and protect health were essential, they inevitably led to significant economic repercussions. The longer these restrictive measures persisted, the more challenging it became for businesses across various sectors to endure their effects. Interestingly, large businesses and micro-enterprises appeared to demonstrate the greatest resilience during this period, relatively quickly returning to their original levels of production, sales, or service provision once the pandemic subsided.

This paper aims to examine and evaluate the status and development of small and medium-sized enterprises (SMEs) within the European Union over the past three years. Despite traditional significant regional disparities in economic performance and indicators, SMEs remain indispensable entities across all Member States. They are vital employers, generate substantial added value, and fulfil demand for a wide array of specific goods and services.

The existence and prosperity of SMEs are influenced by numerous factors, both anticipated and unpredictable. Supporting and financing small and medium-sized enterprises, though often less publicized than efforts for large corporations and investors, is a crucial responsibility for authorities. Such support drives innovation, fosters progress, creates jobs, and delivers considerable added value to regional, national, and the broader European economy.

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2. Theoretical background

In 2023, SMEs accounted for 99.8% of all companies and 53.3% of added value. SMEs are the backbone of the EU labour market, employing a large share of the workforce. In 2023, 26 million SMEs employed around 89 million workers in the European Union. (Shultze et al., 2025) This fact evidences how these companies are crucial to the global economy. SMEs are characterized by close relationships with customers, employees, and suppliers (Mayr et al., 2017), and this proximity allied to entrepreneurship favours the long-term competitiveness of these companies. (Pérez-Luño et al., 2016)

SMEs are at the heart of innovation and entrepreneurship. The ideas and solutions of 26 million entrepreneurs, women and men, contribute to a sustainable and digital economy, central to Europe's competitiveness. The European Commission is committed to supporting enterprises from the moment they start, throughout their lifetime. (Dachs et al., 2022)

European Commission Recommendation 2003/361 defines small and medium-sized enterprises as companies whose number of employees and economic weight do not exceed certain thresholds.

A medium-sized enterprise has no more than 250 employees, a turnover of no more than EUR 50 million, and a balance sheet not exceeding EUR 43 million. A small enterprise has no more than 50 employees and a turnover or balance sheet of no more than EUR 10 million. A micro-enterprise has no more than 10 employees and a turnover or balance sheet of no more than EUR 2 million. (European Commission, 2025)

Over 26 million SMEs operate in the European Union, representing 99% of all enterprises and providing two-thirds of private sector jobs. They are a key driver of the economy.

The EU encourages the use of this definition of SMEs as a reference, including by EU Member States. Furthermore, the definition is only binding for particular areas, such as State aid and the implementation of Structural Funds or other EU programs. (Ploeger & Prutch, 2025)

There are various EU programs to support work on SME-related issues, notably the Single Market Programme.

Small and midsize enterprises can exist in almost any industry but are more likely to operate within industries with fewer employees and smaller up-front capital investments. The most common types of SMEs include legal firms, dental offices, restaurants, and bars.

SMEs are segregated from large, multinational corporations because they fundamentally operate differently. Large, complex firms may require advanced enterprise resource planning (ERP) systems—for accounting, supply chain management and financial reporting, and interconnectivity across offices around the world—or deeper organizational processes. SMEs, on the other hand, may require fewer systems given their narrower scope of operations.

Small businesses also have distinct advantages over larger companies (Liberto, 2025):

- SMEs can often operate more flexibly. Large companies with broader processes touching more employees may find it more difficult to act as nimbly.
- SMEs often garner a stronger sense of community. Slogans such as "shop local" are geared toward supporting SMEs that don't have branches across the nation.
- SMEs are more likely to financially support their community. Instead of collecting revenue and investing it in a new store across the country, SMEs are more likely to remain local, sustain local businesses, contribute local tax dollars, and buy from nearby suppliers.
- SMEs may be engrained with a rich history. Larger, complex companies may have a long history as well (especially if they've been financially successful). However, SMEs are more likely to carry family traditions, preserve how generations have done things, and pass down the family business.
- SMEs may have a narrower, more direct focus than larger businesses. Think of Apple (AAPL). Developing iPhones, iPads, Macs, Apple Watches, accessories, and streaming services requires the staff to support each of these departments. However, an SME with limited staff must limit the scope of what it offers. Instead of attempting to have a broad market presence, successful SMEs often deeply integrate themselves into a smaller target market.

Forecasting key financial indicators of enterprises such as revenues, costs, and profitability is critical for setting the right corporate strategies, achieving long-term stability, and ensuring the competitiveness of businesses. Profit forecasting is essential for managing cash flow, ensuring

liquidity, and evaluating business strategy. (Jenčová et al., 2025) If the business achieves a negative Economic Value Added, it is inefficient and may have competitiveness problems due to problems with its performance. (Horváthová & Mokrišová, 2020)

The competitiveness of companies is determined by institutions, policies and other factors, determining their continued presence in the market, profitability and ability to adapt production to demand. (Chao et al., 2015) In Small and Medium Sized Enterprises focused on high technology launching new products is an important way to maintain their competitive advantage (Pan et al., 2018). It can be noticed that several factors influence in the competitiveness of companies and it is important to determine these factors and the areas in which they can gain competitive advantage. The strength of organizations is determined by their competitiveness and the strategies they adopt to gain competitive advantage and strengthen their positions in the market (Nara et al., 2015)

3. Methods

The European Statistical Office database contains data on small and medium-sized enterprises by number of persons employed. The data in the tables have been aggregated, analysed over time and space, and converted into relative units for relevant comparison. To calculate the average trend indicator, we used the *Average Annual Growth Rate (AAGR)*. It is determined by taking the numerical mean of specified or calculated year-on-year growth rates. The formula is following:

$$\mathrm{AAGR} = \frac{[(Growth\ Rate)y + (Growth\ Rate)y + 1 + \cdots (Growth\ Rate)y + n]}{N(1)}$$

Where:
Growth Rate (y) – Growth rate in year 1
Growth Rate (y + 1) – Growth rate in the next year
Growth Rate (y + n) – Growth rate in the year "n"
N – Total number of periods

Since practical data mining problems high-dimensional data are clustered, the resulting clusters are high-dimensional geometrical objects which are difficult to analyse and interpret. A low-dimensional graphical representation of the clusters could be much more informative than such a single value of the cluster validity one can cluster by eye and qualitatively validate conclusions drawn from clustering algorithms. (Abonyi and Balázs, 2007, Ward, 1963)

We have used the non-hierarchical K-means clustering method to cluster countries. A significant part of these degrees of similarity is based on the calculation of the distance between objects. (Meloun et al.,2012) The Euclidean distance we used is defined by the formula:

$$\mathrm{d}_{ij} = \sqrt{\sum_{k=1}^{K} \left(x_{ik} - x_{jk}\right)^2}$$

Where x_{ik} is the value of k variable for *i-th* object and x_{jk} is the value of k variable for *j-th* object. For calculated distance is than determined the rule of linking statistical units into clusters.

4. Results and Discussion

The EU-27 gross domestic product increased by 0.5% in 2023 compared to the previous year. Growth was moderate, especially compared to 2021 (6%) and 2022 (3.4%) when the economic recovery after the pandemic was still relatively strong. The period between 2021 and 2023 presented a challenging economic environment, characterized by significant uncertainties. This naturally influenced SME access to financing and overall performance. Rising inflation emerged as a primary challenge. Although nominal value added increased in 2023, all SME size classes experienced a real-term decline. Micro-enterprises demonstrated the most resilience, likely due to their enhanced flexibility in adapting to macroeconomic shifts and quicker recovery from shocks compared to larger firms. Small enterprises recorded the most significant decrease in value added (-2.4%), with SMEs collectively experiencing a more pronounced decline (-1.6%) than large enterprises (-1.1%).

Conversely, employment maintained a positive growth rate, with micro-enterprises again showing the highest growth among SMEs. The number of enterprises also increased across all monitored categories, extending the trend observed in 2022.

Table 1. Number of SMEs in the EU-27 (industry, construction and market services)

GEO/TIME	2021	2022	2023	Trend	AAGR	0 to 9 persons SMEs (2023)	50 to 249 persons SMEs (2023)	Number of SMEs to population (2023)
Belgium	841 714	887 433	875 570	▁▇▅	1,0199	96,13%	0,65%	0,07
Bulgaria	381 336	393 368	404 886	▁▅▇	1,0304	92,59%	1,11%	0,06
Czechia	1 252 393	1 290 669	1 308 559	▁▅▇	1,0222	96,60%	0,58%	0,12
Denmark	360 027	379 316	382 289	▁▇▇	1,0305	91,97%	1,28%	0,06
Germany	3 140 490	3 145 455	3 183 601	▁▁▇	1,0068	84,41%	2,00%	0,04
Estonia	125 331	141 608	149 453	▁▅▇	1,0920	95,29%	0,71%	0,11
Ireland	368 247	388 768	380 892	▁▇▅	1,0170	92,34%	1,22%	0,07
Greece	879 779	916 785	947 962	▁▅▇	1,0380	94,36%	0,55%	0,09
Spain	3 353 735	3 446 537	3 467 146	▁▇▇	1,0168	94,90%	0,64%	0,07
France	4 487 381	4 900 985	5 039 616	▁▅▇	1,0597	96,27%	0,47%	0,07
Croatia	217 141	226 980	240 185	▁▅▇	1,0517	93,10%	0,94%	0,06
Italy	4 461 989	4 582 702	4 464 223	▁▇▁	1,0003	94,79%	0,59%	0,08
Cyprus	81 599	87 508	90 862	▁▅▇	1,0552	93,51%	0,87%	0,10
Latvia	138 144	145 203	145 802	▁▇▇	1,0273	94,07%	1,03%	0,08
Lithuania	299 766	328 915	350 880	▁▅▇	1,0819	95,66%	0,71%	0,12
Luxembourg	46 082	46 864	42 635	▇▇▁	0,9619	87,45%	2,21%	0,06
Hungary	948 636	975 969	900 021	▇▇▁	0,9740	95,97%	0,53%	0,09
Malta	49 414	51 397	54 032	▁▅▇	1,0457	93,92%	0,99%	0,10
Netherlands	2 050 157	2 201 653	2 303 389	▁▅▇	1,0600	97,20%	0,48%	0,13
Austria	588 224	582 466	579 487	▇▅▁	0,9925	91,84%	1,12%	0,06
Poland	2 661 662	2 672 267	2 742 834	▁▁▇	1,0151	96,01%	0,57%	0,07
Portugal	1 230 812	1 328 046	1 403 676	▁▅▇	1,0679	96,21%	0,53%	0,13
Romania	939 980	973 289	1 022 750	▁▅▇	1,0431	94,62%	0,77%	0,05
Slovenia	185 395	194 661	201 559	▁▅▇	1,0427	95,37%	0,74%	0,10
Slovakia	594 384	635 126	660 126	▁▅▇	1,0539	97,66%	0,39%	0,12
Finland	428 518	441 504	452 318	▁▅▇	1,0274	95,20%	0,79%	0,08
Sweden	872 172	833 967	864 201	▇▁▇	0,9954	95,11%	0,76%	0,08
Median	594 384	635 126	660 126	▁▅▇	1,0304	94,90%	0,74%	0,08

Source: authors according Eurostat data (2025)

Table 1 shows the development of the number of SMEs in the period 2021-2023. The largest number of small and medium-sized enterprises is naturally in the most powerful European economies, France, Italy, Spain, and Germany. However, the trend in the number of enterprises differs in individual Member States. Compared to 2022, the number of SMEs decreased in Belgium, Ireland, and Hungary.

The highest AAGR within the Union was recorded in Estonia (an average increase of approximately 9.2%). Comparing the number of enterprises decreased the most on average in Luxembourg (a decrease of roughly 3.8%). The other columns of the table show the enormous predominance of enterprises with 0 to 9 employees within all SMEs. Only Luxembourg is below the 90% threshold.

There are currently approximately 30 million enterprises and companies operating in the European Union. The vast majority of these enterprises are micro-enterprises, but large enterprises produce up to half of the turnover. The highest turnover-achieving companies are focused on industry, followed by trade and construction.

Table 2. Number of employed persons by SMEs in the EU-27 (industry, construction and market services)

GEO/TIME	2021	2022	2023	Trend	AAGR	0 to 9 persons SMEs (2023)	50 to 249 persons SMEs (2023)	Employed persons per one SME (2023)
Belgium	2 289 281	2 368 373	2 379 554		1,0195	50,47%	24,80%	2,72
Bulgaria	1 577 474	1 604 089	1 644 305		1,0210	42,55%	27,04%	4,06
Czechia	2 857 340	2 909 076	2 931 062		1,0128	48,83%	26,31%	2,24
Denmark	1 367 572	1 430 712	1 431 192		1,0230	30,56%	33,34%	3,74
Germany	21 657 707	21 865 430	22 038 327		1,0087	35,68%	28,12%	6,92
Estonia	419 677	442 700	435 705		1,0189	48,50%	24,51%	2,92
Ireland	1 363 778	1 557 000	1 555 144		1,0679	39,13%	29,60%	4,08
Greece	2 705 387	2 841 139	2 974 703		1,0486	54,17%	16,28%	3,14
Spain	10 055 218	10 297 374	10 628 903		1,0281	51,87%	20,44%	3,07
France	10 574 841	11 081 106	11 509 993		1,0433	52,74%	20,43%	2,28
Croatia	858 093	887 506	925 733		1,0387	46,26%	24,39%	3,85
Italy	13 221 163	13 660 814	13 922 226		1,0262	54,96%	18,37%	3,12
Cyprus	222 304	308 259	325 977		1,2109	48,08%	23,06%	3,59
Latvia	542 004	526 908	515 573		0,9753	43,16%	28,67%	3,54
Lithuania	871 129	916 502	936 257		1,0367	46,32%	26,58%	2,67
Luxembourg	239 471	246 203	246 113		1,0138	26,07%	38,37%	5,77
Hungary	2 371 641	2 442 634	2 358 908		0,9973	54,85%	19,94%	2,62
Malta	166 570	176 486	186 289		1,0575	42,10%	28,59%	3,45
Netherlands	4 971 870	5 142 565	5 115 608		1,0144	47,94%	25,68%	2,22
Austria	2 374 412	2 459 899	2 458 866		1,0176	42,40%	26,13%	4,24
Poland	7 779 285	7 766 694	7 721 751		0,9963	55,59%	20,79%	2,82
Portugal	2 540 657	2 699 889	3 557 572		1,1833	54,77%	20,43%	2,53
Romania	3 160 260	3 155 650	3 311 676		1,0237	47,60%	24,48%	3,24
Slovenia	552 052	575 292	587 483		1,0316	49,16%	25,53%	2,91
Slovakia	1 279 144	1 332 745	1 353 798		1,0288	61,74%	19,72%	2,05
Finland	1 063 489	1 126 342	1 118 028		1,0253	35,84%	31,28%	2,47
Sweden	2 191 163	2 255 103	2 370 400		1,0401	42,92%	27,90%	2,74
Median	2 191 163	2 255 103	2 358 908		1,0253	47,94%	25,53%	3,07

Source: authors according Eurostat data (2025)

Table 2 provides information on the number of people employed in SMEs in recent years. According to the EU-27 median, enterprises with 0 to 9 employees employ approximately 47.94% of all workers.

The highest value of the indicator in 2023 was achieved in Slovakia, the lowest in Luxembourg, followed by Denmark. The development trend was increasing in almost all economies. A decrease occurred only in Latvia, Hungary, and Poland.

According to AAGR, the number of people employed grew most significantly in Cyprus (+21%). In terms of the number of enterprises in the country, Germany dominates SME employment with approximately 6.92 people per enterprise.

Compared to 2021, employment has fully recovered from the pandemic and has maintained a relatively stable pace of improvement in 2023. Similarly, the number of micro, small, and medium-sized enterprises has also grown, which is naturally linked to employment growth.

For European industrial progress and the presentation of SMEs, they are key tools for innovation in many sectors and the entire Union economy. Regular monitoring of the development of SMEs across 14 sectors on an annual basis has become unique in terms of their significant contribution to all key indicators (in particular employment, turnover and public value).

Table 3. Net turnover od SMEs in the EU-27 (industry, construction and market services)

GEO/TIME	2021 (mil. €)	2022 (mil. €)	2023 (mil €)	Trend	AAGR	0 to 9 persons SMEs (2023)	50 to 249 persons SMEs (2023)	Net turnover per one SME (2023)
Belgium	730 405,52	927 211,50	888 954,52		1,1032	39,13%	30,31%	1 015 287 €
Bulgaria	134 870,03	184 043,37	180 018,78		1,1553	32,88%	33,00%	444 616 €
Czechia	362 524,77	493 885,71	469 879,77		1,1385	30,52%	42,90%	359 082 €
Denmark	396 793,88	522 098,63	438 589,12		1,0513	26,31%	41,97%	1 147 271 €
Germany	3 227 730,54	3 639 621,38	3 813 858,53		1,0870	28,84%	37,14%	1 197 970 €
Estonia	67 137,18	78 595,64	76 452,42		1,0671	41,46%	29,52%	511 548 €
Ireland	474 104,61	555 720,46	607 666,38		1,1321	42,83%	30,15%	1 595 377 €
Greece	200 597,21	252 312,75	267 094,49		1,1539	37,46%	31,24%	281 757 €
Spain	1 348 896,92	1 616 851,78	1 651 404,84		1,1065	35,38%	32,36%	476 301 €
France	1 913 179,49	2 122 626,46	2 208 756,67		1,0745	39,34%	31,12%	438 279 €
Croatia	72 131,32	91 148,70	97 097,50		1,1602	31,42%	31,01%	404 261 €
Italy	2 286 823,52	2 736 831,39	2 609 214,68		1,0682	37,25%	30,83%	584 472 €
Cyprus	31 068,54	51 070,89	54 221,28		1,3211	33,42%	30,98%	596 743 €
Latvia	55 531,15	62 710,67	59 015,74		1,0309	31,15%	35,43%	404 766 €
Lithuania	82 881,50	101 576,57	102 952,45		1,1145	30,95%	36,77%	293 412 €
Luxembourg	181 808,38	197 482,71	181 907,16		1,0003	16,70%	57,58%	4 266 616 €
Hungary	219 706,19	250 451,85	250 226,92		1,0672	33,19%	33,59%	278 023 €
Malta	30 362,25	33 793,84	35 318,34		1,0785	33,92%	30,43%	653 656 €
Netherlands	1 309 952,84	1 545 754,91	1 517 078,91		1,0762	28,88%	43,06%	658 629 €
Austria	509 708,34	611 429,50	538 307,73		1,0277	27,55%	39,06%	928 938 €
Poland	792 438,37	929 547,34	971 789,32		1,1074	41,76%	30,31%	354 301 €
Portugal	196 411,91	232 888,21	375 079,56		1,3819	33,57%	35,93%	267 212 €
Romania	225 360,07	281 049,18	315 849,33		1,1839	32,03%	35,65%	308 824 €
Slovenia	85 201,89	102 657,79	105 037,26		1,1103	31,25%	37,27%	521 124 €
Slovakia	135 714,26	161 096,73	169 396,69		1,1172	38,01%	32,45%	256 613 €
Finland	268 164,54	296 190,25	289 915,04		1,0398	31,40%	37,64%	640 954 €
Sweden	509 232,14	560 526,30	526 534,16		1,0168	29,30%	40,85%	609 273 €
Median	225 360,07	281 049,18	315 849,33		1,1032	32,88%	33,59%	511 548 €

Source: authors according Eurostat data (2025)

Table 3 illustrates the turnover of SMEs across individual years. The overall trend in turnover development among Member States is largely consistent, with decreases compared to 2023 observed only in Denmark, Italy, Luxembourg, Austria, and Sweden.

Nevertheless, the Average Annual Growth Rate of net turnover across all economies is close to 1, signifying average annual growth for this indicator. The highest values were achieved by Cyprus and Portugal. Romania and Bulgaria also recording significantly higher average growth compared to other nations.

In 2023, the median net turnover for SMEs with 0-9 employees was 32.88%. The final column of the table presents net turnover normalized by the number of enterprises. Luxembourg clearly dominates this ranking, with over 4 million euros per SME.

Cluster analysis aims to reveal mutual similarities between 27 Member States based on further analysis of previous research data. Preceding quantitative and graphical analyses indicate differences in the development of three selected indicators. Therefore, we decided to use that statistical tool to analyse multidimensional data.

Three imputed variables for the Member States were AAGR of SMEs number, employed persons per enterprise, and the net turnover per unit. The objective of cluster analysis was to achieve such groups of states, which would be characterized by certain homogeneity in case of selected indicators.

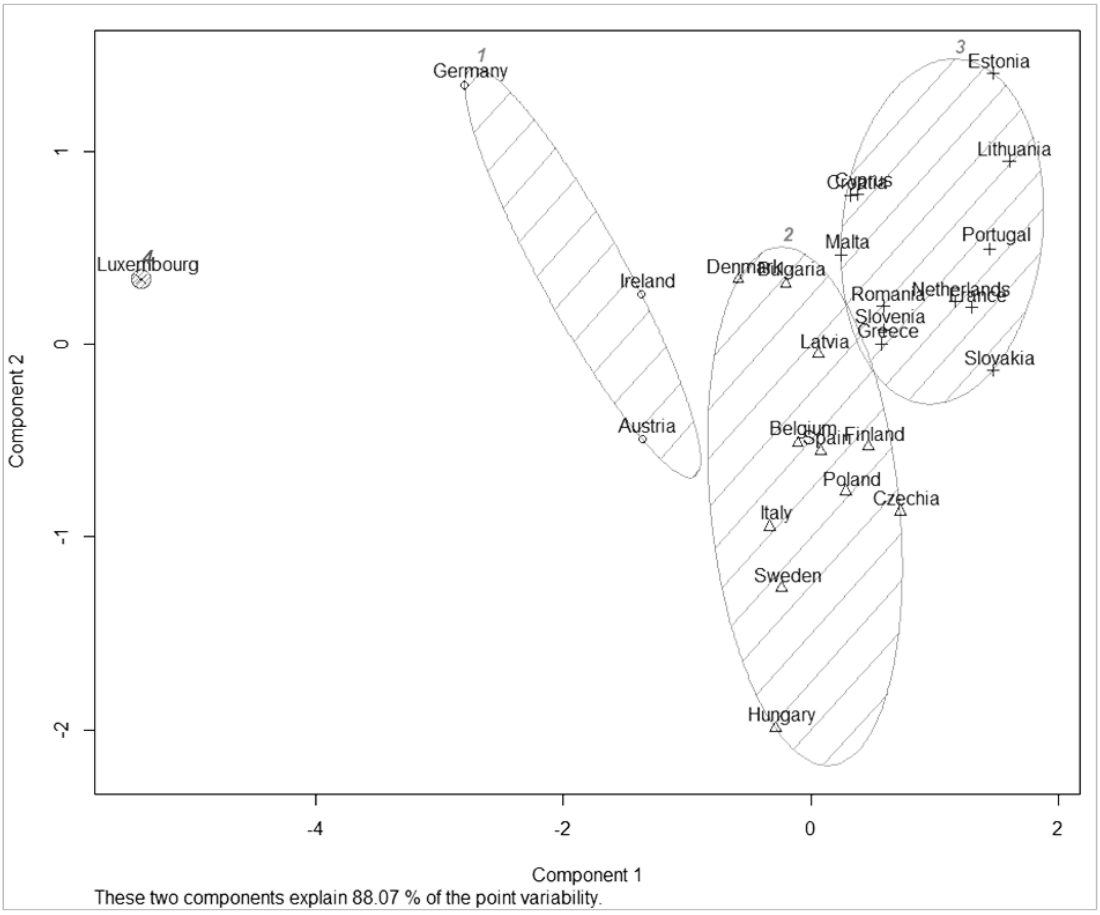

Figure 1. Scatterplot according to K-means method
Source: authors (2025)

To draw conclusions that consider the exact distances, we have also used a non-hierarchical clustering K-means method, which involves two main clustering components (variables). The output of that kind of clustering is a scatterplot. (Figure 1.)

If we consider two variables, clusters are visualized by using the non-hierarchical method. K-means clustering is the most popular partitioning method. It requires the analyst to specify the number of groups to extract. There are two components, which explain 88,07 % of the point variability. Due to testing, we have chosen 4 clusters as an imputed command for a new clustering. We consider the data set, which contains n=27 objects. The essence of ellipses is the average and the covariance matrix of each cluster. Their size is such that they include all the points of their group. The ellipses sizes of all clusters are different. Group of countries no. 1 displays greater variability for Component 2 because of an object on the boundaries of the ellipse (Germany). The denser shading intensity indicates the greater density of divided countries in ellipses. The most tightly arranged countries are in cluster no. 3.

Conclusion

Micro, small, and medium-sized enterprises are the driving force of the European economy. They significantly contribute to job creation, economic growth, and social stability. Furthermore, SMEs stimulate entrepreneurial spirit and innovation across the EU, making them essential for fostering competitiveness and employment.

Given their profound importance to the European economy, SMEs are central to EU policy. The European Commission is committed to supporting entrepreneurship and enhancing the business environment for SMEs, thereby enabling them to fully realize their potential in today's global economy.

Micro, small, and medium-sized enterprises have consistently served as principal employers across all European Union Member States. In Slovakia, their significance extends to economic

performance, job creation, and value added. Microenterprises, in particular, represent the dominant size group within Slovakia. Throughout the EU, microenterprises are most prevalent in sectors such as retail, information technology and services, and culture. Among all sectors, retail and construction clearly generate the highest added value.

The period following the COVID-19 pandemic proved to be a favourable phase for the emergence and development of SMEs in both Slovakia and other Member States. Naturally, microenterprises, being the most susceptible to economic, legislative, and political changes among SME categories, exhibited the largest fluctuations in entity numbers in recent years.

Given that SMEs constitute over 99% of all enterprises in the European Union, they are fundamental to its economy. Therefore, their support and financing are crucial for the survival of individual national economies and the entire integration group. It is thus imperative for governmental authorities to direct economic and political efforts towards continuously fostering SMEs, enabling them to withstand crises and ensure stability in economic development and employment.

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Subsidies as a Tool for Increasing the Competitiveness of Slovak Farms

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Abstract

Research background: Supporting the competitiveness of agricultural enterprises is one of the main priorities of the European Union's Common Agricultural Policy. Therefore, analyzing the effectiveness of its implementation is a crucial element in evaluating this policy. However, the issue of providing subsidies in agriculture is highly debatable both in Slovakia and the EU, raising various conflicting opinions in the long term.
Purpose of the article: The aim of this partial contribution is to analyze that subsidies contribute to enhancing the competitiveness of Slovak agricultural enterprises. The paper also evaluates how subsidies affect the financial stability of agricultural entities and their ability to respond to changing market conditions.
Methods: In examining competitiveness, we applied Porter's generic cost minimization strategy, measured using the Recourse Cost Ratio as a ratio indicator. This contribution focuses on entities operating on agricultural land in Slovakia during the period from 2004 to 2019, encompassing 16 years.
Findings & Value added: Based on available data from Slovak farms, key factors for the successful use of support are identified, along with potential risks associated with the improper or inefficient use of subsidies. The results of the analysis provide recommendations for improving subsidy policies and strengthening the competitiveness of the Slovak agri-sector.

Keywords: subsidies, competitiveness, farms, Slovak Republic

JEL classification: Q14, Q18, H20

1. Introduction

The agri-food sector holds significant cultural and social importance in Europe due to its strong tradition and contribution to maintaining rural economies and preserving rural areas across the EU. The topic of agriculture is extensive and undoubtedly current, intersecting with themes such as rural development, industrial innovations, sustainability, circular economy, and consumerism (Schmerber et al., 2022). Agriculture in the European Union is highly diverse, and one of the objectives of the EU's Common Agricultural Policy is to enhance its competitiveness. Therefore, research concerning the competitiveness of agriculture is highly valuable and aids in making strategic decisions related to the agricultural sector at both national and European levels (Nowak & Rózanska-Boczula, 2022).

The concept of competitiveness and its associated term, competitive advantage, represent a multifaceted notion that can be studied and analyzed at various levels, including the enterprise, sectoral, and national levels. Among these levels, measuring competitiveness at the enterprise level in the agricultural sector has received significant attention from researchers and experts. Notable recent studies in this area include those by Kargi and Bachev (2024), Dabkiene (2025), Fuksová et al. (2024), Gazzarin et al. (2024), Georgieva et al. (2025), Kravčáková Vozárová and Kotulič (2025), and

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Palenychak et al. (2024). It's entirely unsurprising to understand how, in this fast-paced business environment, every company is required to be increasingly competitive and efficient. From a microeconomic perspective, competitive advantage represents a company's ability to offer products and services that meet or exceed customer needs, surpassing what competitors offer at a given time. Therefore, a company's competitiveness encompasses its ability to create, innovate, produce, and sell goods and services in national or international markets, thereby maintaining and enhancing its market position (Sachitra & Chong, 2016; Martinez et al., 2014).

Unlike most other sectors, agriculture is subject to certain unique characteristics that influence its competitiveness (Martinescu, 2019):

- despite the importance of food production, the average income of farmers is approximately 40% lower compared to the average income of other EU citizens;
- agriculture is more dependent on natural and climatic conditions and weather than many other sectors;
- there is an inherent time gap between consumer demand and farmers' ability to supply. For instance, cultivating a larger quantity of wheat or producing more milk necessarily requires time, during which farmers should operate sustainably and ecologically to be cost-effective, maintain soil fertility, and preserve biodiversity.

According to Boháčiková et al. (2021), agricultural enterprises are influenced by specific risks that are not common in other sectors of the economy. The typology of agricultural risks is a key tool for identifying and effectively managing the various threats faced by the agricultural sector, which can be divided into several main categories (see Table 1).

Table 1. Typology of Agricultural Risks

	Micro-level risks	**Meso-level risks**	**Macro-level risks**
Production	Hailstorms, frosts, animal and plant diseases, human risks (illness, death), property risks	Landslides, pollution, rainfall amounts	Drought, pest infestations, floods, transmissible diseases, technology
Market/Price		New regulations in the agricultural sector, land price changes	Input and output price changes, market condition changes, supply shocks, changes in competition, etc.
Financial	Liabilities, indebtedness, income changes, receivables		Interest rate changes, exchange rates, asset values, credit provision
Institutional		Changes in local laws and regulations	Changes in economy-wide legislation, environmental regulations, subsidies

Source: own processing according to OECD (2009) and Boháčiková et al. (2021)

Agriculture is an economically weak sector often influenced by natural and economic factors. Due to the generally higher elasticity of supply compared to demand, agricultural production is subject to significant fluctuations. Subsidy policy is one of the state intervention tools that can stabilize agricultural production and markets (Tan et al., 2013). The primary goal of subsidies is to support farmers in increasing productivity, especially when subsidies are tied to inputs.

Determinants of agricultural competitiveness within the European Union have been extensively studied at both the enterprise and sectoral levels. In Slovakia, the competitiveness of farms is influenced by internal factors such as productivity, innovation, and farm management, as well as external factors including political and economic decisions at the EU level. EU financial

support plays a crucial role in enhancing the competitiveness of Slovak farms. Therefore, it is important to analyze the impact of this financial support on the competitive position of farms in Slovakia within a broader context.

2. Methods

The presented partial contribution, within the framework of a comprehensive research project, focuses on a set of entities operating on agricultural land in Slovakia during the period from 2004 to 2019, encompassing 16 years. The aim is to analyze how subsidies contribute to enhancing the competitiveness of Slovak agricultural enterprises. In line with the established objective of the study, the following hypothesis was tested: *"We assume that there are statistically significant differences in the competitiveness of agricultural enterprises, measured by the RCR index, between those receiving subsidies and those not receiving subsidies."*

In examining competitiveness, we applied Porter's generic cost minimization strategy, measured using the Recourse Cost Ratio (RCR) as a ratio indicator in the following form (Rumanovská, 2010):

$$RCR_i = C_i/R_i$$

where:

- C_i represents the costs in year *i,* including procurement costs, production consumption, personnel expenses, depreciation, taxes, and fees.
- R*i,* represents the revenues in year *i,* encompassing sales revenues, production, and subsidies.

This ratio is particularly useful in evaluating the impact of subsidies on the financial performance of agricultural enterprises. The data for this analysis were obtained from agricultural enterprises and provided by the Ministry of Agriculture and Rural Development of the Slovak Republic in the form of anonymized Information Sheets. The research sample (Table 2) included only those enterprises that maintained consistent financial records throughout the study period and ensured accurate and balanced reporting in their financial statements. This approach ensured a comprehensive and standardized dataset, facilitating a robust analysis of the financial performance and competitiveness of Slovak agricultural enterprises during the specified period.

Table 2. Research sample

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total	1146	1267	1237	1240	1194	1192	1180	1258	1314	1304	1250	1292	1270	1260	1260	1232

Source: authors (2025)

3. Results

Agriculture and the agricultural sector are often undervalued and may seem unattractive or uninteresting from the perspective of ordinary consumers. However, this sector represents a complex system that plays a key role in meeting people's needs, protecting the environment, supporting economic development, and preserving cultural identity. It influences the daily lives of individuals and the functioning of the country in terms of food security. It constitutes a complex system that is essential for sustainable development and the well-being of society.

Upon examining Figure 1, a significant difference in competitiveness levels is evident between agricultural enterprises that receive EU subsidies (RCR SUB) and those that do not (RCR nSUB). The figure clearly shows that subsidies substantially contribute to the revenue side of the Recourse Cost Ratio (RCR) coefficient, thereby reducing its value.

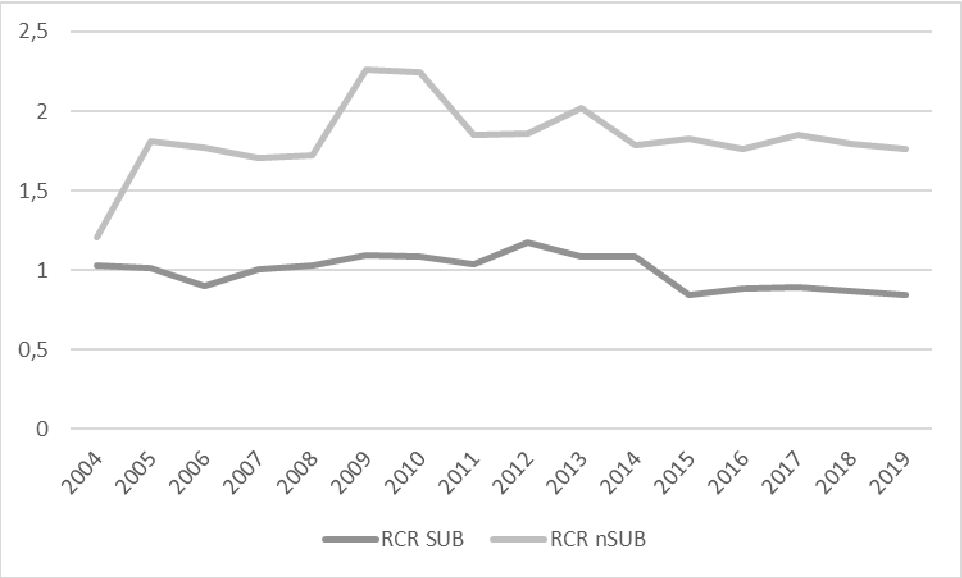

Figure 1. Wilcoxon signed-rank test
Source: authors (2025)

To test the established hypothesis, we used the Wilcoxon signed-rank test, the results of which are presented in Table 3. This test confirmed the existence of statistically significant differences in the competitiveness of agricultural enterprises between those receiving and not receiving subsidies. Based on the research conducted, it can be concluded that EU subsidies have a significant impact on the competitiveness of agricultural enterprises in Slovakia. The results indicate that subsidies support the income side of farms and improve the overall cost-to-revenue ratio, reflecting better cost-effectiveness. These subsidies contribute to increasing the competitiveness of agricultural enterprises by enabling farms to better cover their costs, which can positively impact their ability to compete in the market both in the short and long term.

Table 3. Wilcoxon signed-rank test

Variables RCR SUB/ RCR nSUB	**Wilcoxon signed-rank test - statistically significant at p < 0.05**				
	N	**Sign test Z**	**W test T**	**W test Z**	**p-value**
Total	19099	136.0501	2026759	117.0257	0.0000
2004	1099	32.7590	5491.0	28.1945	0.0000
2005	1221	34.4563	7653.0	29.6466	0.0000
2006	1207	34.3677	5331.0	29.6535	0.0000
2007	1208	34.0945	12009.0	29.1158	0.0000
2008	1164	33.9123	3434.0	29.2536	0.0000
2009	1141	33.5123	4503.0	28.8551	0.0000
2010	1141	33.0978	6825.0	28.6466	0.0000
2011	1222	34.2420	10189.0	29.4542	0.0000
2012	1260	35.0176	6709.0	30.2276	0.0000
2013	1252	34.7336	11871.0	29.7215	0.0000
2014	1183	33.4935	14818.0	28.5323	0.0000
2015	1221	34.1701	7637.0	29.6479	0.0000
2016	1181	33.8128	6680.0	29.1981	0.0000
2017	1184	33.6246	8232.0	29.1061	0.0000
2018	1191	33.9024	7586.0	29.2546	0.0000
2019	1224	34.4998	6097.0	29.8118	0.0000

Source: authors (2025)

4. Discussion

The question of the impact of subsidies on the competitiveness of agriculture is a very broad topic. Gozora (2021) argues that competitiveness is influenced by both external and internal determinants of the economic environment, which shape the conditions for business activity, form the entrepreneurial structure, and are decisive factors for economic growth and the economic differentiation of business entities. Last but not least, decisive factors for economic development are imbalances in production, sales, and monetization of products and services, which are sources of security risks and crisis phenomena in the business of agricultural entities. Therefore, protecting enterprises from adverse influences of the external and internal environment is an integral part of agricultural management.

The financial management of agricultural enterprises is influenced by a range of factors that are not present in other sectors. Kravčáková Vozárová et al. (2019) examined the impact of the legal or organizational structure on the performance of agricultural enterprises in Slovakia. Their study revealed that the legal form of a farm significantly influences its economic outcomes. By analyzing two types of agricultural entities—agricultural cooperatives and business companies—over the period from 2005 to 2014, the authors found that these entities exhibited distinct financial performances across various indicators. This analysis, employing mathematical and statistical methods, confirmed that the legal structure is a determining factor in the economic performance of agricultural enterprises in Slovakia.

Natural and climatic conditions and agriculture are inextricably linked and mutually influence each other. Undoubtedly, agriculture is one of the sectors most at risk from climate change, and these conditions have multiple impacts on the agricultural sector—primarily through changes in productivity and yields, as well as changes in the agri-food market.

According to Kotulič et al. (2018), the relationships between climate change and agriculture are complex and diverse. The factors influencing the climate are constantly changing, and this phenomenon has a multidimensional impact on human livelihoods. As these conditions evolve, indicators related to agricultural sustainability—such as production volume, yields, areas, and production values—also change.

When agricultural sustainability becomes vulnerable, it leads to fluctuations in economic indicators such as total production volume, crop and final product profit margins, and wage rates (Alam et al., 2013). In addition, climatic factors influence the social and economic sustainability of farmers, both directly and indirectly. They cause crop damage, which results in low productivity and high production costs, leading to loss of income for farmers, increased poverty levels, and higher rates of seasonal unemployment Agriculture is a fundamental pillar of the national economy, ensuring not only the nutrition of the population but also job creation and economic stability. Although it may seem unattractive at first glance, its significance is invaluable. This sector influences the daily lives of individuals. Farm management is the operational aspect of agricultural activity. It encompasses strategic planning and the implementation of decisions regarding resource utilization within the agricultural entity. Financial planning serves as the foundation of the entire farm management process. Subsidies can play a significant role in enhancing farm efficiency; however, their impact depends on their design and the broader agricultural context. To maximize positive effects, it is essential to tailor subsidy programs to the specific needs of farmers, support decoupled payments, and ensure that subsidies promote sustainable and effective agricultural practices.

Conclusion

The Common Agricultural Policy (CAP) is one of the European Union's oldest policies, established in 1962, and has been instrumental in shaping the agricultural sector for over 50 years. A distinctive feature of agriculture is its regional differentiation, encompassing both agrarian structures and natural and non-natural conditions. Issues related to the study of agrarian structures have consistently been a focal point, becoming particularly significant in the context of adapting farms in EU countries to compete in the EU's single market.

From this perspective, it is evident that numerous factors contribute to transforming comparative advantages to enhance business competitiveness. One avenue for enterprises is the broader adoption of new technologies, which, however, requires effort from both economic and knowledge management standpoints. Managing and leading an agricultural enterprise necessitates recognizing that a farm is

primarily a business entity aiming to maximize profit. Therefore, it is essential to build upon rational management concepts, with a fundamental aspect being a proper understanding and setting of the enterprise's production costs.

The most general characteristic of any economic activity is decision-making. Proper management and implementation of the decision-making process at the farm level should involve organization and operation aimed at higher productivity and maximum profit. Effective farm management is a key idea for increasing competitiveness, productivity, and profitability of any agricultural enterprise.

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Underexplored Factors of Fiscal Outcomes in the Slovak Local Public Sector: Gender Standpoint

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Abstract

Research background: The literature underexplores gender determinants of local fiscal outcomes in Slovak conditions, even though the increase of female local elected authorities in Slovakia in the last decades is evidenced. Furthermore, the differences in gendered leadership are well-known and examined in the gender literature worldwide.
Purpose of the article: The paper examines the relationship between the women mayor variable and municipal tax revenues, the main fiscal outcome of local budgets. The paper aims to decrease the gap in the literature that focuses on gender topics in Slovak conditions.
Methods: The main research method is regression analysis of panel data. Fixed-effect and Random-effect models are employed to estimate the relationship between the women mayor variable and municipal tax revenue in the sample of all 2,296 Slovak municipalities from 2005 to 2024.
Findings & Value added: The paper´s results show a positive relationship between the representation of women mayors and local tax revenues. The paper contributes to the gender literature by examining local tax revenue determinants regarding the determinants of non-economic character - the gender standpoint of the mayors ' personal characteristics.

Keywords: Local government, Mayor, Gender, Local revenue, Tax revenue

JEL classification: H77, J16, B54

1. Introduction

Although increasingly popular in recent years, the gender of local elected authorities is still underestimated and insufficiently analyzed as a determinant of local fiscal outcomes. This exogenous factor has, in recent years, become an increasingly discussed topic of scientific interest, as confirmed by research by foreign authors (e.g., Geys and Revelli, 2011; Cabaleiro & Gómez, 2017; Slegten et al., 2019; Cabaleiro-Casal & Buch-Gómez, 2020; Jung, 2022; Cuadrado-Ballesteros, Guillamón, and Ríos, 2021; Balaguer-Coll & Ivanova-Toneva, 2021; Avellaneda et al., 2022).

Among the local fiscal outcomes, a significant part of the local public finance and fiscal decentralization literature is dedicated to local tax revenues. This branch of literature gradually introduces variables focusing on the gender of local authorities. For instance, Geys and Revelli (2011) demonstrated that the gender of Flemish (Belgian) elected representatives in local politics influences property tax levels. Slegten et al. (2019) confirmed that female elected representatives in Belgium, in an effort to reduce fiscal deficits, tend to prioritize increasing public revenues (raising local taxes and, subsequently, municipal tax revenues), while their male counterparts prefer expenditure reductions. Jung (2022), who analyzed whether the gender of elected political authorities at the local level affects budgets in Korean cities, including the level of decentralization in the country, found evidence of such a relationship. However, according to him, there is little proof that the gender of local elected authorities truly affects local governments' budgets and revenue levels (including tax revenues). His results suggest that the level of local tax revenues depends not only on the gender of elected authorities but also on various socio-economic factors (such as crises and reforms), which he considers to be more significant than gender. Cabaleiro and Gómez (2017) acknowledged the possible relationship between the gender of

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elected political authorities and municipal tax revenues. However, they argued that female elected representatives in Spanish local governments are associated with lower levels of tax revenues, thereby deepening fiscal imbalances in local budgets. Conversely, Cuadrado-Ballesteros, Guillamón, and Ríos (2021), also analyzing Spain, found that municipalities with female elected authorities tend to underestimate revenues and overestimate expenditures. This holds not only for mayors but especially when there is sufficient representation of women in local councils. According to the authors, women in local governments can thus contribute to the financial health of municipalities. In contrast, Cabaleiro-Casal and Buch-Gómez (2020) identified that female elected representatives worsen Spanish local governments' fiscal performance, which contradicts most empirical studies' hypotheses.

In Slovak conditions, only limited resources on the nexus of gender and local fiscal outcomes could be found (Maličká & Mourao, 2024). However, the examination of women's representation in local politics has wider roots (e.g., Maškarinec and Klimovský, 2017; Lukáčová & Maličká, 2023), and the increase of women mayors is observed.

In this paper, we analyze whether the mayor's gender impacts the development of individual local tax revenues and their individual categories in the Slovak Republic. We employ standard estimation techniques, such as fixed-effect and random effect models, to examine the relationship mentioned above in the sample of all 2,926 Slovak municipalities, as the Ministry of Finance of the Slovak Republic reported.

The paper´s motivation is that the gender determinants of local fiscal outcomes in Slovak conditions are underexplored in the literature, even though the increase of female local elected authorities in Slovakia in the last decades is evidenced, and the differences in gendered leadership are well known and examined in the gender literature worldwide. The paper contributes to the gender literature by examining local tax revenue determinants regarding the determinants of non-economic character - the gender standpoint of the mayors ' personal characteristics.

2. Methods

The paper sample consists of 2,926 municipalities with elected local representatives and creating their own local budgets as reported by the Ministry of Finance of the Slovak Republic (abbreviated as MF SR). The time span is 2005-2024, thus working with all available data. The final data set is an unbalanced panel.

In this paper, the main research method is panel regression analysis. The paper examines the relationship between the women mayor variable and municipal tax revenues using standard estimation techniques for panel data, the fixed-effect model (FEM), and the random-effect model (REM). According to Baltagi (2021), panel regression is an extended version of time series regression, with the addition of a cross-sectional dimension that allows us to observe the individual effects of variables on the dependent variable. The FEM is applied in cases where individual characteristics exist that are constant over time and may influence the dependent variable:

$$y_{it} = \beta^T x_{it} + \mu_{it} + \varepsilon_{it} \quad (1)$$

where μ_{it} represents the fixed effects for the *i*-th observations, and ε_{it} denotes the fixed effects for non-significant variables for the *i*-th observations at time *t*. It is assumed that the error term ε_{it} is not correlated with the explanatory variables x_{it} for the respective *i* and *t*, with the following condition holding:

$$\mu i \sim (0, \sigma_{\mu}^{2}), \varepsilon_{it} \sim (0, \sigma_{\mu}^{2} I), E(\mu_i \varepsilon_{it}) = 0 \quad (2)$$

The REM is used in cases where individual characteristics can be considered random and are not directly included in the model:

$$y_{it} = \alpha + \beta^T x_{it} + u \quad (3)$$

$$u_{it} = \mu_i + \varepsilon_{it} \quad (4)$$

To decide whether FEM or REM is adequate, we conduct a Hausman test with a null hypothesis that GLS estimates are consistent and an alternative hypothesis for the FEM.

The local tax revenue represents the dependent variable in this research. Beside the total local tax revenue, we altern the main dependent variable by employing also tax revenues categories as they appear in local budgets and we follow the economic classification of revenues adopted by the MF SR – e.g., local tax revenues (revenue group 100) contains shared tax (group 110), immovable property tax (group 120) and other local taxes (group 130) (see Table 1). They present particular parts of local total tax revenues. As immovable property tax and other local taxes create own tax revenues of municipalities, we consider their sum as one of the dependent variables, too.

The independent variable, the local tax revenue determinant examined in this analysis, is the gender of the elected political authority, with the assumption that the presence of female mayors in Slovak local governments increases local tax revenues (Slegten et al., 2019; Casarico et al., 2022; Avellaneda et al., 2022). This assumption originates in empirical analyses confirming the positive aspects of women's presence in local politics. Recent research shows that female leaders are more community-oriented (with higher expenditures on healthcare, education, and social policies (Funk & Phillips, 2019) and less prone to corruption (Brollo & Troiano, 2016), which contributes to local development, increased employment, and greater transparency, ultimately leading to higher tax revenues. On the other hand, there are also studies confirming the insignificance of the gender of elected political authorities (Jung, 2022), or even an adverse effect of female mayors on the tax revenues of local governments (Cabaleiro & Gómez, 2017; Cabaleiro-Casal & Buch-Gómez, 2020). We created a binary variable to capture the gender dimension of local government leadership in econometric calculations. This variable takes the value of 1 if the mayor is a woman and 0 if the mayor is a man. This approach allows for precise quantification and subsequent analysis of the impact of gender representation on the observed outcomes within the context of this determinant. Data on the local contest winners are derived from the Statistical Office of the Slovak Republic (abbreviated as SOSR, SOSR 2025).

Based on empirical evidence, we constructed the following equation for the determinant "gender of elected political authority":

$$Tax\ revenues_{i,t} \quad = \alpha + \beta_1 * gender + + \beta_{i,t} \sum_{j=1}^{m} X_{i,t} + u_{i,t} \qquad (5)$$

Table 1. Variable characteristics

Variable	Characteristics	Source
Dependent variables		
Local Tax Revenue 100 pc	Total local tax revenue (revenue group 100) per capita in EUR (logs used).	MF SR SO SR
Local Tax Revenue 110pc	Local tax revenue (revenue group 110 containing portion oi personal income tax that is shared tax) per capita in EUR (logs used).	MF SR SO SR
Local Tax Revenue 120pc	Total local tax revenue (revenue group 120 containing immovable property taxes) per capita in EUR (logs used).	MF SR SO SR
Local Tax Revenue 130pc	Own local tax revenue (revenue group 130 containing other local taxes) per capita in EUR (logs used).	MF SR SO SR
Local Tax Revenue 120 and 130 pc	Total own local tax revenue (revenue group 120+130) per capita in EUR (logs used).	MF SR SO SR
Independent variables		
Woman Mayor	Dummy variable, 1 if a woman is elected as the mayor, otherwise 0	Own based on SO SR
Control variables		
Ageing Index	Number of persons in the post-productive age (65 years and older) to the number of people in the pre-productive age (0-14 years) in %.	SO SR
Population	Total municipal population on January 1st.	SO SR
Moving in	Number of persons moving in the municipality (logs used).	SO SR
Unemployed Persons	Number of registered unemployed persons in the municipality (logs used).	SO SR
Debt Service	Sum of principal and interest payments in EUR (logs used).	MF SR
Current Expenditure	Share of current local expenditure on total local expenditure, in %.	MF SR

Notes: Variables in per capita terms are computed using the total municipal population on January 1st derived from the SO SR.
Source: own processing

Control variables involved in the estimations include socio-economic, demographic, and fiscal variables available at the municipality´s level. The available literature on local tax revenue determinants inspires their choice. Population size is one of the most frequently considered tax revenue determinants (e.g., Allers et al., 2001; Cuadrado-Ballesteros et al., 2014; Hanum & Permata Sari, 2022). The economic conditions of municipalities are evaluated using the unemployment indicator (unemployed people), ageing index, and moving in population (see, e.g., Choi et al., 2010; Cuadrado-Ballesteros et al., 2014). From fiscal variables, it is a debt service related to fiscal stress (Buettner & Wildasin, 2006). Local current expenditure as a fiscal variable is interlinked with local tax revenues when municipalities can cover current local expenditures only with current local revenues (Act no. 583/2004 Coll. on Local government budgetary rules). Socio-economic variables are collected from SOSR (2025), and fiscal variables are collected from MFSR (2025).

Table 1 lists the variables, their characteristics, and data sources. Table 2 displays the descriptive statistics using observations 1:01 - 2926:20.

Table 2. Descriptive statistics using the observations 1:01 - 2926:20

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	C.V.	Missing obs.
Dependent variables							
Local Tax Revenue 100 pc	310.36	276.99	14.780	50435.0	267.35	0.8614	242
Local Tax Revenue 100 pc (log)	5.6231	5.6240	2.6933	10.828	0.4736	0.0842	242
Local Tax Revenue 110pc	244.57	218.87	14.523	34100.0	185.54	0.7587	244
cal Tax Revenue 110pc (log)	5.3875	5.3885	2.6757	10.437	0.4755	0.0883	244
Local Tax Revenue 120pc	45.615	28.637	-5.5513	10669.0	95.008	2.0828	243
Local Tax Revenue 120pc (log)	3.3784	3.3629	-7.2678	9.2751	0.8938	0.2646	659
Local Tax Revenue 130pc	20.179	13.684	0.0000	5591.3	45.754	2.2674	243
Local Tax Revenue 130pc (log)	2.5785	2.6211	-7.1274	8.6290	0.9234	0.3581	566
Local Tax Revenue 120 and 130 pc	65.794	44.669	-1.7026	16261.0	123.97	1.8841	243
Local Tax Revenue 120 and 130 pc (log)	3.8104	3.8019	-7.2678	9.6965	0.8600	0.2257	440
Independent variables							
Woman Mayor	0.2286	0.0000	0.0000	1.0000	0.4199	1.8369	361
Control variables							
Ageing Index	119.32	101.16	0.0000	5000.0	118.68	0.9946	16
Population	2082.4	658.00	7.0000	4.8e+005	10837.0	5.2039	0
Population (log)	6.5479	6.4892	1.9459	13.080	1.2187	0.1861	0
Moving in	39.717	12.000	0.0000	17065.0	288.92	7.2744	361
Moving in (log)	2.5828	2.5649	0.0000	9.7448	1.2801	0.4956	3727
Unemployed Persons	100.89	36.000	0.0000	13985.0	347.73	3.4466	0
Unemployed Persons (log)	3.6224	3.5835	0.0000	9.5457	1.2758	0.3522	239
Debt Service	69112.	4647.1	0.0000	7.4e+007	6.6e+005	9.5833	38
Debt Service (log)	9.7923	9.9679	-4.6052	18.120	2.0444	0.2088	20919
Current Expenditure	0.7867	0.8470	0.0128	1.0000	0.1976	0.2512	187

Source: own processing

3. Results

3.1 Stylized facts

Among the EU countries, when considering women´s representation in local politics, Slovakia exhibits values above the EU average (see Figure 1) in both cases: women mayors and women councillors. The highest values of women´s representation in local politics in 2024 are evidenced in Finland, Sweden, and the Netherlands in the case of women mayors. In the case of women councillors, the highest representation is in Sweden and Finland, accompanied by Spain and France (see Figure 1).

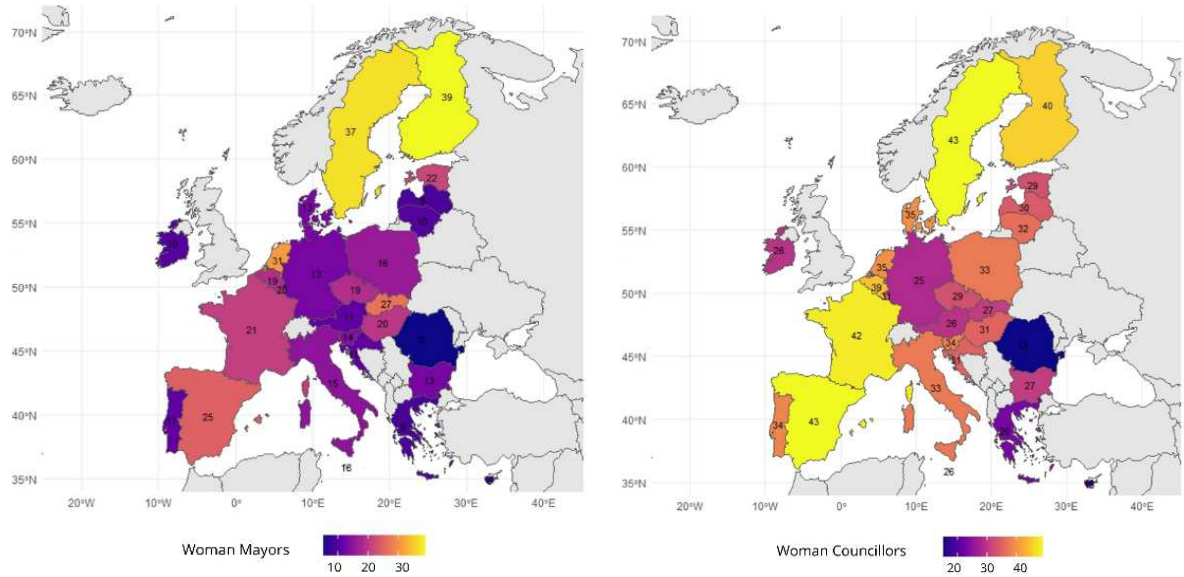

Figure 1. Women mayors and councillors in the European Union (year 2024 displayed, in %)
Source: own processing based on European Institute for Gender Equality (EIGE, 2025)

After the 2022 elections, women mayors represent 26.01% of all mayors (our database is unbalanced, considering only the results of the first election round, this might cause the difference between the EIGE´s statistics and ours). Compared to the year 2002, the increase of 7% is evidenced in the Slovak local public sector. This increase seems to be stable, as it exhibits 19.31% in 2002, 20.23% in 2006, 21.29% in 2010, 22.83% in 2014, 24.78% in 2018, and 26.01% in 2022 (Lukáčová & Maličká, 2023). However, the growth rate of the share of women mayors decreased between 2018 and 2022. Moreover, the most numerous size categories with elected female political authorities in the Slovak Republic are still those with a low number of inhabitants, i.e., size category 1 (up to 199 inhabitants), size category 2 (200–499 inhabitants), size category 3 (500–999 inhabitants), and size category 4 (1,000–1,999 inhabitants). This analysis once again confirms the presence of a fragmented settlement structure in the Slovak Republic, characterized by many small local governments with a low population (Lukáčová & Maličká, 2023). Figure 2 compares the years 2002 and 2022. The increase of 7% is evidenced in the share of elected local political authorities of the female gender in the past 20 years.

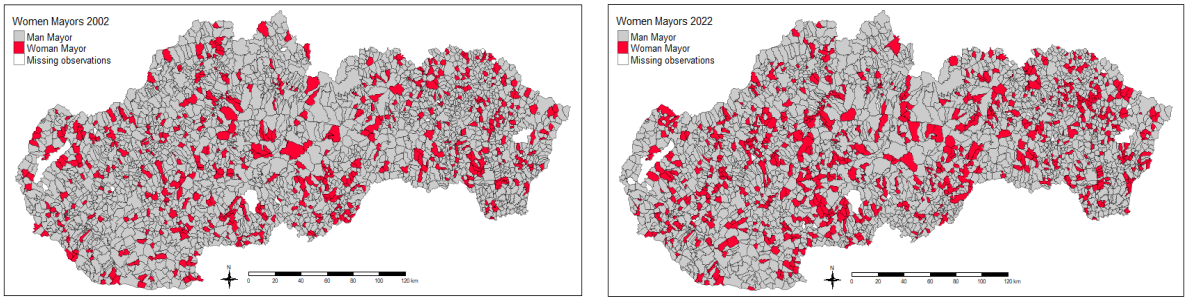

Figure 2. Women mayors in Slovakia: a comparison in the 2002 and 2022 local elections
Source: own processing

3.2 Regression analysis results

The regression analysis is conducted for five models, where the dependent variable is alternated according to the category of local tax revenues, comprising the local total tax revenues and its specific parts. The explanatory, independent variable in each model is a dummy variable for the mayor's gender. In all cases, the FEM and REM were estimated. Based on the Hausman test, Table 3 shows the final estimation results. All models are adjusted by the HAC (Heteroskedasticity and Autocorrelation Consistent Standard Errors).

Table 3. Estimation results

Dependent variable	Local Tax Revenue 100 pc (log)		Local Tax Revenue 110 pc (log)		Local Tax Revenue 120 pc (log)		Local Tax Revenue 130 pc (log)		Local Tax Revenue 120+130 pc (log)	
Variables	Coeff.	Signif.	Coeff.	Signif.	Coeff.	Signif.	Coeff.	Signif.	Coeff.	Signif.
Intercept	0.7533 (1.4468)	0.6026	0.0465 (1.5013)	0.9753	3.5232 (1.0018)	0.0004 ***	−3.4417 (1.6264)	0.0344 **	1.1110 (1.2890)	0.3888
Woman mayor	0.0516 (0.0120)	<0.0001 ***	0.0525 (0.0123)	<0.0001 ***	0.0309 (0.0130)	0.0176 **	0.0705 (0.0186)	0.0002 ***	0.0436 (0.0132)	0.0009 ***
Ageing Index	0.0019 (0.0007)	0.0110 **	0.0019 (0.0007)	0.0108 **	0.0017 (0.0007)	0.0145 **	0.0021 (0.0008)	0.0127 **	0.0018 (0.0007)	0.0133 **
Population (log)	0.8179 (0.2072)	<0.0001 ***	0.9124 (0.2155)	<0.0001 ***	−0.0332 (0.1400)	0.8128	0.9207 (0.2324)	<0.0001 ***	0.4001 (0.1824)	0.0283 **
Moving in (log)	−0.0121 (0.0058)	0.0354 **	−0.0146 (0.0060)	0.0154 **	−0.0009 (0.0048)	0.8554	−0.0050 (0.0072)	0.4871	−0.0013 (0.0055)	0.8155
Debt Service (log)	0.0508 (0.0024)	<0.0001 ***	0.0505 (0.0025)	<0.0001 ***	0.0471 (0.0025)	<0.0001 ***	0.0625 (0.0032)	<0.0001 ***	0.0517 (0.0025)	<0.0001 ***
Unemployed Persons (log)	−0.4138 (0.0129)	<0.0001 ***	−0.4611 (0.0129)	<0.0001 ***	−0.1803 (0.0127)	<0.0001 ***	−0.3204 (0.0163)	<0.0001 ***	−0.2272 (0.0135)	<0.0001 ***
Current Expenditure	0.2996 (0.0155)	<0.0001 ***	0.3317 (0.0159)	<0.0001 ***	0.1991 (0.0149)	<0.0001 ***	0.2585 (0.0232)	<0.0001 ***	0.2033 (0.0169)	<0.0001 ***
R2	0.4394		0.4688		0.1456		0.1838		0.1930	
Hausman test (p-value)	4.1e-174 FEM		0.0000 FEM		2.7e-32 FEM		1.5e-32 FEM		6.5e-30 FEM	
No.obs.	36071		36071		35875		35945		35975	

Note: Standard errors in parentheses; Significance expressed by the p-values, and *** denotes significance at the 1% significance level, ** at 5%, and * at 10% significance level.
Source: own processing

The estimation results show a positive relationship between the women mayor variable and local tax revenue in all estimations (see Table 3). This confirms our expectations, and our findings are in line with those of Slegten et al. (2019), Casarico et al. (2022), and Avellaneda et al. (2022).

When considering the effects of control variables, the variable on population predominantly exhibits a positive, statistically significant beta estimate that corresponds to findings of Allers et al. (2001), and Hanum and Permata (2022), when a larger population presents more taxpayers. The relationship between local current expenditure and local tax revenues in all models is positive and statistically significant. In line with the legal requirements of the Act no. 583 on Local governments budgetary rules, the increase in current expenditure must be covered by the increase in current revenue, thus creating pressure on local tax revenues, which create a dominant part of local budgets. In a similar vein, the relation between the debt service and local tax revenues is positive and statistically significant. The municipality's financial health could be achieved when current local revenues cover interest and principal payments, and indebtedness is solved by capital budget operations only exceptionally, best ever. The positive relationship between the Ageing index and local tax revenues is observed, which points to tailored public policies to address the problem of an ageing population by several financial supports and inter-governmental fiscal equalization performed using the shared taxes in line with findings of Valkana and Oulasvirta (2021). The variable on local unemployment is in a negative, statistically significant relationship with local tax revenues. It points to the decrease in personal income taxes in times of higher unemployment rates, which are via several vertical fiscal equalization schemes shifted to local budgets. Another point of view is the limited possibility of long-term unemployed people to fulfill their obligations, and tax rates in underdeveloped areas are usually lower. The relationship between the moving-in persons and tax revenues is negative, opposite to the findings of Choi et al. (2010) and Cuadrado-Ballesteros et al. (2014). In this case, the structure of immigrants might play a role when collecting the local taxes, as discussed in Hansen, Schultz, and Tranaes (2017).

4. Discussion

The results of our models, as well as those of several international authors (Slegten et al., 2019; Casarico et al., 2022; Avellaneda et al., 2022), confirmed an increase in municipal revenues in periods

when female elected representatives manage local governments. The percentage of women in local politics in Spain also influences variations in municipal expenditures and revenues (Cuadrado-Ballesteros et al., 2021). Similarly, Balaguer-Coll and Ivanova-Toneva (2021) confirmed that female leadership in local governments contributes to improving their financial sustainability and budgetary stability, which is directly related to the revenue performance of municipalities.

The positive impact of female political representatives in leadership positions of local governments in the Slovak Republic was also confirmed by the results of the econometric estimations. We examined the effect of the gender of elected political authorities on the individual categories of tax revenues of Slovak local governments. The model results clearly demonstrated a positive and significant impact of women on the tax revenues of Slovak local governments across all analysed categories of tax revenues (Table 3). The results regarding the control variables are consistent with empirical findings. Despite the insufficient analysis of this determinant in the context of the Slovak Republic, Maškarinec and Klimovský (2017) confirmed the contribution of female mayors in several areas of public life within Slovak local governments.

The results of this determinant within our analysis also confirm the broader empirical evidence pointing to the positive impact of women in local politics. Some studies have shown that women in public office tend to prioritise more transparent and prompt governance, not only during times of crisis (Funk, 2020). This increases citizens' trust in public administration, leading to greater willingness to pay taxes, ultimately resulting in higher tax revenues (Funk, 2020). Female elected representatives also demonstrate different political priorities than their male counterparts, including a stronger emphasis on social expenditures, education, and healthcare.

The financing of these areas of public services may require a more efficient use of existing tax revenues or the introduction of new tax measures, which can increase overall tax revenues while also raising the share of specific categories of tax revenues within total tax income (Alberti et al., 2021; Barnes et al., 2020; Funk & Philips, 2019).

In addition, some studies also confirm that the presence of women in public office may be associated with lower levels of corruption. Brollo and Troiano (2016) demonstrated that, at the Brazilian local level, the likelihood of corruption is 29 to 35 percent lower in municipalities with female mayors compared to those with male mayors. Since corruption often reduces the efficiency of tax collection, its reduction can lead to higher tax revenues. However, in the context of the Slovak Republic, this area is difficult to quantify, as it involves conduct in which an individual abuses their position or function in public administration, and political representatives face potential penalties such as long-term imprisonment, disqualification from office, financial sanctions, or confiscation of assets obtained through criminal activity.

Conclusion

The world gender literature evidences several contributions of females in local and national politics, when there is a plethora of studies on the effect of women political leaders on local fiscal outcomes such as indebtedness, fiscal discipline, social expenditures, corruption, public procurement outcomes, or saving, including the field of taxation, too. In the Slovak conditions, the literature underexplores gender determinants of local fiscal outcomes, even though the increase of female local elected authorities in Slovakia in the last decades is evidenced, and the differences in gendered leadership are well-known and examined in the gender literature worldwide.

In this analysis, we examine the relationship between the gender of the elected political authority and the level of tax revenues of local governments in the Slovak Republic. The results of regression analyses on the sample of all 2,926 Slovak municipalities from 2005 to 2024 showed a positive effect of women mayors on local tax revenues and their categories, in line with the expectations based on the literature review.

However, the gap in this kind of scientific literature in Slovak conditions is also evident when considering other fiscal outcomes, except for a limited number of studies focusing on indebtedness. Thus, further research might focus on several aspects of gendered local budgeting and decision-making. Besides, the research limitations are present because of the different types of Slovak municipalities when classifying them from the point of size measured by their population. The fragmented residential structure of the Slovak local sector, meaning a lot of small-sized municipalities, is widely discussed. The related research, combined with gender literature, stresses women´s

representation in a mayoral position in small municipalities with limited possibilities to drive local development through tailored local tax policies.

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The Analysis of Key Indicators of Europe's Digital Transformation

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Abstract

Research background: Digital transformation is one of the strategic priorities of the European Union, as it significantly affects economic growth, innovation, competitiveness, and societal resilience. To assess progress in this domain, global composite indices such as the Network Readiness Index (NRI) have been increasingly used to evaluate countries' technological capabilities, governance quality, and digital impact.
Purpose of the article: The aim of this article is to identify the key indicators of digital transformation in selected European Union countries, reveal their impact on GDP per capita, and provide recommendations for improving digital transformation, readiness, and competitiveness of the analyzed countries.
Methods: The study applies quantitative correlation analysis (Kendall's tau) to examine the statistical relationships between the NRI score, its pillars and sub-pillars, and GDP per capita. The analysis is based on secondary data from the Network Readiness Index (2022–2024) and macroeconomic data provided by the World Bank.
Findings & Value added: The results confirm strong and statistically significant correlations between the overall NRI score and its main pillars and sub-pillars particularly in the areas of technological infrastructure, governance, and economic impact. Furthermore, GDP per capita shows a positive relationship with the overall NRI score and selected digital performance indicators, underlining the role of economic strength in supporting digital development. The contribution identifies notable disparities among countries and emphasizes the importance of strategic investment in digital infrastructure, digital skills, and institutional capacity to foster inclusive and sustainable digital transformation in Europe.

Keywords: Network Readines Index, GDP per capita, European countries, Correlation analysis

JEL classification: O11, O33, O52, O57

1. Introduction

Digital transformation contributes to company performance through the implementation of digital technologies, innovations in business models, and changes in value creation. Supporting the development of digital infrastructure and promoting markets with a skilled workforce is essential; therefore, countries and governments that adopt resilience and antifragility measures aim to enhance digital readiness. Digital transformation can be supported by strengthening digital literacy programs, providing financial incentives for digital upgrades, and establishing digital hubs to facilitate the digital transition and digital preparedness of countries (Mátyus et al., 2025).

Digital readiness is defined by Dutta et al. (2023) as the ability to effectively utilize modern technologies to achieve goals and enhance performance, which is becoming a key factor in the innovation process. This complex process includes not only technological infrastructure but also organizational changes, and the ability and skills of employees to adapt to dynamic global markets. An increasing number of researchers and institutions emphasize the importance of digital infrastructure, innovation ecosystems, and AI readiness as determining factors in supporting economic and social performance (IMD, 2023).

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The digital economy has become a widely studied topic as the world transitions to digital technologies (Skvarciany et al., 2023). Digital technologies present challenges for entities operating in both global and national markets, transforming how businesses and institutions strategically plan and organize, reduce costs, and develop new types of products and business models on an international scale.

The contribution focuses on assessing the digital readiness of selected EU countries and examining how the Network Readiness Index (NRI) influences the economic performance of these countries.

1.1 Digital transformation

Digital transformation represents a vital component of the digital revolution and a prerequisite for ensuring the competitiveness of economies. The literature offers a wide range of definitions of digital transformation. Papathomas and Konteos (2023) and Teng et al. (2022) define digital transformation as the process of using (emerging) digital technologies to meet customer needs and enhance business empowerment. Fuentes et al. (2024), Ubiparipović et al. (2023), and Korachi and Bounabat (2020) perceive digital transformation as a process involving a comprehensive reconsideration of organizational strategies and structures. Another group of authors describes digital transformation as a process that initiates fundamental changes in a company's organizational characteristics and reconstructs its organizational structure, behavior, and operating systems through the combined use of information technology (IT), computing, communication, and connectivity technologies (Nazari & Musilek, 2023; Teng et al., 2022). According to Czakon et al. (2024), Li & Fei (2023), and Dąbrowska et al. (2022), effective digital transformation requires profound socio-economic change that affects multiple levels including individuals, organizations, ecosystems, and ultimately entire societies.

Traditional firms with established organizational structures and processes face the challenge of digital transformation to a significant extent. A large number of companies consider digital transformation to be the use of new digital technologies to enable significant business improvements, enhance customer experience, streamline operations, or create new business models (Furr et al., 2022). Some economic entities perceive digital transformation as a set of new strategies and business models facilitated by a multitude of emerging information technologies. Views on digital transformation vary, with some institutions and firms regarding it as a straightforward process that improves performance, while many others see it as complex and fraught with challenges (Kane et al., 2021).

Digital transformation involves not only the implementation of digital technologies but primarily changes in established business practices and processes that help companies compete in the digital world (Kane et al., 2021). Its implementation requires new sets of capabilities that enable not only organizational changes but also new processes to leverage digital technologies in order to maximize firm value (Matarazzo et al., 2021). Existing research highlights that although technology is a vital part of digital transformation, it is not the sole area of focus (Hanelt et al., 2021). Talent management, corporate culture, strategy, leadership, and organizational structure play key roles in the digitalization of companies (Elia et al., 2024).

Grimpe et al. (2023) emphasize the importance of providing opportunities in the field of digital knowledge to maintain digital human resources. Digital transformation and innovation (Dong & Verhoef, 2024) have fundamentally changed consumer expectations and behavior, placed pressure on established companies, and disrupted various markets. The main exogenous drivers of digital transformation and business model innovation are considered to be: digital technologies, digital competition, and the behavior of digital consumers. According to Proksch et al. (2021), digital technologies are the main driving force behind digital transformation, yet they require a skilled workforce. The implementation of digital technologies influences most socio-economic and economic processes and activities, from agriculture to public services (Volkova et al., 2021). According to Vasyltsiv et al. (2022), the digital economy requires effective government regulation and support, with mechanisms and tools that evolve in accordance with the current conditions of the digitalization environment through the identification of appropriate incentives.

The necessity of implementing digital technologies depends on a nation's technological infrastructure, such as access to mobile phones, wireless networks, and broadband connectivity—

collectively known as digital infrastructure (Andrews et al., 2018). This infrastructure varies significantly both across and within countries. Weaknesses in traditional infrastructure create opportunities for digital service providers to bridge existing digital divides and support economic development (Kumar et al., 2021; Pelletier et al., 2024).

As a result of these disparities, the ways in which companies use digital technologies to deliver digital products and services differ across countries, influencing their digital readiness in terms of infrastructure, innovation, and technological availability.

1.2 Digital readiness

ICT is often regarded as the most remarkable advancement of the 20th century and is considered one of the key drivers of development, particularly economic growth, in human societies. The use of ICT requires a reliable infrastructure capable of handling the rapidly increasing number of users transitioning to the online environment.

In efforts to enhance digital readiness and competitiveness, the following factors play a crucial role: innovative support for socio-economic indicators in the field of human capital through digital education at all levels, the use of digital skills in the digital labor market and workforce, the development of digital infrastructure across various sectors of the economy, and the promotion of investment in digital technologies and digital innovation in research and development (R&D) for e-business and e-society (Kiseľáková et al., 2024). Digital infrastructure, AI readiness, and digital quality represent key determinants that significantly influence the level of competitiveness (Košiková & Maťovčíková, 2024).

According to Vasyltsiv et al. (2022), digital readiness refers to the widespread adoption of digital technologies in economic and public structures, which determines GDP growth. The authors also confirm that digital readiness is becoming one of the key drivers of national competitiveness. Otola & Knop (2023) emphasize the significant impact of the Network Readiness Index (NRI) on the development of e-Government, transparency, and the formulation of public administration strategies.

Digital readiness and transformation are strategic in nature; however, there is a growing need to strike a balance between technological advancement and the digital literacy of the population (Sulistyanto et al., 2025). Access to and the use of ICT supports sustainable development in all countries, but it is essential for nations to bridge the digital divide in order to fully benefit from sustainable development (Alhassan & Adam, 2024).

1.3 Network Readiness Index (NRI)

The Network Readiness Index (NRI) is used to measure countries' capacities to leverage opportunities offered by ICT and to assess their level of digital readiness. The NRI is one of the most significant indicators reflecting the digital development of nations, providing a much broader view of global digital preparedness (Bánhidi & Dobos, 2024). It is a composite index designed to capture the multifaceted impact of ICT on society and development.

Within the framework of the Network Readiness Index, countries are assessed in terms of infrastructure, innovation, and technology availability. It is a holistic framework that measures the impact of ICT across four key dimensions of society: technology, people, governance, and impact. Its aim is to integrate people with technology in a way that enhances the effectiveness of government strategies for the economy, society, and the environment, making it a reliable tool for measuring a country's e-readiness (Dutta & Lanvin, 2023).

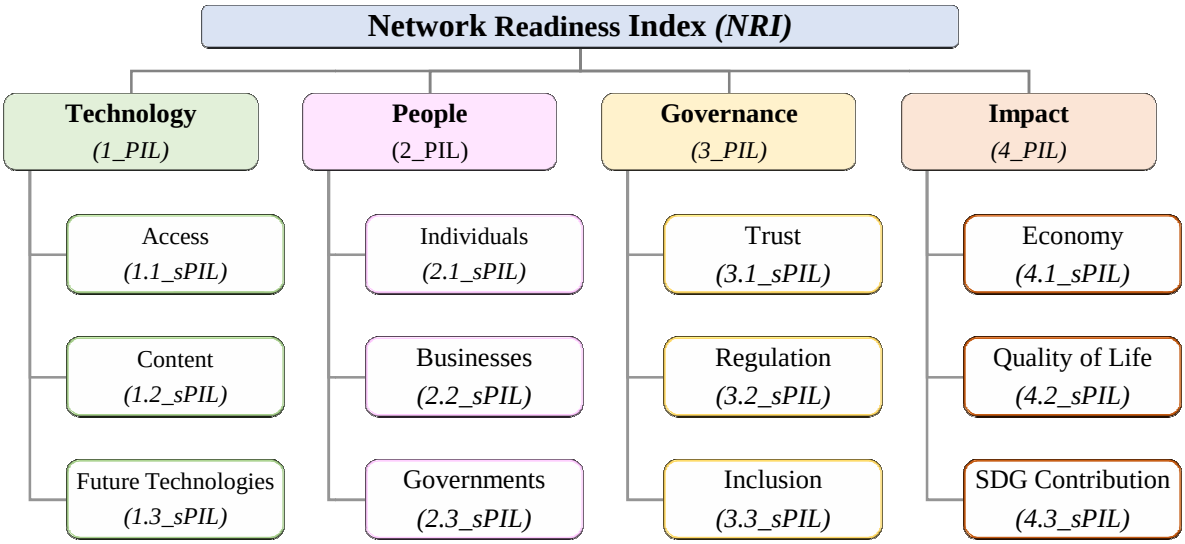

Figure 1. NRI Model of 2024
Source: own processing by Dutta & Lanvin (2024)

As noted by Tokmargenova & Dobos (2024), the NRI index determines a country's readiness for the digital economy. The aim of this index is to evaluate the progress of a country's economy in terms of adopting digital technologies that enhance competitiveness and the well-being of its citizens. The NRI also highlights specific factors that influence the development of the digital economy within a country.

From a structural perspective, the NRI index consists of four pillars, each comprising three sub-pillars. A total of 58 indicators are included in the assessment, although this number was reduced to 54 in 2024.

2. Methods

The aim of this article is to identify the key indicators of digital transformation in selected European Union countries, reveal their impact on GDP per capita, and provide recommendations for improving digital transformation, readiness, and competitiveness of the analyzed countries.

To assess digital transformation, we selected the Network Readiness Index (NRI) for the period 2022 to 2024, and the research analysis includes 40 European countries.

The NRI index evaluates more than 130 countries, with the number continuously changing over time. In 2022, a total of 131 countries were assessed; this number increased to 134 in the following year and slightly decreased to 133 economies worldwide in 2024. From this global set, we focused on European countries and selected 40 of them for our analysis.

The main objective was achieved through the following partial goals:

- *Partial objective 1* → To evaluate the development of digital transformation in the EU-40 countries using the overall score the Network Readiness Index (NRI) for the period 2022–2024,
- *Partial objective 2* → To identify the existence of mutual influences between the overall NRI score and its pillars, sub-pillars, and input indicators,
- *Partial objective 3* → To identify the existence of mutual influences between GDP per capita and selected indicators of the NRI index (overall score, pillar scores, sub-pillar scores, and input indicators).

In accordance with the defined partial research objectives (2 and 3), the following research hypotheses were formulated. Their purpose is to verify the existence of statistically significant relationships between selected variables. The hypotheses will be tested using correlation analysis.

- *Research Hypothesis H1*: There is a statistically significant relationship between the overall NRI index score and its pillars, sub-pillars, and input indicators;

- *Research Hypothesis H2*: There is a statistically significant relationship between GDP per capita and selected indicators of the NRI index.

Interpretation of the correlation coefficient is a frequent problem because there are no generally valid limits. Based on the achieved absolute value of the correlation coefficient, Chajdiak (2013) defined the following 3 degrees of strength of mutual dependence: low dependence (0.10-0.39), medium dependence (0.40-0.79) and higher dependence (0.80-1.00). This scale was used to interpret the results of the correlation analysis.

To test the research hypotheses, the non-parametric Kendall Tau correlation test was employed. The selection of this coefficient was based on the results of normality tests (Kolmogorov–Smirnov test, Lilliefors test, and Shapiro–Wilk test), which indicated a violation of the normality assumption for certain variables within the secondary dataset of the NRI index.

3. Results

In the following section of our contribution, we focus on assessing the development of digital transformation in the EU-40 countries using the Network Readiness Index (NRI) for the years 2022 to 2024, with an emphasis on the evolution of the overall score.

The 2024 edition of the Network Readiness Index (NRI) ranking is dominated by countries characterized by a high level of digitalization, economic advancement, and effective public administration. For the third consecutive year, the United States remains at the top of the ranking, followed by Singapore and Finland, both of which consistently hold positions within the top three. Notable improvements were observed in Sweden and the Republic of Korea, which advanced to fourth and fifth place, respectively. The remaining top 10 positions are primarily occupied by European countries, including the Netherlands, Switzerland, the United Kingdom, Germany, and Denmark. The regional composition of the top ten highlights Europe's dominance, with seven countries represented in the elite group. The Asian region is represented by only two countries (Singapore and the Republic of Korea) while the Americas are solely represented by the United States. This distribution underscores the persistent disparities in digital readiness across global regions and emphasizes the importance of systematically developing digital capacities as a key component of national competitiveness.

3.1 Development of the NRI in the analyzed European countries from 2022 to 2024

The following Table 1 provides an overview of the overall NRI scores of the analyzed countries for the years 2022 to 2024, along with their rankings among the 40 European countries included in the analysis.

Table 1. Evolution of NRI Scores in EU-40 Countries from 2022 to 2024

Country	NRI_2022	RANK	NRI_2023	RANK	NRI_2024	RANK
Albania	46.50	39.	44.98	39.	44.67	39.
Austria	71.31	11.	69.13	10.	66.05	12.
Bosnia and Herzegovina	42.67	40.	40.06	40.	43.20	40.
Belgium	70.04	13.	67.02	13.	65.88	13.
Bulgaria	55.51	32.	52.18	33.	53.15	30.
Cyprus	59.95	25.	58.43	24.	56.68	25.
Czechia	66.83	16.	63.20	17.	63.47	18.
Germany	76.11	6.	74.00	6.	73.54	6.
Denmark	78.26	4.	74.06	5.	72.70	7.
Estonia	69.79	14.	66.11	14.	67.85	10.
Spain	66.51	17.	64.77	16.	65.15	15.
Finland	77.90	5.	76.19	1.	75.76	1.
France	72.19	9.	70.17	8.	68.71	9.
United Kingdom	73.41	8.	72.75	7.	73.57	5.
Georgia	47.14	38.	45.25	38.	49.30	36.
Greece	55.74	30.	53.02	30.	52.90	31.
Croatia	56.86	28.	52.75	31.	51.96	34.
Hungary	59.20	27.	58.21	25.	55.33	26.
Switzerland	78.45	3.	74.76	4.	73.71	4.

Ireland	70.15	12.	67.51	12.	66.20	11.
Iceland	67.48	15.	65.70	15.	64.86	16.
Italy	64.11	21.	62.20	20.	63.6	17.
Lithuania	62.78	22.	60.41	22.	59.95	20.
Luxembourg	72.10	10.	67.84	11.	65.45	14.
Latvia	59.86	26.	57.77	26.	57.68	24.
Republic of Moldova	49.54	36.	47.69	36.	48.11	37.
Montenegro	50.38	35.	48.14	35.	49.58	35.
North Macedonia	48.46	37.	46.26	37.	45.92	38.
Malta	64.87	20.	61.94	21.	59.75	22.
Netherlands	78.82	2.	76.04	2.	73.94	3.
Norway	75.68	7.	69.70	9.	69.70	8.
Poland	61.16	23.	60.20	23.	59.94	21.
Portugal	65.63	19.	63.08	18.	61.73	19.
Romania	54.89	33.	52.41	32.	52.77	32.
Serbia	53.52	34.	51.68	34.	53.91	29.
Sweden	78.91	1.	75.68	3.	74.99	2.
Slovenia	65.67	18.	62.57	19.	59.38	23.
Slovakia	60.27	24.	57.08	27.	54.88	28.
Turkiye	55.77	29.	53.22	29.	52.65	33.
Ukraine	55.71	31.	55.16	28.	55.32	27.

Source: own processing

The average NRI score for the 40 analyzed European countries showed a declining trend during the observed period. In 2022, the average reached 63.50. In 2023, it decreased to 60.98, representing a drop of approximately 4%, and in 2024, the average slightly declined further to 60.60.

In 2022, Sweden ranked first in the European index with a score of 78.91, followed by the Netherlands (78.82) and Switzerland (78.45). The top ten also included Denmark, Finland, Germany, Norway, the United Kingdom, France, and Luxembourg, reflecting their high level of digital readiness. On the other hand, countries at the bottom of the ranking included Bosnia and Herzegovina (42.67), Albania (46.5), and Georgia (47.14), all located in the Western Balkans.

In 2023, a change occurred at the top of the European ranking. Finland became the new leader with a score of 76.19, ahead of the Netherlands (76.04) and Sweden (75.68). Switzerland, Denmark, Germany, the United Kingdom, France, and the Netherlands remained in the top 10, and Austria joined them for the first time. Most countries experienced a slight decline in their scores. The largest year-on-year decrease was recorded by the Netherlands (−5.98), while Luxembourg, Denmark, and Croatia also dropped by more than four points. The smallest decline was observed in Ukraine (−0.55). Bosnia and Herzegovina (40.06), Albania (44.98), and Georgia (45.25) remained at the bottom.

The year 2024 brought several notable changes. Finland maintained its leading position with a score of 75.76, followed by Sweden (74.99) and the Netherlands (73.94). Estonia significantly improved its score, rising from 66.11 to 67.85, which moved it up to 10th place. Bosnia and Herzegovina, although still in 40th place, recorded the largest year-on-year improvement, gaining +3.14 points. In total, 13 countries experienced an increase in their scores, with the highest recorded in Georgia (+4.05 points). On the contrary, 26 countries saw a decline, with the largest drop in Slovenia (−3.19 points). An interesting observation is that Norway achieved the same score of 69.70 in both 2023 and 2024.

Leaders such as Finland, Sweden, the Netherlands, Switzerland, and Denmark continue to hold strong positions and consistently improve their performance. In contrast, Western Balkan countries, despite slight progress, remain at the bottom of the European ranking.

3.2 Evaluation of correlation analysis results

In the following section of our contribution, we focused on conducting a correlation analysis in order to identify the mutual relationships between the NRI index and its pillars and sub-pillars, as well as with the selected macroeconomic indicator, GDP per capita.

Based on the results of the correlation analysis between the NRI index and its individual pillars and sub-pillars (see Table 2), it can be concluded that most relationships are moderately strong and statistically significant.

Table 2. Results of the correlation analysis at the significance level $p \leq 0.05$ (N=120)

Pair of Variables	Kendall Tau	Z	p-value	Pair of Variables	Kendall Tau	Z	p-value
NRI & 1_PIL	0.8297	13.4371	0.0000	*GDPc & 1_PIL*	0.5947	9.6309	0.0000
NRI & 2_PIL	0.7174	11.6179	0.0000	*GDPc & 2_PIL*	0.3938	6.3783	0.0000
NRI & 3_PIL	0.7667	12.4163	0.0000	*GDPc & 3_PIL*	0.6275	10.1617	0.0000
NRI & 4_PIL	0.8255	13.3690	0.0000	*GDPc & 4_PIL*	0.5782	9.3633	0.0000
NRI & 1.1_sPIL	0.4501	7.2901	0.0000	*GDPc & 1.1_sPIL*	0.4050	6.5598	0.0000
NRI & 1.2_sPIL	0.6944	11.2459	0.0000	*GDPc & 1.2_sPIL*	0.4510	7.3037	0.0000
NRI & 1.3_sPIL	0.7350	11.9037	0.0000	*GDPc & 1.3_sPIL*	0.6266	10.1481	0.0000
NRI & 2.1_sPIL	0.0616	0.9980	0.3183	*GDPc & 2.1_sPIL*	-0.0793	-1.2838	0.1992
NRI & 2.2_sPIL	0.6356	10.2933	0.0000	*GDPc & 2.2_sPIL*	0.4129	6.6868	0.0000
NRI & 2.3_sPIL	0.7381	11.9536	0.0000	*GDPc & 2.3_sPIL*	0.4627	7.4943	0.0000
NRI & 3.1_sPIL	0.6504	10.5337	0.0000	*GDPc & 3.1_sPIL*	0.5706	9.2408	0.0000
NRI & 3.2_sPIL	0.6364	10.3069	0.0000	*GDPc & 3.2_sPIL*	0.6193	10.0302	0.0000
NRI & 3.3_sPIL	0.7437	12.0444	0.0000	*GDPc & 3.3_sPIL*	0.5064	8.2020	0.0000
NRI & 4.1_sPIL	0.6389	10.3477	0.0000	*GDPc & 4.1_sPIL*	0.4062	6.5779	0.0000
NRI & 4.2_sPIL	0.5773	9.3497	0.0000	*GDPc & 4.2_sPIL*	0.4852	7.8572	0.0000
NRI & 4.3_sPIL	0.7014	11.3593	0.0000	*GDPc & 4.3_sPIL*	0.6014	9.7398	0.0000

Note:
0.1 - 0.39 → low dependence
0.4 - 0.79 → medium dependence
0.8 - 1.00 → higher dependence

Source: own processing

The main pillars (1 to 4) demonstrate moderately strong and statistically significant correlations with the overall NRI score, all exceeding Kendall's Tau values of 0.7. The highest associations were recorded for Pillar 1 – *Technology* ($\tau = 0.8297$) and Pillar 4 – *Impact* ($\tau = 0.8255$), confirming that a country's technological advancement and the tangible effects of digital transformation are closely linked to its digital readiness.

Among the sub-pillars, the strongest relationships with the NRI were found in:

- 1.3_sPIL (*Future Technologies*) → $\tau = 0.7350$,
- 2.3_sPIL (*Governments*) → $\tau = 0.7381$,
- 3.3_sPIL (*Inclusion*) → $\tau = 0.7437$,
- 4.3_sPIL (*SDG Contribution*) → $\tau = 0.7014$.

These results suggest that key drivers of digital readiness include innovation capacity, effective public governance, social inclusion, and the contribution of digital transformation to sustainable development goals.

In contrast, sub-pillar 2.1 (*Individuals*) showed no statistically significant relationship with the NRI ($\tau = 0.0616$; $p = 0.3183$), indicating that the level of digital access and engagement among individuals as currently measured may not directly influence the overall readiness score.

In conclusion, a country's digital performance is most influenced by its future-oriented technological infrastructure, institutional quality, and digital impact. Meanwhile, certain aspects of individual-level inclusion appear less connected to national-level digital readiness, highlighting the need to balance structural advancements with inclusive digital policies. These findings support the importance of a multidimensional framework for assessing digital transformation across countries.

In the following correlation analysis, we focused on identifying the mutual relationships between the NRI (overall score, pillar scores, and sub-pillar scores) and GDP per capita of the selected 40 European countries.

Correlation analysis indicates a statistically significant moderate positive relationship between GDP per capita and the NRI (Kendall's Tau = 0.5908; $p < 0.001$), indicating that a higher level of economic development is moderately associated with higher digital readiness in the analyzed European countries. This correlation suggests that countries with higher GDP per capita tend to score

higher on the NRI, indicating that economic prosperity is closely linked to digital readiness. This may be due to better infrastructure, higher investments in technology, and more effective digital governance.

The results of the correlation analysis confirm that there is a positive and statistically significant relationship ($p \leq 0.05$) between GDP per capita (GDPc) and most of the pillars and sub-pillars of the NRI index. The strongest correlation was observed between GDP and Pillar 3 – *Governance* ($\tau = 0.6275$), followed by Pillar 1 – *Technology* ($\tau = 0.5947$) and Pillar 4 – *Impact* ($\tau = 0.5782$). These findings suggest that countries with higher economic performance tend to score better in areas such as regulatory effectiveness, technological innovation, and the measurable impacts of digital transformation.

Among the sub-pillars, the most significant associations were found in:

- 1.3_sPIL (*Futures technologies*) → $\tau = 0.6266$,
- 3.2_sPIL (*Regulation*) → $\tau = 0.6193$,
- 4.3_sPIL (*SDG Contribution*) → $\tau = 0.6014$.

These dimensions exhibit the strongest direct links to a country's level of economic development. In addition, robust correlations were also observed for other indicators such as digital skills, ethical use of technology, and trust in the digital environment, reinforcing the assumption that advanced digital infrastructure and effective governance mechanisms contribute positively to national economic performance.

The only exception was sub-pillar 2.1 (*Individuals*), which showed statistically insignificant correlation ($\tau = -0.0793$; $p = 0.1992$). This implies that the degree of individual digital inclusion is not directly associated with GDP per capita, and in some cases, a slight inverse relationship may exist. Such a result could be attributed to internal digital divides within more economically advanced countries.

3.3 Evaluation of Research Hypotheses

Based on the results of Kendall's correlation analysis, *hypothesis H1* was confirmed at the significance level of $p \leq 0.05$. All four main pillars of the index showed a moderate and statistically significant positive correlation with the overall NRI score ($\tau > 0.70$; $p < 0.05$). Most sub-pillars also demonstrated significant correlations. The only exception was sub-pillar 2.1 (*Individuals*), where no statistically significant relationship was found ($\tau = 0.0616$; $p = 0.3183 > 0.05$).

Hypothesis H2 was also confirmed at the significance level of $p \leq 0.05$. The overall NRI score was significantly correlated with GDP per capita ($\tau = 0.5908$; $p < 0,05$). Statistically significant relationships were also confirmed between GDP per capita and several NRI sub-pillars, particularly *Future technologies* (1.3), *Regulation* (3.2), and the *SDG contribution* (4.3). Again, no significant relationship was found for sub-pillar 2.1 (*Individuals*) ($\tau = –0.0793$; $p = 0.1992 > 0.05$).

4. Discussion

The results of the correlation analysis provide valuable insight into the structural interconnectedness ofkey indicators of digital transformation in Europe. The relationships identified between the Network Readiness Index, its main pillars and sub-pillars, and the macroeconomic indicator GDP per capita, reflect the degree to which digital advancement is embedded in the broader socio-economic context of European countries.

A positive and statistically significant correlation between GDPc and the overall NRI ($\tau = 0.5908$; $p < 0.05$) suggests that a country's digital readiness is closely linked to its level of economic development. In other words, economically stronger countries are generally better equipped to leverage the benefits of digital transformation. This supports the hypothesis that digitally advanced countries tend to achieve higher productivity, stronger innovation performance, and more efficient institutions.

At the pillar level, the strongest correlation with GDPc was found for Pillar 3 – *Governance* ($\tau = 0.6275$), followed by Pillar 1 – *Technology* ($\tau = 0.5947$) and Pillar 4 – *Impact* ($\tau = 0.5782$). These results underscore the importance of technological infrastructure and an effective regulatory framework as fundamental elements of digital competitiveness. Among the sub-pillars, the strongest associations were observed for *Future technologies* (1.3), *Regulation* (3.2), and *SDG contribution*

(4.3) – all with correlations exceeding $\tau = 0.60$. These findings confirm that material and institutional foundations of digitalization are strongly related to a country's level of economic development.

From a social perspective, the results for sub-pillar 2.1 (*Individuals*) are particularly noteworthy, as this dimension showed no statistically significant correlation either with GDP per capita ($\tau = -0.0793$; $p = 0.1992$) or with the overall NRI score ($\tau = 0.0616$; $p = 0.3183$). These findings suggest that the level of individual digital inclusion is not directly determined by a country's economic performance or its overall digital readiness. In other words, a higher GDP does not automatically ensure equal access to digital technologies for all citizens, highlighting the persistence of digital inequality even in economically advanced countries.

In conclusion, digital transformation is a multidimensional process, with technological and economic factors at its core. However, its long-term sustainability depends on the quality of human capital and the level of social inclusion. The key indicators identified in this study thus provide a strong foundation for further monitoring, benchmarking, and targeted digital policymaking across Europe.

Conclusion

An analysis of leading countries reveals a common profile characterized by strong performance across all four pillars of the index: technological advancement, human capital, effective governance of public institutions and positive socio-economic impact. These countries consistently rank within the top twenty to twenty-five in all evaluated dimensions, highlighting their comprehensive readiness for digital transformation.

The key factors of digital transformation identified in this study include technological infrastructure, digital skills, the quality of governance and regulatory environment, and the economic impact of digitalization. These dimensions showed the strongest correlations with both the overall Network Readiness Index (NRI) score and the macroeconomic indicator GDP per capita. In contrast, digital inclusion emerged as a dimension with relatively weaker links to economic performance, highlighting persistent inequalities in access to digital services.

The correlation analysis confirmed a strong and statistically significant relationship between the overall NRI score and most of its pillars and sub-pillars ($\tau > 0.7$; $p < 0.05$). The strongest associations were recorded for technological infrastructure, digital skills, trust and ethics in the digital environment, and the economic impact of digitalization. The only exception was sub-pillar 2.1 (*Individuals*), which did not show a statistically significant relationship with either the NRI or GDP per capita. This finding suggests that social aspects of digital transformation, such as individual digital inclusion, are not necessarily determined by the level of economic development or digital readiness.

The results indicate that countries' economic prosperity is closely tied to their level of digital readiness, with infrastructure, regulation, and the ability to translate digital capacity into real impact playing the most critical roles. On the other hand, social dimensions require specific policy attention, as their connection to economic performance is more complex and not always straightforward. These findings highlight the need for balanced policy-making that, alongside technological and institutional development, also addresses the inclusive nature of digital transformation.

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Economic and Political Implications of Public Transport Discount Fares in Czechia

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Abstract

Research background: Public transport fare discounts serve as a prevalent policy tool aimed at assisting specific demographic groups, fostering social equity, and encouraging sustainable transportation practices. Nevertheless, the economic and political ramifications of these subsidies are frequently overlooked or insufficiently assessed. In the Czech Republic, notable modifications in the scope and regulation of public transport fare discounts took place from 2017 to 2023, particularly impacting students, elderly individuals, and those with disabilities. Although these policies are designed to yield social advantages, they can also impose significant financial strains on public budgets, disrupt competitive dynamics, and affect the quality of services provided.
Purpose of the article: Paper offers a critical examination of the economic justifications, political motivations, and wider socio-economic effects of the public transport discounts enacted in the Czech Republic during the specified timeframe. The objective is to discern both the intended benefits and the unintended repercussions, thereby providing a thorough analysis for policymakers.
Methods: The research utilizes a mixed-methods approach, integrating qualitative policy analysis, structured reviews of legislative documents, and quantitative evaluations of data sourced from several Czech ministries, Czech Railways, and Flixbus CZ s.r.o. as a private operator of bus public transportation. A systematic analysis of comparative statistics and economic indicators, including budgetary expenditures, and market share distributions, was conducted.
Findings & Value added: Findings reveal that fare discounts have led to a significant increase in fiscal expenditures and contributed to market distortions that favor state-owned operators over private competitors. This study contributes to the discourse by identifying policy inefficiencies and proposing alternative strategies for more economically viable and socially equitable transport subsidies.

Keywords: Fare discounts, Third-degree price discrimination, Czech Republic, České dráhy, a.s., FlixBus CZ s.r.o.

JEL classification: E00, J14, H41, H42, R4

1. Introduction

In contemporary society, various forms of discounts can be observed as both social and commercial constructs across a wide range of economic sectors. These discounts are prevalent in specialized retail outlets, subsidized public transportation fares, and online retailers operating on both national and international levels. The rationale behind these financial incentives is rooted in the classification of the economically inactive demographic, which includes pensioners and students, and their associated productivity levels. Despite their potential contribution to the economy as future labor market participants or active contributors to the silver economy, their current status represents a financial burden rather than a source of revenue for the state. Alongside younger minors and individuals with health challenges, they comprise what is referred to as the unproductive segment of the population, which typically benefits from discounts as well as other socio-political initiatives or state subsidies. According to the Czech Statistical Office, in 2023, there were nearly 1,730,000

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individuals under the age of 15 and over 2,230,000 aged 65 and above in the Czech Republic. Additionally, there were 484,758 secondary school students and 308,640 university students enrolled. Furthermore, over 1.1 million individuals with disabilities were documented. Collectively, these groups represent a substantial portion of the Czech populace, accounting for over 43%. Due to their prolonged economic inactivity, they are frequently monitored by authorities overseeing social policy, as they are recipients of various benefits, including reduced prices for goods and services. This approach is not solely a governmental initiative but also a common strategy employed by retailers to attract new customers and enhance their market competitiveness. Public transportation systems are similarly influenced, with financial support directed towards the aforementioned demographic groups.

This article seeks to examine the discounts implemented in public passenger transportation and their effects on the extent and quality of services provided by specific carriers, as well as the broader economic context of the Czech Republic. A comprehensive analysis will focus on the state railway operator České dráhy, a.s., and the private bus service Flixbus CZ s.r.o. during the timeframe from 2017 to 2023, particularly highlighting the period from September 1, 2018, to March 31, 2022, when a nationwide discount of 75% on fares was applicable for children aged 6 and above, students up to 26 years, and seniors aged 65 and older.

1.1 Discount as a form of price discrimination

Various prices are assigned to distinct categories of goods, diverse consumers, and different consumer groups. This situation exemplifies price discrimination, driven by the aim to achieve greater economic profit alongside consumer surplus (Bergemann et al., 2021).

For price discrimination to be effective, three essential conditions must be met. Firstly, the firm needs to identify at least two market segments or consumer groups. Typically, these segments vary in terms of income levels, which sellers can discern. Additionally, customer groups exhibit differing demands, which tend to decrease in an imperfectly competitive market. Lastly, sellers must possess the capability to implement a so-called dual pricing strategy. Economically, this serves as a straightforward method for enhancing revenue and optimizing consumer utility (Jurečka, 2018).

Pigou (1932) identified three levels of price discrimination, which categorize prices based on different consumers (1st degree), varying quantities of goods (2nd degree), and distinct consumer groups (3rd degree), with these categories not being mutually exclusive. The first degree embodies rather an idealized perfection, whereas the third stage, recognized as the most prevalent manifestation of this microeconomic phenomenon, operates effectively under the condition that distinct groups refrain from trading the specified goods amongst themselves, meaning they do not engage in arbitrage. Consequently, sellers can adjust prices based on geographical location while simultaneously providing preferential pricing to wholesale clients. In the new millennium, an alternative classification was introduced, based on compatibility, profitability, and information complexity (Chao, Nahata, 2021). This classification, in descending order, includes total discrimination, direct segmentation, and indirect segmentation (Rabay, Andrade, 2019).

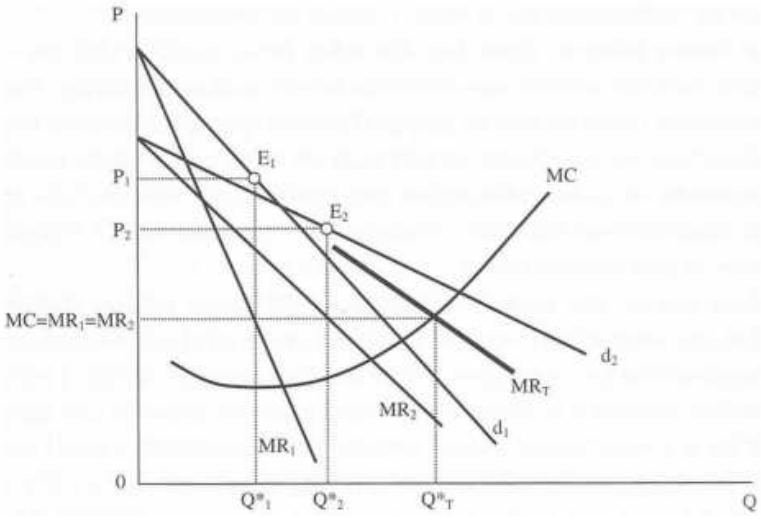

Figure 1. Third-degree price discrimination
Source: Musil (2009)

The studies reviewed primarily investigate the link between third-degree price discrimination and welfare evaluation, questioning its societal benefits or drawbacks. Analysis indicates that social welfare improves for consumers paying lower prices under price discrimination. To enhance overall social welfare[1], aggregate production must increase, thereby strengthening the market. In oligopolistic markets, one segment may operate outside the single price, causing cross- and inter-market consumption externalities (Adachi, 2022). Recent research in platform economics considers these externalities in the context of imperfect competition (Belleflamme, 2021). The differences between traditional third-degree price discrimination in monopolies and its modern interpretation in oligopolies are slight, as both can be analyzed through consumer behavior (Wang et al., 2023). If firms are symmetrical, the graphical analysis applies to both cases. This reasoning can also extend to more heterogeneous inter-firm environments through empirical research (Adams and Williams, 2019). Future theoretical advancements are expected in exploring third-degree price discrimination in imperfectly competitive intermediate markets (Gaudin and Lestage, 2022).

In duopoly markets, price discrimination can enhance competition and benefit consumers. However, if data access or processing technology is uneven, consumers may not gain advantages; instead, sellers and price-sensitive buyers may benefit (Graham, Mulley, 2012). While this may seem efficient, it overlooks consumer living standards, raising issues of social justice and privacy. Allowing data ownership, especially of big data, could reduce incentives for its collection, highlighting the need for alternative data utilization methods beyond price discrimination or advertising (Ezrachi, Stucke, 2016).

1.2 Development of price regulation in domestic public transport in the Czech Republic

In accordance with the Regulation of the Ministry of Finance of the Czech Republic No. 1/2023 (2022) and the statutory authorization specified in Section 10 of Act No. 526/1990 Coll. (Prices Act), there are three categories of price regulations that are applicable in the Czech Republic: maximum prices, objectively guided prices and fixed prices. All categories encompass public transport fares. Although regions and municipalities possess the authority to establish maximum prices, passenger transport that is based on nationally integrated public services is regulated by what are known as fixed prices. These fixed prices enable transportation to the destination station utilizing the services of any public carrier, all based on a single document[2]. Other transported goods are subject to material price guidelines, which, while not legally mandated, are determined through negotiations between sellers and buyers according to established protocols. This material guideline is relevant to both rail and bus public transport.

The price regulation outlined in the Regulation also mandates that carriers provide certain demographic groups with preferential fares that range from 50% to 100% of the standard fare. Each carrier determines these fares individually, following the guidelines and calculations specified in the Regulation. The extent of these discounts, along with their amounts, is monitored by regional and municipal authorities in collaboration with the Specialized Financial Office. This oversight primarily focuses on ensuring the accuracy of price records, the proper application of discounts in line with price regulations, and preventing any misuse of the carrier's economic position. Should any infractions of these regulations be identified, the authorities are empowered to impose fines or implement other corrective actions (Ministry of Finance of Czech Republic, 2022).

The evolution of price regulation in domestic rail and bus transport has been shaped by objective price guidance. This requires carriers to provide discounts to vulnerable passenger groups to ensure their access to public transport. Fare rates have varied due to factors like vehicle purchase prices, fuel costs, excise tax changes, and operational expenses, alongside commercial considerations[3]. A key

1 The group of consumers paying a higher than equilibrium price is defined as a strong market, while consumers paying a lower price as a weak market.

2 Carriers that wish to adhere to the provisions of the uniform tariff system must enter into an access agreement with the system's owner, which is the state, represented by the Ministry of Transport of the Czech Republic.

3 Mandatory discounts on travel fares for pensioners were initially implemented in the Czech Republic in 2001, providing a reduction of 50% off the standard fare for second-class passenger trains, which includes EuroCity and Intercity services. As of September 1, 2004, following Government Resolution No. 624/2003, discounted travel fares were made available for pupils and students attending all educational institutions in the Czech Republic up to the age of 26, who are fulfilling compulsory school attendance or are engaged in full-time studies to prepare for their future careers. Over time, the extent of

example is the government resolution from 27 March 2018, which adjusted discount rates. From 1 September 2018 to 31 March 2022, certain groups (children, students, and pensioners) paid only 25% of the full fare, which increased to 50% on 1 April 2022 as part of consolidation efforts[4]. Additionally, the fare structure transitioned from a zone tariff to a distance-based model, supported by a financial cap from the Ministry of Transport. Recently, a unified tariff system was introduced, allowing travel on a single ticket across multiple railway companies since December 2020.

1.3 The concept of public support and public service provided by the private sector in the quality of public transport

The legal framework for public support is defined by European law[5], with the European Commission determining its compatibility with the internal market. This applies to measures that meet four defining features[6], which, if satisfied, allow for execution without determining the form of public support. The key concern is the impact on competition. Generally, measures meeting all defining features are prohibited unless a legal basis is found that the Commission recognizes as compatible[7]. An exception is small-scale support (de minimis), which does not distort competition or trade among Member States and adheres to financial thresholds. In the transport sector, the satisfaction of all defining features is common, especially for compensating public passenger transport services[8]. If conditions in the Regulation are met, this support is compatible with the internal market without prior Commission evaluation[9]. In the Czech Republic, this framework was amended by Act No. 194/2010 Coll., regarding public passenger transport services.

In general, the support provided by public entities is inherently associated with the development and functioning of transport infrastructure due to its considerable capital intensity. Although the European Union does not explicitly establish any regulations defining infrastructure projects that do not qualify as public support, the European Commission differentiates between initiatives aimed at constructing or enhancing what is referred to as general and specific infrastructure when implementing these regulations (Kekelekis, 2011).

The regulation of public support within the transport sector is marked by a duality of legislation, where the legal framework for evaluating the compatibility of public support with the internal market varies depending on the type of transport being subsidised. In conjunction with the gradual liberalisation of prices since the 1990s, a crucial element of public support in transport is also the liberalisation of markets, which has become prevalent throughout the Union. The extent of this liberalisation differs among various transport types and thus serves as a primary factor influencing the Commission's decision-making processes. The rail transport sector remains the least liberalised among all transport modes. In terms of passenger rail transport, the market has only been opened to international transport, while national transport remains closed. Conversely, in the realm of road

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discounts has also evolved for various demographic groups, such as individuals with disabilities, members of state authority, war veterans, and political dissidents (Ministry of Finance of the Czech Republic, 2022).

4 The policy regarding discounts for individuals with disabilities (those holding ZTP and ZTP/P cards) remains unchanged. In 2022, the cap on the number of children under the age of 6 who can travel for free was eliminated, and a new discount of 50% off the full fare was introduced for individuals classified as disabled in the 3rd degree. Between April 1 and August 1, 2022, individuals escaping the war in Ukraine were provided free transportation to secure essential documentation.

5 In the primary law of the European Union, the legal definition of public support is contained in Article 107(1) of the Treaty on the Functioning of the European Union (Part Internal Policies and Actions of the Union, Section State Aid).

6 The measure is granted through State resources; The measure is selective and favours certain undertakings or specific production sectors; The measure distorts or threatens to distort competition; The measure affects trade between Member States (Rydelski, 2006).

7 In the cumulative fulfilment of all defining features, the provider of public support is obliged to inform the Commission per Article 108(3) of the Treaty on the Functioning of the European Union.

8 In accordance with Regulation (EC) No 1370/2007 established by the European Parliament and the Council regarding public passenger transport services via rail and road, the primary intervention of this obligation was to provide a clearer legal framework concerning the duration of passenger transport contracts, the process for selecting carriers, and the requirements for information publication. This regulation applies to public services in both national and international passenger transport by road and rail.

9 In accordance with the individual exemption for compatibility with the internal market as outlined in Article 107(3) of the Treaty on the Functioning of the European Union, public support can only be provided following prior approval from the Commission. Specifically, in the realm of public transport, this pertains particularly to those forms of support that align with the coordination of transport or that serve as compensation for specific services associated with the notion of public service (Article 93 of the Treaty on the Functioning of the European Union).

passenger transport, international transport was liberalised as early as the 1990s[10]. The Commission considers the market for urban, suburban, or regional public transport to be competitive, as companies providing transport services are permitted to operate in member states other than their country of origin.

Although the public sector often provides purely private goods at no cost, this is a matter of political choice[11], and the efficiency of delivering these goods tends to be lower. However, private services in public passenger transport, known as the open access regime, have positively impacted the quality of the services offered. In the context of rail transport, this model relies on adequate infrastructure capacity. If the service is to be established on a commercial basis, it may struggle to adequately address the fluctuations in demand during peak times, which can arise from directional asymmetry or inefficient utilization of rolling stock. Consequently, this leads to costs that are not offset by sales, resulting in financial losses. To mitigate this issue, commercial carriers typically provide reserved seating, which helps them manage relatively inconvenient demand during peak periods. For passengers, this necessitates purchasing a seat well in advance, thereby reducing service flexibility and potentially causing a loss of some prospective customers. As a result, numerous public transport frameworks in various countries are exploring relevant enhancements to their current models (Ministry of Transport of the Czech Republic, 2021).

Long-distance bus transport mainly operates commercially on routes lacking quality rail infrastructure, facing significant fluctuations due to competition. Regions struggle to manage these fluctuations, and the Czech Republic does not intervene due to a lack of regulatory tools. Regulation No. 1370/2007 outlines state involvement in public transport, particularly through compensation for losses from mandatory discounts, improving profitability. A key goal of revising the Public Transport Concept is to create new authorities to regulate congested bus routes and better integrate them into long-distance transport. Ensuring quality through rapid bus services is essential, paving the way for a sustainable rapid rail connection and enhancing passenger transport services (Ministry of Transport of the Czech Republic, 2021).

2. Methods

The theoretical framework of this article is grounded in a comprehensive literature review, which includes an analysis of various international studies and professional monographs. The practical component relies on a comparative assessment of publicly accessible data from the companies being examined. Specifically, for both companies compared, the provisions of Act No. 106/1999 Coll. concerning the right to information were utilized. Conversely, the practical section delves into the evaluation of economic metrics and service quality offered by both transport providers from 2017 to 2023, a timeframe during which both entities were active in the public transport sector concurrently, with a particular focus on state compensation and the resulting economic and political ramifications in the Czech Republic.

3. Results

Offering discounts to designated target groups enables carriers to manage the socio-demographic composition of their passengers while also assisting individuals with limited disposable income. This analysis centers on the state-owned railway operator České dráhy, a.s., as well as the private bus service provider FlixBus CZ s.r.o..

10 At present, this refers to Regulation 1073/2009 established by the European Parliament and the Council, which outlines standard regulations for accessing the international market for coach and bus services. This regulation permits, among other provisions, cabotage—defined as national road passenger transport conducted by an entrepreneur who does not reside in the respective Member State—in specific contexts such as regular, occasional, and international regular transport.

11 In this manner, governments tackle scenarios in which discriminatory pricing practices intensify income disparities or serve as a tool of state paternalism, particularly when the consumption of goods yields positive societal impacts. Furthermore, such consumption may be restricted, for instance, through the implementation of a governmental pricing system or by employing specific measures such as quotas or other forms of quantitative limitations (Stejskal et al., 2023).

On March 27, 2018, the government approved a proposal for a 75%[12] fare reduction for youth and seniors, effective September 1, 2018. This initiative faced criticism from experts and the public regarding fund allocation, potential budget cuts in other departments, and concerns about market interference, which may persist regardless of government changes (Tomeš et al., 2018).

Discounts for specific demographics varied significantly, as shown in the table below. Notably, pensioners over 65 received no discount[13]. Before September 1, 2018, pupils and students could access discounts for educational travel during the academic year, excluding summer vacations. After legislative changes, all demographic groups received a standardized 75% discount, except for travelers visiting parents in institutions.

Table 1. Amount of discounts on travel fares for selected population groups in the Czech Republic before and after the introduction of the 75% discount

Discount Category	***Discount until 1.9.2018***	***Discount from 1.9.2018 to 31.3.2022***	***Discount since 1.4.2022***
Children under 6 years old	100 %	100 %	100%
Children from 6 to 15 years old	50 %	75 %	50%
Pupils from 6 to 15 years old	62,5 %	75 %	50%
Students from 15 to 26 years old	25 %	75 %	50%
Pensioners aged 65 years and over	-	75 %	50%
Persons with disabilities	75 %	75 %	75%
Guide for people with disabilities	100 %	100 %	75%
Parental visits to institutions	75 %	50 %	50%

Source: Ministry of Transportation of Czech Republic, own processing (2024)

The increase in discount percentages led to a significant rise in state fare compensation, complicating the financial aspects of the measure. This complexity was supported by bus operators receiving compensation to ensure the public transport network remained cohesive. As a result, the system functioned effectively during simpler times, allowing occasional passengers to benefit from discounts and no entry fees.

On January 1, 2020, the Ministry of Transport began limiting the fare amount used to calculate discounts, which allowed carriers to continue reimbursing 75% of the fare while the Ministry compensated based on kilometers traveled. This change was necessary due to inflated ticket prices. Since fare pricing is at the discretion of each carrier, the state must reimburse carriers for lost revenue from discount regulations, but cannot limit the compensation amount. Therefore, the measure sets a ceiling on the full fare price for discount calculations[14], with compliance monitored by the Specialized Financial Office, which can enforce price controls if needed (Ministry of Finance of Czech Republic, 2019).

12 The initial proposal aimed to provide free rail transport for students and seniors for an annual fee of 1,000 CZK, inspired by a similar initiative in Slovakia that began in 2014. Following the Czech Ministry of Transport's advice, the proposal was revised from a full discount to a 75% discount and expanded to include bus transportation.

13 Until September 1, 2018, a 25% discount was provided to pensioners based on the carriers' own commercial decision (Ministry of Transport of the Czech Republic, 2018).

14 Discounts are deducted from the standard fare that the carrier charges to passengers who do not qualify for the state-mandated discount. Concurrently, the fare amount must not surpass the figure that each carrier determines based on its allowable expenses, and the cost of one ticket cannot be balanced by the cost of another ticket.

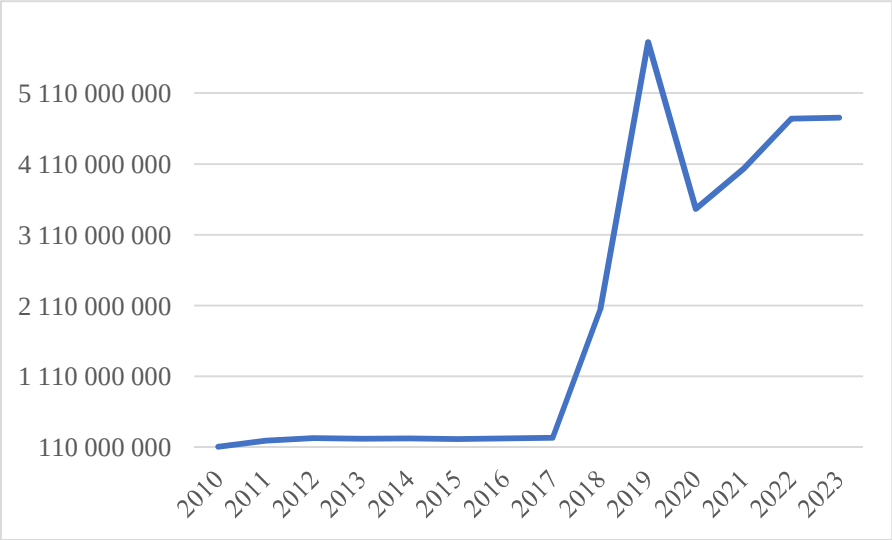

Figure 2. Development of the total amount of compensation provided (in CZK) in public passenger transport in the Czech Republic in 2010 - 2023
Source: Ministry of Transportation of Czech Republic, own processing (2024)

The graph above shows the growth of compensation payments to public transport carriers in the Czech Republic since 2010. A significant increase occurred in 2018 when the state began compensating all carriers, including those in the public sector, whereas previously only commercial route operators received compensation.

On April 1, 2022, the compensation payment structure changed, reducing the discount rate from 75% to 50%[15]. Minister of Transport Martin Kupka stated this was necessary to lower state debt, control inflation, and cut operational costs, while still supporting public transport as a socially responsible and budget-friendly option, preventing a shift back to private car use (Ministry of Transport of the Czech Republic, 2022).

The public sector heavily depends on the state budget for financing and management, affecting discount pricing and operational efficiency based on public finance conditions and fiscal policy changes. A notable example of preferential pricing is public transport fares, which include city subsidies for urban transport and integrated systems funded by European grants, as well as the primary railway operator, České dráhy, a.s. In analyzing České dráhy, it's important to note that long-term profitability for railway operators in Europe is rare, with most funding coming from public subsidies[16]. Historically, governments have influenced railway development and operations, often leading to state ownership (Seideglanz, 2006; Tomeš, Pospíšil 2006), a trend also seen in the Czech Republic.

Czech Railways' revenue primarily comes from three sources: passenger transport income, state or regional subsidies, and leasing of freight wagons. Passenger transport revenue mainly stems from ticket sales for domestic and international travel, with compensation for discounts factored in. The table below shows total ticket sales revenue and compensation from 2017 to 2023. Despite competition and the COVID-19 pandemic, Czech Railways has increased ticket sales revenue annually, surpassing 11 billion Czech crowns in 2023, mainly due to more passengers. Notably, compensation payments have remained below 25% of total revenues over the past eight years, indicating that many passengers likely pay full fare rather than using discounts.

15 Complimentary transportation continued to be provided for children aged 6 and under, along with a prior 75% discount for individuals with disabilities. Furthermore, this year, the discounts have been expanded to encompass individuals with 3rd-degree disabilities.

16 Transport providers depend on state subsidies since fare income does not cover operational costs. Raising fares may lead to customer loss to competitors due to high price elasticity, ultimately reducing overall revenue (Tomeš, Pospíšil, 2005).

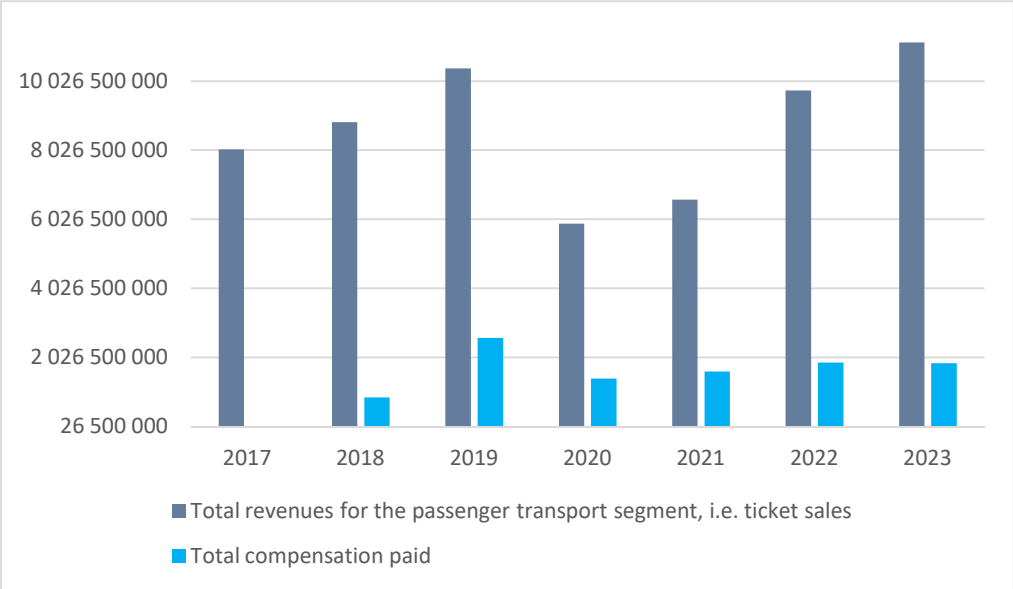

Figure 3. Ratio of total revenues (in CZK) for tickets sold and compensation paid in 2017–2023 for the carrier České dráhy, a.s.
Source: Annual reports of the company, own processing (2024)

Flixbus, s.r.o. offers discounts to specific demographic groups similar to other companies in the industry. Currently, discounts are available for students under 26, children under 17, disability cardholders and their companions, seniors 65 and older, and those with a 3rd degree disability status (flixbus.cz, 2025). From September 1, 2018, to March 31, 2022, these groups received a 75% discount. After state-mandated discounts were reduced on April 1, 2022, Flixbus chose to maintain higher discounts at its own cost to ensure affordable mobility amid rising inflation.

The particular reality of the company lies in its concept of dynamic pricing, which it was the first to implement in the market using relatively sophisticated calculation techniques. This system does not solely rely on the bus's occupancy and the interval between the ticket purchase and the bus's departure. It also takes into account various other factors (such as the days of the week or the influence on the occupancy of alternative routes). Ultimately, the method of purchase is determined by the passenger (Tomeš et al., 2022).

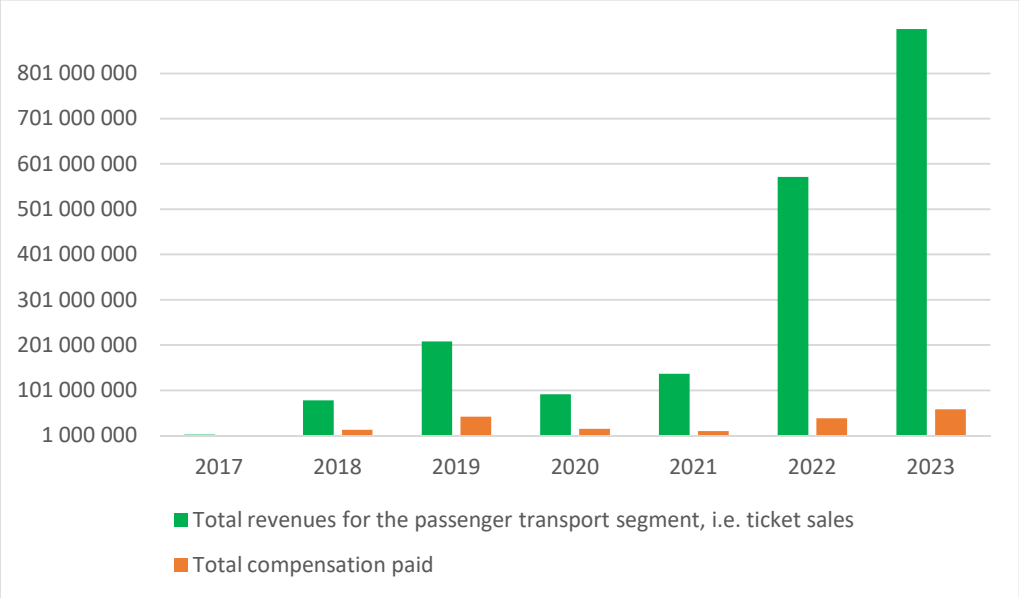

Figure 4. Ratio of total revenues (in CZK) for tickets sold and compensation paid in 2017 - 2023 for the carrier FlixBus CZ s.r.o.
Source: Annual reports of the company, own processing (2024)

Based on the graph presented above, one can infer that there will be a significant surge in ticket sales following the decline of the COVID-19 pandemic, with projections indicating nearly 900 million Czech crowns in sales by 2023. The extent of state compensation provided is particularly noteworthy. Considering the company's extensive operations, particularly in international transport as opposed to domestic transport, and acknowledging that discounts are exclusively available within the Czech Republic, this notable disparity can be understood. Thus, it can be concluded that passengers predominantly utilize the services of FlixBus CZ s.r.o. for international travel, where the aforementioned discounts do not apply. Nevertheless, offering greater discounts than its competitors could yield multiple advantages for the company. Primarily, this strategy could attract a larger segment of price-sensitive customers, fostering long-term loyalty. Furthermore, if the carrier can successfully merge competitive pricing with consistent or enhanced service quality, it may be regarded as both reliable and innovative.

4. Discussion

The fare discounts provided by the state railway and private bus services have significant economic and political effects in the Czech Republic. These effects mainly involve compensation payments, where the state reimburses carriers for losses due to discounts. Since reducing discounts from 75% to 50%, over 1 billion Czech crowns have been saved compared to 2019. About 40% of total compensation goes to Czech Railways, highlighting its strong position in the railway sector. In contrast, private bus operator Flixbus has received only 1% of total compensation since 2017, reflecting the intense market competition.

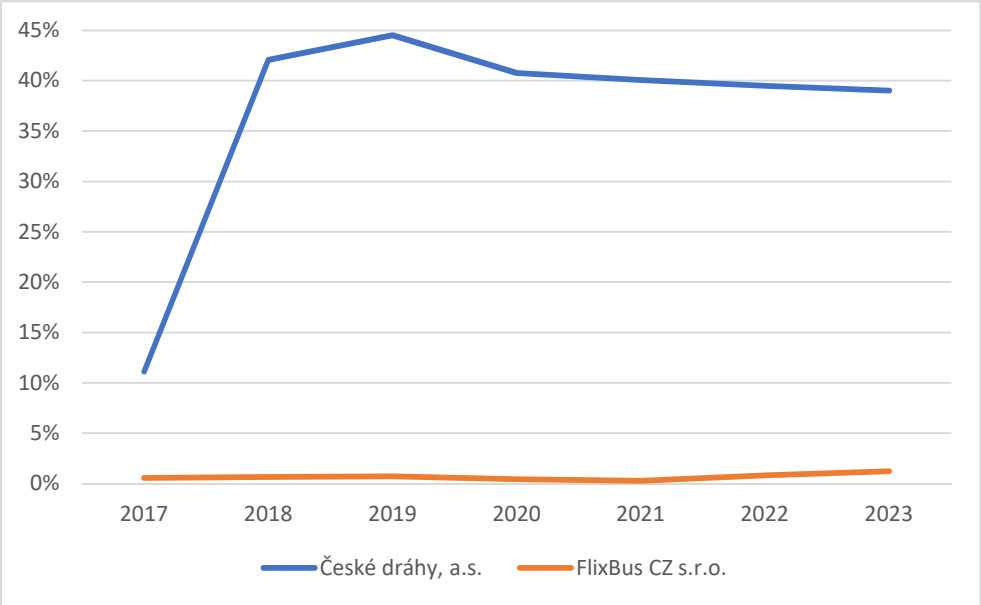

Figure 5. Ratio of compensation paid to České dráhy, a.s. and FlixBus CZ s.r.o. to the total amount of compensation paid in the Czech Republic in 2017 - 2023
Source: Annual reports of the companies, own processing (2024)

The primary concern in this situation is whether the state will cover this expense. Throughout the period of the 75% discounts, the state disbursed more than 14 billion CZK in compensation. It is important to consider that the largest beneficiaries of discounts are students and pensioners. Given their economic or life circumstances, one must question the necessity of such a universal and solidarity-based expenditure. Although pensioners have preserved their purchasing power in recent years, despite volatile economic conditions, students are more likely to encounter qualitative issues, particularly an increase in psychological challenges that subsequently lead to economic difficulties (Henriques et al., 2024). In the Czech Republic, 26% of students have classified their financial issues as serious or very serious. While this figure is not the worst in the current context, a comparison over the last decade reveals that the economic situation for students has worsened the most in the Czech Republic, declining by 12 percentage points (Hauschildt et al., 2024).

The data regarding the number of individuals utilizing public transport does not support the necessity of this expenditure, as it fails to demonstrate a positive correlation with the level of discounts offered. The lack of tax benefits as a corporate incentive is also significant. This incentive applies when companies purchase vehicles for their employees, yet it is not similarly applied to public transport usage. At that time, the Association of Transport Companies also opposed substantial discounts, with its chairman expressing doubt about this expenditure, arguing that passengers should contribute to the costs associated with transportation. Given the state of public finances, the Czech Fiscal Council (2022) also advised the complete elimination of discounts. Consequently, the debate and final decisions have been confined to the realm of high politics.

Conclusion

Discounts are a key part of pricing strategies for both private and public sector companies. They go beyond just quantity or loyalty, reflecting societal values, especially when aimed at specific groups like minors, students, retirees, or those with health issues. This article examines discount pricing and its economic and political effects in the Czech economy, focusing on public transport. It compares the state railway operator, České dráhy, a.s., with the private bus service FlixBus CZ s.r.o. The discussion frames discounts as third-degree price discrimination, where different prices are set for various consumer groups. A future concern is how price discrimination will function in oligopolistic markets and the impact of evolving information technologies on personal data protection. Less productive and more price-sensitive populations lead traders to adjust prices, though price is not the only factor. České dráhy uses fare discounts to promote social policy for accessible public transport, while FlixBus CZ s.r.o. offers significant discounts from its revenues, aiming for a similar strategy.

From an economic and political perspective, personalized discount pricing in the Czech Republic serves as a crucial mechanism not only for businesses but also for the government, which employs it to enhance service accessibility for specific demographic groups. While the discourse among professionals or those deeply engaged in the transport sector tends to be more cautious than bold, political figures approach the issue from a more socially conscious angle, aiming to convey empathy. In the upcoming months, the Czech Republic is poised to experience renewed discussions on this topic in light of the forthcoming parliamentary elections, as political parties seek to solidify and broaden their voter support. Achieving a balanced solution for offering travel fare discounts necessitates a rational examination of the matter. A professional framework, efficient management, and appropriate resource distribution can positively impact both commercial and social policies, potentially generating a synergistic effect that benefits all stakeholders involved.

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Transforming Housing Through the Sharing Economy: The Case of Co-living as an example

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Abstract

Purpose of the article of the sharing economy in Russia through the prism of coliving. Its impact on social and economic aspects of urban life is assessed, factors contributing to the development of coliving are identified, consumer motivation is studied and a comparative analysis of international experience is conducted. The results of the article can contribute to the development of recommendations for stimulating the economy of shared consumption.
Methods: The qualitative analysis included polystructured interviews with coliving residents, managers, and experts in real estate and social policy. The quantitative analysis was based on the processing of data from open sources and the results of target audience surveys. An important element was the case study method, which allowed us to consider successful and unsuccessful projects and identify key development factors. SWOT analysis was used to comprehensively assess the situation, revealing the strengths and weaknesses of coliving, as well as the opportunities and threats.
Research results we can conclude that motivations of coliving residents range from cost savings to a desire for social integration and exchange of experiences. Successful projects are characterized by flexible management, resident involvement in decision-making, and developed infrastructure, while unsuccessful ones face a lack of funding and a lack of a clear concept. The SWOT analysis noted accessibility and facilitation of community formation as strengths/
Findings & Value added: Coliving contributes to the increase of housing affordability and development of urban communities. Its growth requires flexibility of legislation, support of the authorities and increased public awareness.

Keywords: Sharing economy, Collaborative consumption economy, Co-living, Rent, Resources

JEL classification: O33, P12, O57, M20

1. Introduction

Sharing economy or collaborative consumption economy is an economic model based on the exchange of access to goods and services instead of their traditional ownership purchase. The concept has become possible owing to digital technology development - it simplifies the search, booking and payment of temporary resource usage, it profoundly alters our idea of owning and consuming. The basis of sharing economy is the idea of resource managing optimizing and expense reducing because of the shared access (together access) to them. Co-living, as one of the brightest forms of sharing economy, is oriented at the housing sector and offers an alternative to traditional models of rent and

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real estate purchase. It is focused on the housing community formation and provides tenants with an access to common space, services and infrastructure; it shapes the sense of community and reduces individual housing expenses.

Looking at constantly speeding up social and economic transformations, the concepts of sharing economy and co-living are acquiring a special meaning. The concepts reflect a new approach to resource management and influence the formation of up-to-date social models and lifestyle. The current article is aimed at the all-sided research of sharing economy and co-living evolution - via state-of-the-art context and considering them as crucial components of modern social and economic system. The analysis goal is a comprehension of present-day development trends, highlighting prospects and potential problems that may be connected with their integration, further evolution (including legal aspects, security issues and sustainable development). Aside from that, we are to analyze a co-living impact on the real estate market and its social role in the formation of city communities.

2. Literature and research survey

Co-living studying as a phenomenon of sharing economy has been attracting more and more attention in the recent years. It reflects wider urbanization trends, housing accessibility and community dynamics. The research has singled out several primary topics and directions in terms of co-living - especially via the context of its evolution and impact on urban life.

One of quite considerable fields of the research is people's motivation to participate in co-living projects. According to the research, motivation may vary from economic background - such as housing expenses decrease and resource co-usage - to social factors including inclination to communication and community formation (Vereshagina and Korshunova, 2021).

This motivation duality underlines a complex character of co-living in which economic and social aspects get intertwined and influence tenants' experience and contentment (Goryachkina, 2023).

Another important co-living research aspect is structural characteristics of successful projects. It has been proved that efficient management practices, tenants' involvement into decision-making and presence of supporting infrastructure are the key factors for creating positive co-living environment (Pupentsova, 2022).

On the contrary, the projects which lack the above mentioned elements frequently come across the problems as follows: shortage of financing and unclear operation frames - and it can become an obstacle to their stability and growth.

A comparative analysis of international co-living models has also become a significant part field of the research. While exploring global experience, the researchers have discovered the best practices and innovative approaches that can present information about the development of co-living in various cultural and economic contexts (Balakina and Pavlyuk, 2022).

This comparative prospect is especially relevant in terms of understanding how co-living may be adapted in order to meet the demands of local necessities and relying on successful strategies from other regions (Golovin and Korotkova, 2023).

Besides, the application of analytical frames - such as SWOT-analysis - has turned out to be useful for the estimation of strong and weak sides, possibilities and threats connected with co-living initiatives. This approach gives us an opportunity to make a complex estimation of co-living landscape - it highlights key factors that influence its survivability and growth potential within wider sharing economy (Voronkov and Elfimov, 2023).

The literature on co-living opens a multi-aspect phenomenon that intercrosses different social, economic and cultural measurements. As long as urban locations pursue developing, the role of co-living and community formation mechanism requires further study - especially in the context of changing economic reality and society necessities (Mirgorodskaya, 2018).

Co-living can be considered as a process that includes:

1) impact of social and economic factors on the community formation - it can be depicted on different levels of participants' involvement and their capability to adapt to new conditions (Oghienko, 2024);

2) application of innovative approaches towards space and interaction organization - it influences, in its turn, the mechanisms of formation and social-bond maintaining among tenants (Shlegel and Generation, 2022; Sonina, 2022);

3) adaptation of co-living management and interaction models - a special meaning here is given to the flexibility of organization system and character of changes which may be initiated by the participants themselves or external circumstances (Taranov and Basenko, 2023; Protasievich, 2023; Sapozhkova, 2022).

Therefore, co-living is a dynamic eco-system that provides interaction of various factors and participants for living and working together, and it requires further analysis and study (Dolinskaya and Yakovenko, 2021).

Future research should aim at deepening of understanding of co-living dynamics and exploring strategies of its enhancing impact on urban life.

3. Methods

A few methods envisaging an integrated approach to the topic have been applied in this article on the analysis of the Russian sharing economy development on the case of co-living as an example. When applying an integrated approach, technical, environmental, economic, organizational, and social aspects of activities and their interrelationships should be taken into account (Mustafin et al., 2019). A qualitative analysis is most notably used for bringing to light deep-laid social and cultural aspects of co-living. Speaking about the above mentioned method, semi-structured interviews with co-living tenants, real estate managers and experts are held - it all can present a picture of motivation, preferences and co-living tenants' experience, moreover, public opinion on co-living as an economic model in different regions. Aside from that, in order to estimate the popularity of co-living and its impact on economic indicators, a quantitative analysis, based on open-source statistic data and target public's questionnaire results, is applied. All this permits to hold a comparative analysis of various co-living models and their efficiency in different regions of Russia.

Moreover, certain examples of successful and unsuccessful co-living projects with the application of case-stage technique, are in the centre of study - it enables to bring key factors into sharp focus (the factors that trigger the model development) and analyze their impact on local communities. In addition, we apply SWOT-analysis for the estimation of co-living's strong and weak sides, possibilities and threats connected with its development in terms of Russian economy and social structure. Therefore, combining these methods brings the possibility of getting a full-scale picture about co-living development - as an element of sharing economy in Russia; it helps to work out recommendations for its further implementation and optimization.

4. Results

Monitoring the level of citizens' income, their structure, as well as the calculation of the degree of income differentiation of various population groups, allows the state to determine the direction of social and economic policy (Vasilova et al., 2018). The idea of resource co-usage is not new, its re-considering in the context of sharing economy and co-living is also an up-to-date phenomenon. Internet-technology and mobile application evolution has simplified the processes of resource exchange and co-usage that promoted the development of these practices at the beginning of the XXI century. The re-considering of traditional approaches to owning and renting, as well as enhancing an inclination for sustainable development and resource usage optimization, have become the priority factors - the ones that maintain the growth of sharing economy and co-living popularity.

The analysis of sharing and co-living requires the introduction of economic, social and urban aspects. The science of Economics studies resources allocation, the science of Sociology focuses on the alteration of social norms, Urban Studies - the impact on city environment. It is crucial for the understanding of modern social and economic alterations and their influence on society and city.

The research of sharing and co-living includes the analysis of their influence on society and economy. We are to consider positive and negative aspects of these concepts, their current trends and possible challenges. As a result, we are to make conclusions and offer a range of directions for further research.

Speaking about sharing economy, we can firmly claim that it has been developing strongly during the last decade. Since 2013 on, the market has increased 25-fold and reached the volume of 387,1 billion US-dollars (From Houses to Clothing, 2024). The future prospects of sharing economy can be seen as optimistic: according to the estimations of analysts, from 2023 to 2032 the resource co-usage consumption will have been demonstrating a 7,7% growth a year; up to the end of this period the

world market of sharing economy may have reached 827,1 billion US-dollars (Sharing Economy Market Size, accessed on 23 February 2024).

The sharing has many forms: even routine services have appeared as a consequence of sharing economy evolution. There is a multitude of sharing types - however, not all of them have received their further development. On the basis of the analysis of scientific literature, magazine articles and internet sources, we have singled out the most wide-spread forms (see Table 1). Each type of sharing has received our definition and a possible reason of popularity. The comparative analysis of these reasons can give us a possibility to highlight general development trends of the co-usage consumption models.

Table 1. Popular types of sharing

Type of sharing	Explanation (definition)	Possible popularity reasons
Car-sharing	Short-term vehicle (car) rental	High car and taxi pricing, parking difficulties
in large cities		
Co-living (flat-sharing)	Format of community living, when soulmates can live in one apartment or house	High property pricing in large agglomerations
Kick scooter sharing	Short-term scooter rental	Traffic jams in large cities, high client's mobility, expensive taxi
Bicycle-sharing	Short-term bicycle rental	Possibility to combine physical activity and road, traffic jams in large cities, expensive taxi
Equipment and tool sharing	Short-term construction tool and equipment rental	Tool expensiveness,
Outfit rental	Suit, costume rental	Outfit expensiveness, photography development
Libraries	Public book usage	Expensiveness of paper books, one-time usage, ECG lifestyle
Book-crossing	Paper books exchange	Expensiveness of paper books, one-time usage, ECG lifestyle, desire to share
Media-services	Using i-nets for scrolling content	Convenience of usage, digitalization, accessible price
Co-working	Co-usage of working space	Convenience of usage, cheaper than office rental, possibility of changing your work
Team shopping	Consumers' wholesale buying cooperation	Cheapening of shopping prime cost

Source: compiled by the authors based on sources: Plotnikov and Anisimova (2023); From Houses to Clothing (2024).

Referring to the table in general, we can note that digital technology development has become a chief growth driver of practically all types of sharing: 20 years ago it was almost impossible to imagine that a click of a few smartphone buttons would make transaction via electronic banking, call a taxi, choose a hotel, etc. And today there are a lot of digital services simplifying people's life and it has settled into a routine.

One more growth factor has been triggered by the expensiveness of things. The cars are high-priced - we can say the same about apartments, a purchase of which has got almost inaccessible for regular consumers, so many of them prefer renting apartments or co-living.

Sharing usage is about certain mutual profit for consumers: there is a possibility to stay in one place, make new bonds, exchange experience.

Technologically speaking, as we see it, a chief driver of growth is economy digitalization and development of new technologies that provides interaction between suppliers and consumers.

We have also paid attention to the fact that the widest institutional development goes to the types of sharing that are connected with the so-called "splittable" life-comforts of high price (apartments, vehicles, etc.).

The brightest example of this growth is “Delimobil” IPO companies that offer short-term car rental (News, 2024). The companies working in the sphere of sharing economy have been transforming from start-ups into strong businesses.

Still there are sharing forms that have not received any further popularity: personal outfit sharing, sharing of pets.

In our opinion, the above mentioned forms have received zero feedback for a number of reasons: a consumer cannot be fully sure that the outfit he/she rents is clean enough and there are no traces of overusing that may possibly be left from a former consumer. Many people feel unpleasant with the idea that your clothes may not be ideally clean and it touches your body. The clothes issue is about lots of individual traits: size, cut, colour, etc. It is quite difficult to meet everyone’s demands. Pets are living beings that evoke deep emotional feeling of bond with humans. Moreover, constantly changing owners are not a good thing for pet’s health - it is quite negative.

Therefore, having analyzed the most popular forms of sharing, we have arrived at the conclusion as follows: some types of sharing have started their active development thanks to the expensiveness of sharing objects and increasing economic efficiency of using the comforts via sharing. Meanwhile, the types of sharing that have not received their development were directly connected with a consumer (they have individual characteristics or evoke strong bonds).

5. Discussion

Legislative framework in force

Currently definite legislative norms regulating such form of community living as co-living are absent in Russia.

The absence of the legislative framework regulating co-living activity is connected with negative consequences. Firstly, the uncertainty of legal status of the housing sector segment, high business and consumer risks. Secondly, the absence of investment incentives and innovation approach development in the sphere of residential construction.

Practically, present-day Russian co-livings use the norms of hotel legislation. Hotel work in Russia is based on a number of regulatory legal acts - the Government Regulation of the Russian Federation N 1860 which defines a classification of inns (hotels), however, does not consider co-living as one of the categories (Government Resolution of the Russian Federation "On Approval of the Regulation on Hotel Classification", accessed on 19 February 2024). Due to the absence of clear legislative regulation, co-living does not have a certain status - it brings legal uncertainty and increases risks for economic players and tenants of the house where illegal co-livings may be located. And in accordance with Part 3 Section 17 of the Housing Code of the Russian Federation, the location of hostels is prohibited in block-of-flat type houses (1. "Housing Code of the Russian Federation", accessed on 26 February 2024).

The uncertainty of the legal status challenges the interaction between exchanging parties and it can restrain further development of this sector (The Communal Apartment Syndrome, accessed on 19 February 2024). The absence of legal regulation of co-living hinders effective housing resource usage and limits the access to alternative housing forms and innovative housing services. This, in its turn, hampers the growth of competitiveness of the housing branch and triggers negative tendencies for macro-economic development. In order to provide sustainable and efficient housing market functioning, special laws and regulations should be created for setting clear legal frames for co-living. Both entrepreneurs and service-consumers would have protection from the law. The sphere regulation could stimulate investment, increase the housing service quality and enhance macro-economic indicators of the housing market development in Russia (Rambler/Finance, 2021).

Co-living prospects

Co-living as a community living form attracts more and more attention, especially among young people, students and digital nomads. We have inquired 1135 co-livers of the Volga region federal area in order to highlight basic problems and advantages of co-living.

Possibilities of co-livings:

1. Social integration. And again it can be noted, that private life directly affects other aspect (Rudaleva and Mustafin, 2017). Co-living offers a unique possibility for social integration especially for people moving to a new city or country. 74,6% of respondents noted that co-living has assisted in

making new bonds, new friends; about 72,1% of respondents underlined communication with other people as a primary benefit of community living.

2. Economic accessibility. Co-living frequently turns out to be more economically profitable in comparison with apartment renting or property purchasing. Utility fees included into the rental value and a zero necessity to purchase furniture and appliances make co-living especially attractive, financially speaking. It has been confirmed by 68% of respondents who have underlined financial profit as a decisive factor to choose co-living. The topic is especially acute for the age-group of 21-25 years old - 88% of respondents have noted financial profit.

3. Flexibility. One of the key merits of co-living is renting conditions flexibility. A possibility of medium-term - and partly short-term - renting attracts temporary housing seekers and those whose life circumstances change quickly. Flexibility has been marked by 62% of respondents. According to these co-livers, a quick change of location is relevant (31,3% of respondents), going on a longer trip (45% of respondents), moving to a different city (21% of respondents), etc.

Risks:

1. Lack of personal space. Limited personal space may become the source of stress for some co-livers. A considerable part of respondents (86%) has pointed out this as a problem - it underlines the necessity of creating spaceous well-planned housing zones.

2. Problems with tidiness. Common areas require regular cleaning and order maintenance - especially in case of many co-livers. Many co-living tenants (51,8%) of economically lower price segment have complained about mess and dirt in bedrooms, and more than a half of respondents (57%) - about disorder in co-usage areas.

3. Confidentiality and safety. Confidentiality and safety of personal belongings may also cause worries with many co-living tenants. Almost half of respondents (47%) have expressed their feeling unsafe in terms of secrecy while telephoning and messaging.

4. Absence of clear legislation-confirmed community rules. 42% of respondents have noted that they are not aware of their housing rights in co-livings, 54% - that local rules set by co-living administration is insufficient as they do not cover relations between a tenant and a renter.

We have estimated a three-factor model that has been received by means of Excel package - it expresses dependence of a co-living number in a region (y) on a number of students in a region (x1), and a number of middle-aged people co-living in different regions (x2), and a number of people who believe that co-living expands horizons and welcomes new social bonds and acquaintances (x3):

$$y=44148{,}665+0{,}271*x1-2009{,}128*x2+0{,}819*x3 \quad (1)$$
$$(2{,}67)\quad (7{,}92)\quad (2{,}53)\quad (7{,}73)$$

Checking the practical meaningfulness of the coefficients, we may conclude that in all the cases we see Prob<0,05. Therefore, the coefficients are meaningful on the accepted reliability level, and the factors that we have singled out (x1, x2, x3) influence the number of co-living in a region. According to statistics, the Fisher coefficient illustrates the reliability of the model, Prob (F-statistics) shows the value of 0,000001. Aside from that, the analysis of correlation matrix of all factors proves the absence of multicollinearity.

Estimating the calculation data of the regression table, we can summarize that the coefficient of determination equals R=0,78. In other words, 78% of X-factor alteration cases lead to Y-alteration, as long as the segment of blind spots (non-marked factors) in the considered model equals 22%. Consequently, the interconnection among the factors is quite strong.

As the equation (1) shows, the larger the number of students in a region and believers in co-living as priority of social bonds is, the larger is the quantity of co-livers, who co-rent a flat or apartments, and v.v. However, the older they get, the fewer the number of co-livers becomes.

We can also claim that with a 1% student number increase in a region, the number of co-livers also demonstrates 0,54% growth OTE (other things equal). As the number of co-living-friendly people shows 1% growth, the co-living number is to show 0,46% increase in average OTE. Meanwhile, in case the average age of co-livers shows 1% increase, the number of people renting a flat together may show 0,37% decrease OTE.

Co-living offers a lot of possibilities for consumers including social intergration, economic profit and housing conditions flexibility. However there are certain risks such as limited personal space,

problems with cleanness and anxiety about safety. To minimize the risks, co-living operators have to carefully plan the space, provide regular cleaning and implement effective safety measures.

Development prospects

The Russian Federation does not have the legal framing on regulating co-living objects. However we can offer a range of recommendations and standards that may simplify the life of our consumers and bring them comfortable living:

1. Introduction of measures regulating quality and safety standards while co-living renting (Standard Agreement of LLC "COLIVING", accessed on 16 February 2024):

1.1 co-living companies have to provide all essential information on the quality and safety standards - the standards residential premises should meet. Minimal requirements on the condition of co-living residential premises equipment should be set, as well as sanitary-and-hygienic and communal conditions should be observed;

1.2 regulation setting on following “silence hours” at certain time should be observed - in order to provide rest period for all participants;

1.3 determining the minimal floorspace of residential premises, an obligatory presence of own rooms for each consumer;

1.4 guaranteed by the agreement access granting to appliances, furniture, internet and television, and common areas: kitchen, living room, gym hall and swimming pool (the list of offered services may vary - it depends on co-living company conditions);

1.5 presence of FSS (fire safety system) and emergency warning in common areas. Regular check-up of electronic equipment to prevent electric out-of-balance load;

2. Obligatory licensing for co-living residential property. The measure is to protect consumer rights in case a consumer faces problems with a co-living operator. Licensing also guarantees the quality of housing and proper living conditions.

3. Setting rules on rental and life in co-living housing

3.1 determining a clear and transparent rental contract, procedure for the conclusion of a rental contract, period of residence and possibility of contract dissolution (Standard Agreement of LLC "COLIVING", accessed on 16 February 2024).

4. Implementation of efficient monitoring mechanism of the choice of co-living neighbours:

4.1 Recommended for implementation: effective neighbour-choosing process for the rental procedure, an algorithm of partner selection on the basis of potential co-livers’ character features and preferences analysis. The algorithm based on individual preferences can optimize the neighbour-choosing process for ideal matching in terms of lifestyle and interests. This approach is good for enhancing the quality of interaction and comfort of co-living, which is an extremely crucial aspect for harmonized neighbouring environment in rented residential premises.

Potential consumers of co-living have been surveyed - the survey was based on our recommendations on applying standards and requirements for better co-living.

The survey says 78% of potential tenants of property agreed on the first point: “Introduction of measures on regulating quality and safety standards for co-living rental”. They marked the importance of sub-points 1.1, 1.2, 1.3 which says about the necessity to provide comfort for clients.

As for the second point, 60% of the surveyed agree with it: all requirements offered by co-living operators are to be satisfied in the case. However 35% of respondents disagree with this measure: licensing may influence rental of premises increase and bring their financial status to the negative mode.

Speaking about the third point “Setting rules on rental and life in co-living housing”, 80% of respondents agree with it. Many of them underlined the necessity of making a clear and transparent rental contract.

85% of respondents agree with the last point of the survey. The chief argument is as follows: good neighbouring is a basis of calm and friendly co-living. Moreover, a possibility to live with people who have common interests is one of the priority aims of tenants of property.

To summarize, the results of the survey and our monitoring have enabled to conclude that consumers are interested in co-living housing regulation. Firstly, a clear and transparent rental contract is definitely conducive to the trust from potential consumers. This is a key factor for this direction development in Russia. Secondly, the implementation of efficient monitoring mechanism of choosing

neighbours may increase co-living ratings, its popularity among young people. More consumers would like to have a try co-living with people who their views and values coincide with. Thirdly, the implementation of measures on regulating quality and safety standards is to become one of the decisive factors in terms of choosing co-living as a place of permanent residence.

Conclusion

In the course of the survey the key aspects of sharing and co-living as crucial elements of modern social and economic paradigm have been considered. The analysis of literature and current practices has shown that these phenomena do not only reflect the alterations in consumer preferences and technological development, but may become a powerful trigger of creating more sustainable and inclusive communities. Sharing economy and co-living demonstrate a considerable potential for optimizing resource usage, decreasing eco-unfriendly impact and consolidating public bonds. However, despite numerous advantages, these practices may meet certain challenges including regulation issues, keeping privacy and safety, and the risks of enhancing social inequality.

Further research in the field should concentrate on working out efficient mechanisms of regulation in order to keep the balance between innovation stimulation and the protection of rights of all the participants. Besides, an important direction for would-be research is studying long-term social and ecological consequences of sharing and co-living. Finally, we can claim that sharing and co-living make a considerable contribution into the formation of a more sustainable and flexible society. However, for a better potential opening, active participation of all interested sides is needed: the state, business and society. Only united work and efforts can provide the development of these practices in the direction of a more just, eco-friendly and inclusive world.

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Moldova at the Gates of the European Union

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Abstract

Research background: Moldova is in the news more and more. It is a country that is still rather unknown to Europeans, with headlines varying from 'Europe's poorhouse' to 'Europe's next powder. In May, the status of Moldova was also raised in the context of the Romanian presidential elections, when one of the candidates campaigned again for the creation of a Greater Romania.
Purpose of the article: Recognition of autonomy gives national minorities certain rights, while it guarantees the state that these minorities recognise the political, territorial unity and sovereignty of the state. In Moldova, an interesting situation arose, where we can find both positive and negative examples to prove the above statement.
Methods: Seconder research was conducted by analysing the historical and theoretical background of autonomy. The choice of literature used in the analysis was motivated primarily by content and conceptual soundness rather than topicality. Economic performance was examined by using international institutes datasets such as the Word Bank, the IMF and the WIPO.
Findings & Value added: Tthe situation of the territory is very precarious from an autonomy perspective. We can even say that the borders of the country may change in the near future. History of Moldova is very closely linked to the concept of autonomy. The current conflicts could have an impact on foreign policy, stem from the desire for autonomy of each of the territories.

Keywords: Moldova, Concept of autonomy, Gagauz, Transnistria, the European Union

JEL classification: K10, K40, N4, P20

1. Introduction

Moldova's historical background

Between the 5th and 13th centuries, present-day Moldova served as a marching area for horse-riding nomadic tribes. Scythians, Thracians, Pechenegs, Cumans, and Huns also roamed here. Later, Kievan Rus, Poland, and Hungary wanted to integrate this area into their own borders.
During the reign of Louis, the Great, the Hungarians drove the Tatars beyond the Dniester, and thus, with the permission of the Hungarian king, the Principality of Moldavia was established (1359). The Principality was bordered by the Dniester to the east, the Carpathians to the west, and the Black Sea and the Lower Danube to the south.

Although they seceded from the Kingdom of Hungary in the following century, they remained in contact as allies, but in the mid-16th century they lost their independence to the Ottoman Empire.
Although a vassal relationship was established with the Ottoman Empire, the fate of the territory differed from the situation in the Balkans. They left behind the roots of cultural independence, which still affects the lives of the ethnic groups there today.

At the end of the 18th century, national demands also appeared in this area, and from 1812 the history of the former Principality continued in two threads.
Bessarabia, located between the Prut and the Dniester, became part of the Russian Empire, the area initially received a certain autonomy, but then lost it after the Russo-Turkish War of 1828-29. Culturally, its identity was increasingly determined by the Russian language and culture,

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From 1834, the use of the Romanian language in education and church liturgy was gradually suppressed, and after 1850, the import of books in Romanian was banned.

In contrast, the area between the Carpathians and the Prut is dominated by the linguistic and cultural challenges of the Principality of Havasalföld, which considered the awakening of Romanian national consciousness as an important task.

In 1918, this territory was annexed to Romania, but the Soviet Union did not recognise the annexation. In response, the Moldavian Autonomous Socialist Republic was created in 1924 within the Ukrainian Socialist Federal Republic. The undisclosed aim was to weaken the creation of Greater Romania. The relatively small area of Moldovan autonomy could only be retained within the Ukrainian Socialist Federal Republic for Soviet interests.

In 1940, the territory was annexed to the Soviet Union under the Molotov-Ribbentrop Pact, and the Moldavian Soviet Socialist Republic was created.

World War II did not change the situation, and the inhabitants of Romania and the Moldavian SSR became increasingly distant from each other. In terms of identity, they became more and more detached from the Romanian identity, although they used Romanian language but wrote in Cyrillic letters, and the Soviet way of life and culture became dominant.

In 1991, after the break-up of the Soviet Union, these areas also underwent major changes: in May, the Republic of Moldova was incorporated. At the end of August, the Republic declared independence, but with Soviet help a thin strip was torn off and a new one was established east of the Dniester. Thus, the Transnistrian Republic (Transnistria) was created, with Tiraspol as its capital. Moldova rejected this, and the breakaway territory fought a short war with the central power.

The parties concluded a peace agreement on 21 July 1992, the essence of which was that the Moldovan authorities would have no say in the politics of the territory but would not recognise its independence and would continue to consider it part of Moldova.

To date, the Transnistrian Republic of Moldova has not been recognised by any state, despite repeated requests for its admission to the UN as an independent state after Kosovo's recognition.

There are currently 2,600 Russian “peacekeeping” troops stationed there and the Transnistrian “army” still holds the Soviet army's abandoned weapons stockpile to ensure the territory's survival as a country. The war in Ukraine has put further strain on the situation, but the “autonomy” of the area remains in place.

It can be seen that the creation and history of Moldova is very closely linked to the concept of autonomy. The current conflicts, which could have an impact on foreign policy, stem from the desire for autonomy of each of the territories (Cretu, 2025; Osipov, 2019; Ratzmann, 2014).

2. Methods

2.1 Introduction to the concept of autonomy

The aim of this section is to clarify and introduce the concept of autonomy. Autonomy springs from man's desire for freedom, insofar as the majority of people wish to minimize outside influence in shaping their lives for their own happiness and well-being, because ultimately a free man can decide for himself what is good for him (Tóth, 2014).

In order to understand the conceptual and substantive elements of autonomy, minority rights must first be introduced.

In state theory, autonomy always expresses a group's desire for freedom of choice. The desire for freedom to decide one's own affairs may arise within a state when that state does not allow someone to decide their own affairs. This need is most likely to arise in the case of a group that is in a minority position in relation to the majority within the state because of some characteristic/property. These minority groups may formulate minority claims.

The use of the term “minority” may arouse resentment in many people, because members of a group may demand that the state take account of their specific characteristics and, if necessary, treat them differently on the basis of these characteristics.

The creation of a state is always the result of an artificial process, whereby a sovereign power is organised that can and will regulate the lives of a population living in a defined area. A problem can arise when the people living in a given territory do not belong to the same ethnic group/ethnicity. If only groups of people with the same language, the same roots and the same culture live in the territory of the state, conflicts between different ethnic groups will not arise.

However, in a given territory, different groups may exist on the basis of different languages, cultures, religions or traditions, common memories or values. These groups can only live side by side if they are able to accept their differences as a criterion for the recognition of a different group in the community.

If a group with different attributes is growing in number relative to the majority, their acceptance becomes more problematic, as those in political power may fear them. The fear may be triggered by the assumption that this minority group also wishes to gain political power or at least wants a share of it. In many cases, this fear is not only expressed by denying these groups the right to recognise otherness different from that of the majority, but the majority may even seek to "eliminate" the group through forced assimilation. An example of this can be seen in the history of Moldova, when the Bessarabia region was annexed to the Russian Empire and from the 1860s onwards the use of Romanian was gradually replaced by Russian, with the result that the population was also replaced, as the Romanian-speakers who had left the country were replaced by Russian-speakers from the interior of the empire.

The strongest, but also the most controversial, minority rights are autonomy, and the rights associated with claims. The problem may be generated by the conceptual tensions between the sovereignty of the inhabited territory, the homeland, the nation-state. The right to autonomy can be claimed on the basis of a territorial or personal principle.

According to (Vizi, 2006), there are two types of autonomy: "Territorial autonomy is when a given nationality is in a majority in a specific territory or region of a country, so that it can benefit from public authority in its own right. In this territory, this minority, i.e. the local majority, has its own decision-making and executive institutions in accordance with the laws and constitutional arrangements of the state."

In addition to territorial autonomy, we can also speak of cultural autonomy (or non-territorial autonomy), which operates on the principle of personal autonomy. In this sense, it is not linked to a specific territory, but always to a national minority in the country, which is the main facilitator of the exercise of cultural rights by this minority, especially through rights related to language and education.

Even if the right to autonomy is guaranteed, states always specify its content: usually only the right to cultural autonomy is understood, while the right to territorial autonomy is usually excluded.

The right to autonomy is primarily linked to the concept of self-government and does not always have to be accompanied by the idea of separation from the state. The same problems of understanding can be observed with the concept of autonomy as with the rights of national minorities. Even here, the individual states have not been able to agree on a common concept. There are states that accept it, and others that deny it completely. It is also important to note that minority rights, including the right to autonomy, can only be imagined in a democratic state.

According to Swiss political scientist Andreas Gross, autonomy as a concept should be an inherent part of strong democracies. The recognition of the right to autonomy is always part of the democratisation process. Autonomy does not eliminate conflicts, which are a natural part of democracy, but it does reduce violent conflicts; autonomy avoids conflicts escalating into violence. Autonomy is part of strong democracies, and the concepts of democracy and autonomy are thus inseparable." (Kántor, (ed.) 2013:3)Recognition of autonomy gives national minorities certain rights, while it guarantees the state that these minorities recognise the political, territorial unity and sovereignty of the state. Based on his book regarding ethnocultural rights, Pentassuglia does not see territorial autonomy as the highest goal to be achieved but also mentions other possibilities in this regard. "Territorial autonomy in the sense of a grant of decision-making authority in a number of areas intended to benefit a sector of the population, which is located within a geographically defined unit, may not be the only – or even the most desirable – solution in all circumstances requiring group accommodation. Territorial autonomy, just as non-territorial one (or a combination of both), is a means to an end, not an end in itself." (Pentassuglia, 2018).

3. Results

3.1 Status of autonomy in Gagauz

In Moldova, an interesting situation arose, where we can find both positive and negative examples to prove the above statement.

After 1991, in the processes of independence, the demand for the right to self-determination arose in two different areas of the country. In one place, the issue was resolved by maintaining the status of autonomy, as we can see in the case of the territorial autonomy of Gagauzia. In the case of Transnistria, this was not enough for the residents there, and they chose to secede from the Moldovan state. (Although it can be argued here that the will of the local residents was not the primary one, but rather dictated by Russian political interests)

The Gagauzian autonomy illustrates some of the key challenges of elaborating and implementing autonomy provisions in the context of fledging democratic institutions and a weak system of rule of law. Although the Gagauz autonomy is often considered as a rare case of successful conflict transformation in post-Soviet space, the actual implementation of autonomy provisions has been a highly contested issue (Protsyk, 2009).

Gagauzia is a very small area, not large on the map of Moldova anyway. Its population does not exceed 170.000 inhabitants. In fact, many people emigrate in search of a better life. The inhabitants have a very modest economic position, living mainly from agriculture and selling their products in the nearby areas.

However, two factors have helped to give this relatively insignificant area territorial autonomy. One factor was Russia's foreign policy interests. After 1991, there was a growing desire for relations, even union, between Moldova and Romania. Russian policy wanted to prevent this. The beginning of the EU accession process further strengthened the Russian desire to somehow block Moldova's relations with Europe/Romania.

The other state is Turkey, which supports Gagauz autonomy from the outside. The Gagauz are the only ethnic group of Turkish origin that is not Muslim but Orthodox. Their Turkish national consciousness is strong, but there are already uncertainties about the use of their language. The Turkish language is mostly used only at home, while Russian is more common in official places. They are most afraid of their identity being dominated by Moldavian (Romanians), which is perhaps why they are turning to Russian language and culture. But they receive a lot of help from the Turkish state in maintaining their identity.

The 1994 autonomy agreement, which established the self-government of Gagauzia within Moldova, is also credited to Turkey's President Suleyman Demirel. Süleyman Demirel was able to play a role in the Gagauz's interest because Moldova was facing significant ethnic tensions after the collapse of the Soviet Union and was unwilling to risk a fragile peace.

The Autonomy Agreement established Gagauzia as the Autonomous Territorial Unit of Gagauzia (ATUG) and gave it the right to manage internal affairs in areas such as education, culture and local governance. Crucially, the agreement also recognised the right of the Gagauz to secede if Moldova lost its independence - a clause designed to address fears of possible unification with Romania. (Karahindiba, 2024).

Although in 1994 it was probably only the image of Romanisation that was frightening, since then it is possible that the globalisation effects of the EU could set in motion processes that the Gagauz believe could lead to the loss of Moldova's independence. These perceptions have been reinforced by the political situation since then.

On 15 October 2024, the EU added Evghenia Guţul, Governor of the Autonomous Territorial Unit of Gagauzia (Başkanja), to the sanctions list for promoting separatist aspirations in the region and thus attempting to overthrow the constitutional order and threatening Moldova's sovereignty and independence (EU Council, 2024).

The President was joined on the sanctions list by Mihail Vlah, Vice Governor of Gagauzia (Başkan) and Media Relations Advisor, Iurii Cuzneţov, Vice Head of the Foreign Affairs Department of the region, and Illia Uzun, Vice Chairman of the Executive Committee and member of the Gagauz National Assembly. The assets of listed persons shall be frozen, and it shall be prohibited to make funds or economic resources available to them, whether directly or indirectly. In addition, sanctioned persons will not be allowed to enter the territory of the EU. This can be a problem because the Gagauz leaders are not able to attend the EU bodies' meetings, to negotiate and to participate in the Gagauz interest group in the field. The EU has no regulations on ethnic minorities. It expects the candidate countries to settle such issues before accession, as it does not want to complicate relations between member states with this type of debate.

3.2 Transnistria as a state

On the map of Eastern Europe, there is a strange, almost timeless world - a breakaway territory that we barely know, yet has its own government, flag, army and even its own money. This is Transnistria, or officially the Transnistrian Republic - a state that virtually no one in the world believes exists yet is very real. Its capital, Tiraspol, looks as if it was left over from the Soviet Union: Among Lenin statues, red stars and Russian soldiers, another world exists in the middle of Europe (Morvai, 2025).

After the collapse of the Soviet Union, the mainly Russian and Ukrainian minorities living east of the Dniester River feared for their identity. On 2 September 1990, the region declared independence as the Transnistrian Moldavian Socialist Republic, with Tiraspol as its capital. Moldova rejected this, and the breakaway region even fought a short war with the central authorities (the separatists were helped by troops of the 14th Russian Army in the area).

The parties concluded a peace agreement on 21 July 1992, the essence of which was that the Moldovan authorities would have no say in the politics of the territory, i.e. it was an unspoken guarantee of territorial autonomy. But Moldova does not recognise the independence of the territory and continues to consider it part of the country.

The "non-existent" state has repeatedly applied to join the UN, citing Kosovo as an example, but has never succeeded. In the winter of 2025, hundreds of thousands of people were left without gas, for which Western aid was offered, subject to certain conditions being met. The Transnistrian leaders have accepted this offer, giving the Moldovan government greater influence in the breakaway region. Although Russian influence is still very strong in the area, this can only be changed by the removal of the 14th Division.

We can certainly say that the situation of the territory is very precarious from an autonomy perspective. We can even say that the borders of the country may change in the near future. In the case of the European Union, this is a very sensitive issue, since the existence of the common market requires the precise delimitation of external and internal borders. The European Union must certainly be forward-looking in its preparations for the entry of Moldova.

3.3 Moldova as a possible part of Greater Romania (Romania Mare)

In this chapter, it is also worth examining a possible scenario: the historical background shows that Moldova's independent status depended only on external forces, the will of the Western powers and Russia. The idea of a Greater Romania, with the rise of Romanian nationalism, had an impact on the Romanian-speaking inhabitants of Moldova.

In 1920, after the First World War, Transylvania, Bukovina, Bessarabia and parts of Banat, Gyria and Maramures were united, giving the Romanian state its largest geographical area (295 049 km^2) to date.

The idea of uniting Moldova with Romania is currently being repeatedly voiced by nationalist political forces. Nationalism is a site of struggle over the particular set of ideas describing the nation. In this process, the latter is instituted as a taken-for-granted re-presentation (Hall, 1997) of the social. This is achieved with the help of several key tenets that are generally stable: nations are said to have clear boundaries (both in terms of people and territory) and to be characterised by a culture (portrayed as shared systems of signification, belief, customs, etc.), temporal depth (historical presence) and common descent. Furthermore, nations are instituted as sovereign and intimately linked to a particular territory (Calhoun, 1997). These tenets are rooted in an ‘us’ vs. ‘them’ logic, where the drawing of boundaries around the nation heightens and, on occasions, creates differences (ethnic, linguistic, religious, etc.). The latter, in particular, are positioned as a threat to the very existence of the nation. (Dumitrica, 2019).

The Alliance for the Union of Romanians (AUR) keeps the idea of a Greater Romania on the agenda, promoting the integration of Moldova.

In the context of the war in Russia-Ukraine, European parliamentarian Sosoaca (the representative of AUR) proposed a bill to terminate the Romanian Ukrainian treaty of good friendship. She then wanted to annex territory from Ukraine for the benefit of Greater Romania (Rotaru, 2023). The AUR presidential candidate George Simion wins the first round of the re-run Romanian presidential election. However, he lost the second round by a small difference on 16 May 2025. Simion had accused Moldova of voter fraud, which allowed him to lose. There was no proof of fraud,

but it is more likely that the Moldovans wanted to keep their Romanian roots alive in an independent Moldova. By electing Simion, they did not want to help to power a politician whose dream was to create a Greater Romania in which Moldova would lose its independence and thus its autonomy of decision. (Bakk & Szász Alpár, 2010; Paun, 2025)

3.4 Moldova and the EU

The European Commission (EC) and Moldova signed the Association Agreement and Deep and Free Trade Areas (DCFTA) in 2014 and entered into force in 2016 July. It allows to assess to the European Single Market in selected sectors and to grant EU investors in those sectors the same regulatory environment in the associated country as in the EU. The DCFTA helps Moldova enhance its economic and trade integration with the EU in advance of accession. The EU has fully liberalised all imports from Moldova, except seven agricultural products. (European Commission, 2024c; Official Journal of the EU, 2014)

In 2022 Moldova applied for the EU membership and the Commission recommended candidate status and finally the European Council granted candidate status in June in the same year. In 2023 November the Commission recommended opening accession negotiations.

Accession negotiations were opened with Moldova at the first intergovernmental conferences in June 2024 and it has been an important recognition of Moldova's determination to pursue reforms on the path of EU accession despite facing continuous Russian interference and the impact of Russia's war of aggression against Ukraine.

Following the first intergovernmental conference the Commission started the bilateral phase of the screening process immediately. The Commission is looking forward to the opening of negotiations on clusters, starting with the fundamentals, as soon as possible in 2025. (European Commission, 2024a, 2025) A national referendum to anchor EU integration in the Moldovan Constitution took place together with the presidential election on 20 October 2024. The proposal to enshrine EU accession in the Constitution was supported by 50,38% of voters (European Commission, 2024b)

Between 2021-2024 the EU has allocated over €430 million in non-repayable grants to Moldova. These funds provide financial and technical assistance for social and economic development (European Union, 2024). In October 2024 European Commission adopted its annual Enlargement Package, providing a detailed assessment of the progress made by the Republic of Moldova. The assessments are accompanied by recommendations and guidance on the reform priorities. (European Commission, 2024a, 2025)New tools and instruments are boosting the socio-economic growth in this country. In addition to the successful Economic and Investment Plans, the Growth Plan for the Western Balkans with its €6 billion Reform & Growth Facility and the €50 billion Ukraine Facility are incentivising reforms, with justice and the rule of law at the core. Since 2021, the EU has mobilised €1.6 billion in Moldova. Funds are raised through tools such as the Neighbourhood Investment Platform. (European Union, 2024)

Last year in October the EU adopted a Growth Plan for the Republic of Moldova (1.8 billion euro) to support investments and alignment with the Union acquis and values and underpinned by a Reform and Growth Facility for the period 2025-2027. €400 million are expected to be grants and the rest concessional loans with long maturities. Reform areas include: competitiveness, economic resilience, economic governance, social capital, green transition, and public administration and rule of law. (European Union, 2024; IMF, 2024; World Bank Group, 2024).

The EU Economic and Investment (EIP) for the Eastern Partnership supports the investments needed to make the economies of the region more resilient and able to generate concrete benefits in areas such as transport, private sector, energy, environment and climate, water and sanitation, digital and human capital.

The EU remains deeply committed under the Common Foreign and Security Policy to deepen cooperation with Moldova. In 2024, Moldova became the first country to sign a Security and Defence Partnership with the EU. The EU has provided €137 million support to the Moldovan Armed Forces through the European Peace Facility (EPF) since 2021.

In light of the impact on Moldova of Russia’s war of aggression against Ukraine, the EU has mobilised special support measures, which include direct budget support, humanitarian assistance to support vulnerable Ukrainian refugees and families hosting them in Moldova, investments to support the Solidarity Lanes initiative that helps ensure secure supply chains and food security.

Since 2014, Moldovans benefit from visa-free travel to the EU. The EU has funded over 1 300 exchanges between EU and Moldovan citizens in the areas of education, training, youth, and sport under ERASMUS+ since 2021. (European Commission, 2024b, 2024c)

3.5 Economic performance

According to the (World Bank Group, 2024) and (BTI, 2024)country reports revealed that the Moldovan economy managed to rebound significantly in 2021 after the recession caused by the COVID-19 pandemic and related restrictions on economic activity, increasing more than 10 % compared to 2020, however GDP growth was halted in 2022. The Moldovan economy started to turn the corner in 2023; real GDP grew by a modest 0.7% compared to the sharp decline of 4.6% in 2022. This decline was the result of Russia's war of aggression against neighbouring Ukraine, a severe drought and energy supply disruptions. In 2023 the household spending was stagnated, and investment was balanced by strong net exports. Moldova's income per capita is just under a third of the EU-average. The National Strategy for Economic Development was adopted in June 2024 and its aims to kickstart economic growth and faster convergence.

Inflation has fallen steeply, from a high of 34.6% in October 2022 to 3.5% in April 2024. This disinflation was driven in large part by global food and energy and fuel prices falling. Additionally, Moldova experienced an inflation increase not seen in over 20 years. The inflation rate began to rise sharply in late 2021 and reached 34.62% in September 2022. (BTI, 2024)

While Moldova's public debt ratio remains relatively low, 37.2% of GDP in 2023, driven by the large primary deficit and higher interest payments on short-term domestic debt. The country has run large deficits in recent years, and liquidity management remains challenging.

The large account deficit was financed by net capital inflows in the form of currency, deposits and loans, while net foreign direct investment fell in 2023, to 2.5% of GDP from 3.7% compared to 2022. A new foreign direct investment and export promotion programme was prepared to counterbalance those trends. Moldova's external debt decreased as a share of GDP from 65.4%.

The general government deficit widened to 5.2% of GDP in 2023 compared with 3.2% in 2022 reflecting weak growth and the high cost of measures to support households and firms as well as higher interest payments. The government debt in the period from 2000 to 2022 was between 1.1 billion and 4.9 billion USD. The highest level of the last years at five billion US Dollar was reached in 2022.

Looking ahead, fiscal policy will need to increase much-needed public investment to support the recovery while ensuring sustainability via consolidation that protects growth-enhancing spending.

Nevertheless, while ensuring fiscal sustainability, Moldova will need to increase public investment to begin converging to EU income levels. Major risks are related to the possible interruption of the current arrangement for natural gas supply from Russia to the Transnistrian region. (European Commission, 2024b)

However, Moldova has continued to steadily progress on its EU accession path (European Commission, 2024c)The Moldovan people voted on 20 October 2024 in a referendum on EU accession and in the presidential election. The proposal to enshrine EU accession was supported by 50,38% of voters.

According to the (IMF, 2024) report the economic activity shows a pick-up in 2024 with stronger private consumption and investment.

Moldova further improved its alignment with the EU common foreign and security policy by continues implementing a comprehensive justice reform. Further consolidating anti-corruption institutions, proactive and efficient anti-corruption investigations and convictions at all levels will underpin the building of a solid track record.

The country continued deoligarchisation efforts and launched investigations and prosecution of illegal financial flows and voter bribery. Collaboration with European and international agencies to fight international criminal networks should continue and be further reinforced. Additional efforts are necessary to reinforce the independence of public media and increasing media ownership transparency.

Despite all, the Corruption Perceptions Index (CPI) for the public sector showed 42 out of 100 points for 2023. With this result Moldova ranks 76th. So, compared to other countries, it is slightly below average. Compared to the previous year, the level of corruption decreased a bit. In the long

term, it has also declined moderately in recent years. (Valérian, 2024). The CPI ranks a country by its perceived levels of public sector corruption, scoring on a scale of 0 (highly corrupt) to 100 (very clean). Over two-thirds of countries score below 50 out of 100, which strongly indicates that they have serious corruption problems. The global average is stuck at only 43, while the vast majority of countries have made no progress or declined in the last decade.

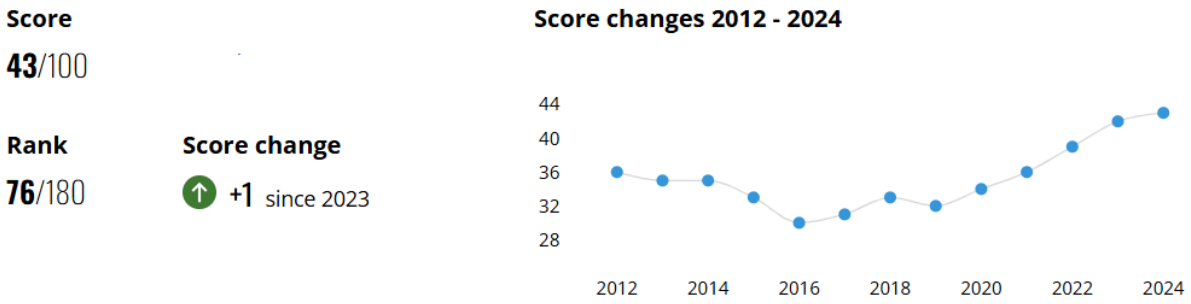

Figure 1. Moldova CPI ranking
Scource: Valérian (2024)

4. Discussion

Moldova is facing a critical moment as it seeks closer ties with the European Union while managing internal challenges and external threats. The country has EU candidate status and is pushing forward with reforms. However, Moldova still struggles with poverty, corruption, and regional divisions, particularly in the breakaway region of Transnistria and the autonomous, pro-Russian Gagauzia.

The war in neighbouring Ukraine has increased Moldova's vulnerability, especially with Russian troops still present in Transnistria. Moldova is working to reduce its reliance on Russian energy and improve ties with the West, but the path ahead remains uncertain due to economic instability and political opposition at home.

Conclusion

To navigate these challenges effectively, Moldova will need to foster collaboration with international partners, implement comprehensive economic strategies, and engage citizens in dialogue about the necessary reforms. However, the country requires comprehensive economy-wide reforms, build a more resilient and sustainable economy capable of withstanding external shocks and improving the quality of life for its citizens. Despite sustained economic growth over two decades, poverty remains penetrating, particularly in rural regions where access to services and viable economic opportunities is limited. The country remains vulnerable to converse weather events and energy shocks due to its heavy dependence on energy imports and limited diversification in energy sources.

With EU candidate status, strong reform momentum and growth-enhancing, climate-resilient investments are needed to foster long-term, sustainable development and convergence toward EU income levels (World Bank Group, 2024)

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The Influence of Geopolitical Situations in the Middle East and Iran on the European Construction Sector in Cement and Concrete Production and Imports

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Abstract

Research background: The paper examines the impact of geopolitical developments in the Middle East and Iran on the European construction industry, with a focus on the configuration of cement and concrete production and imports. It examines how regional conflicts, trade policies, and economic sanctions affect supply chains, production costs, and market stability in Europe. The study also examines the impact of foreign contracts and the strategic responses of European construction companies to these geopolitical challenges.
Purpose of the article: This paper aims to identify the impact of conflict, trade sanctions, and regional instability on the European supply chain and pricing and project delivery in the construction supply chain.
Methods: We employed thematic analysis, which enables us to identify, analyse, and interpret various sources, including scientific journals and political information.
Findings & Value added: The European construction sector, a key driver of economic activity, is highly vulnerable to external disruptions in the supply and prices of its primary materials – notably cement and concrete. Rising geopolitical tensions between the Middle East and Iran have led to significant fluctuations in material prices, logistical uncertainties, and project delays across the continent in recent years. These trends have increased the level of economic risk for construction companies, exposing them to global risk factors that necessitate adjustments in procurement strategies, project planning, contract structures, and pricing mechanisms.

Keywords: Cement manufacture, Concrete deliveries, Iran, European building activities, Supply chain interruption

JEL classification: E00, F14

1. Introduction

The materials to bind them together (Sverdrup and Olafsdottir, 2023). Cement production accounts for a sizeable European construction sector, the backbone of euro area economic activity, is dependent almost entirely on raw materials, among which are cement and concrete, as noted by Crawford (2022). They are more than just building materials; they are the basic building blocks of infrastructure projects, urban development, and industrial construction. Cement and concrete are strategic commodities that support housing policies, transport networks, and renewable energy infrastructure. In 2022, the EU construction sector accounted for approximately 9% of the EU's GDP, with around 18 million people employed in its value chain (Hafez et al., 2020). As such, this sector's performance is closely tied to the availability and cost of a few essential materials, with cement and concrete being the primary drivers in both building structures and overall development goals.

Cement, in its basic definition, is a binding substance used in construction that sets, hardens, and sticks to other amount of greenhouse gas, which can be attributed to the complete excavation of limestone and the sealing emissions that occur during cement manufacturing. When combined with

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aggregates and water, it becomes concrete, the second most widely used commodity in the world after water. The EU has consistently required cement and concrete supplies, amounting to more than 250 million tons per annum (Karlsson et al., 2020). Although Europe features a mature and technologically sophisticated cement production centre, with significant producers in Germany, France, Italy, and Spain, home production has increasingly been supplemented through imports due to the convergence of environmental regulations, energy costs, capacity constraints, and geostrategic diversification of resources.

The movement by Green and the European Green Deal has imposed new constraints on energy-intensive industries, such as cement production (Lim et al., 2020). Tighter carbon tax measures under the EU Emissions Trading System (ETS) have increased costs, and some companies have reduced their home production or looked beyond bolstering imports. In addition, the drive for economic growth in Eastern Europe and post-COVID economic recovery programs have substantially increased demand—in some regions, faster than the local availability of building materials.

This article aims to provide a critical, systematic, and integrative analysis of the impact of geopolitical dynamics in the Middle East and Iran on the European construction industry, particularly in the areas of cement and concrete manufacturing and imports. It aims to identify the impact of conflict, trade sanctions, and regional instability on the European supply chain, pricing, and project delivery within the construction sector.

The following section gives a literature review. It determines the significance of economics and, in Europe, the dysfunctions of the construction sector due to the use of materials and unhealthy substances imported from geopolitically unreliable regions. Likewise, it explains the objectives and goals of the study.

The section 'Methodology' presents our methodological approach. The section includes the choice of peer-reviewed sources from Scopus and Web of Science, the criteria used to include papers in the analysis, and the approach used for examining geopolitical events and their consequences for commercial flow. A qualitative content analysis, along with a thematic analysis, provides both depth and scope of insight. The section 'Discussion' places the findings within a broader strategic and policy context. It analyses the weaknesses revealed by geopolitical dependencies and looks at how to enable European industries and governments to adapt. This section concludes with practical suggestions and opportunities for further research.

2. Literature review

We decided to critically examine the regional impact and influence of geopolitical events in the Middle East and Iran on the construction sector of the Middle East and the European Union, particularly concerning cement and concrete imports. Sergent and Smith (2024) and Tkachenko et al. (2023) conducted a systematic and methodical literature review. The objective of these reviews was to identify, summarise, and draw insights from research and professional opinion concerning the high-level connection between geopolitics, the global construction supply chain, and the cement and concrete industries.

Charles (2023) introduced "The Effect of Current Geopolitical Shift on MEA's Construction Industry," where he examined how shifts in diplomatic partnerships, regional rivalries, and economic sanctions have shattered supply chains, labour movements, and investment flows in the Middle East and Africa. Although the paper takes the broadest view of the MEA region, the article provides interesting analogies for the European context, particularly in terms of the spillover impacts of Middle East disruptions on global construction material price and supply. Also, Allen (2020) highlights the worldwide effects of political instability on the construction industry in "Geopolitical Impacts on the Future of Construction." Country risk and uncertainty in oil-rich regions, particularly in the Gulf, have been shown to have clear correlations with the volatility of transportation costs for heavy chemicals, such as cement, as noted in the article. Allen also stresses the importance for companies to improve their geopolitical risk model practices and overhaul procurement approaches to limit exposure to a single region.

In "Geopolitics and a Cement Strategy", Pavlopoulos (2017) gives a case-focused account of how companies producing cement are becoming actors in geopolitics. He further suggests that firms need to have a "cement strategy" that is not solely economic but also diplomatic and adaptive and able to respond to both regional conflict areas and global climate directives. Pavlopoulos presents an

interesting argument that cement producers typically operate in weak or weak authoritarian regimes, where a democratic vote can instantly undermine state-corporate connections, logistical convenience, and control over resources.

Additionally crucial is Saeed (2025), whose oeuvre in the Asian Review of Political Economy aims to achieve a timely and deeper validation of the effect of Middle Eastern crises—inter alia, the Iran–Saudi Arabia conflict, the Yemen conflict, and Syrian reconstruction—on re-arranging economic ties. Saeed's compelling evidence suggests that such geopolitical shifts are altering the way cement and building materials are transported within the region and beyond, thereby impacting imports in Europe, particularly for countries with Mediterranean coastlines.

Institutional contributions will also increase the literature. The Council on Foreign Relations (2024) provides a valuable overview of educational objectives, both non-lexically and analytically, in "Middle East and North Africa: The Essentials—Regional Politics," which describes the intertwining of politics, trade, and development in the region. It demonstrates how trade routes, port access, and political relationships impact Europe's ability to secure stable imports of key construction materials from these markets.

Nejad (2025), covering Modern Diplomacy, narrows in on Iran specifically, discussing how Iran's foreign policy and its shifting position in the post-Assad Middle East could be depicted and how a concentration could impact its erosion of partnerships and export prospects. His essay, "The Future of Iran's Foreign Policy in the Post-Assad Middle East Complex Geopolitics," ties Iran's isolation, caused by US-led Western sanctions, to its turn toward non-Western allies, such as China's Belt and Road Initiative. Nejad suggests that these macro-changes could, over time, realign Iranian cement exports to Asia and Africa, further marginalising its role in the European market but also subjecting Europe to secondary market volatility.

The Clingendael Institute's 2022 report, "The Geopolitics of Regional Conflict," offers a consolidated view of Middle Eastern instability for the period 2010–2021. The report details each of the strategic choke points—the Strait of Hormuz and the Bab el Mandeb Strait—that bear on shipping lanes for bulk commodities. These insights are crucial for understanding how even a small armed conflict can escalate into a supply chain crisis for Europe's construction industry, as hostage shipments, stalled shipments, high insurance costs, and uncertainty in sourcing timelines all become factors.

There is a common thread that runs through these sources, and that is that European dependence on Middle Eastern cement is no longer just an economic issue; it has become a strategic and resilient issue. This change, of course, amplifies the exposure to external shocks, especially those resulting from unstable geopolitical regions.

Individually, the research tells a story: the cement-and-concrete-based construction business has an inherent vulnerability to geopolitical shocks. Iraq's supply routes from the Middle East and Iran are particularly vulnerable due to the dual pressures of internal conflict and geopolitical tensions. On the other hand, the literature suggests that the European construction sector may expect risk management, regional diversification, and strategic policy-making to achieve resilience against external dependencies.

This study aims to investigate the impact of conflict, trade sanctions, and regional instability on the European supply chain, including pricing and project delivery in the construction sector. We decide to find answers to our research questions:

1. How reliant is the European construction sector on cement and concrete imports from the Middle East and Iran?
2. What are the main geopolitical events disrupting cement trade from these regions?
3. How do such disruptions affect pricing, timelines, and project feasibility in Europe?
4. What strategies have European stakeholders implemented to mitigate these impacts?
5. What policy measures can enhance the resilience of the European construction material supply chain?

3. Data and Methodology

We used thematic analysis to explain the impact of geopolitical issues in the Middle East and Iran on the European cement and concrete supply chain. The topic is interdisciplinary, specifically dealing

with international relations, trade economics, and construction materials; therefore, a multi-activity data strategy was employed.

The analysis was performed using academic databases, including Scopus and Web of Science. These databases provided access to scholarly work in political science, international trade, construction management, and regional studies. A search was made, using examples such as "geopolitical risks," "cement import," "Iran sanction," "Middle East conflict," and "European construction supply chain." etc. The search was limited to articles published between 2015 and 2025 to ensure that the literature reflects the most recent geopolitical changes and their significance in the contemporary European construction context. Digests were only to peer-reviewed sources or institutional publications of proven academic standing to sustain analytical thoroughness. Articles like Charles (2023), Allen (2020), and Saeed (2025) initially explored long-range views of how instability in the Middle East and realignments are being linked to crucial discussions in the construction supply chain.

Supporting the literature review, numerous secondary data sources were analysed to measure quantitative trends and insights within cement and concrete production, imports and trade dependencies (Mostert et al., 2022). Eurostat, the statistical office of the European Union, was essential for gathering country data on cement production, import-export balance, and demand growth at the country level. Additional information from the European Cement Association (CemBureau) and the World Cement Association, which are associated with the industry, includes civic intensity wake-up, regional constituent malt abilities, and the carbon encyclical pressures associated with adverse domestic access and own constraints.

Data from international trade databases, including the UN and the International Trade Centre (ITC), can be used to identify cement imports from the Middle East and North Africa (MENA) region to Europe, as reported by Poolsawad et al. (2023). These datasets have been particularly useful for analysing changes in source countries over the past decade. For example, Ankara-based Turkey has become the largest non-EU supplier of cement to Europe thanks to its presence and production capacity. However, the roles of Egypt, Algeria, and Saudi Arabia have also increased. Although direct imports from Iran remain small due to international sanctions, Iran's latent production potential and its strategic geographical location make it a key player in the wider MENA supply chain (Zhang et al., 2021).

Changes in regional trade patterns, as well as indirect trade patterns, also contribute to Iran's influence. However, its role remains marginal mainly as long as current sanctions regimes remain in place. Trade data in this research also include other relevant government, geopolitical and regulatory documents, such as sanctions records from the US Treasury Department's Office of Foreign Assets Control (OFAC) and the EU Sanctions Map (Argeime López-Malest et al., 2024). This documentation was key to studying the common and implicit restrictions imposed on all Middle Eastern companies – especially on Iranian exporters. Sanctions not only hinder the legality of trade but also affect risk perceptions and premiums, as well as access to international banking – factors that influence supply chain decision-making in the European construction sector.

For a regional perspective and geopolitical analysis, reports and policy papers from international forums such as the Council on Foreign Relations (CFR) and the Institute for Modern Diplomacy (Caro et al., 2023) were utilised. These sources provided helpful insights into maritime security, conflict escalation and political differences that affect trade infrastructure and readiness for the vault. The closure of the Suez Canal in 2021 following a blockade or ongoing tensions in the Strait of Hormuz and the Bab El-Mandeb Strait is a warning sign of the fragility of the transport routes for bulk construction materials to Europe. The data obtained were, therefore, multidimensional in nature, encompassing both qualitative and quantitative aspects. It provided a comprehensive view of production capacity, trade dependencies, political obstacles and regional instability that encompasses the entire European cement and concrete supply chain.

4. Results

4.1 Impact of Geopolitical Tensions on Supply Chains

The results of the analysis by Erixon et al. (2022) suggest that geopolitical pressures in the Middle East and Iran have significantly and measurably strengthened the logistics of cement and concrete supply chains in the European construction industry. This impact is reflected in both short-

term trade disruptions and long-term changes in procurement patterns and production organisation. The findings utilise multiple data sources – case-based evidence and statistical records – to demonstrate how conflict zones, sanctions regimes, and diplomatic reconfigurations have transformed the import landscape of construction materials into Europe.

Perhaps the most striking illustration of geopolitical disruption was the 2021 blockade of the Suez Canal, which stranded a container ship and then prevented shipping for six days on one of the world's busiest shipping lanes (Fattouh et al., 2021). Although not the conflict itself, it is a case in which it was clear how much European supplies were exposed to bottlenecks in the most politically tense regions. The canal carries around 12% of world trade. Although loose limestone is likely to be transported in bulk, many related materials, including clinker and by-products, also pass through the canal, as noted in Horák (2022). In southern European countries, cement imports fell by 8.3% in the second quarter of 2021 compared to the previous quarter. This decline is observed in this isolated case, as reported by Eurostat. Transport rates also temporarily increased sharply, putting additional pressure on importers and construction companies who were already experiencing material shortages after the pandemic.

In a more persistent and politically tense situation, the change in US sanctions against Iran in 2018 – following the Trump administration's withdrawal from the Joint Comprehensive Plan of Action (JCPOA) – had both direct and indirect impacts on cement flows in the region (Häfner et al., 2023). Iran, once the world's tenth-largest cement producer, had limited export opportunities as the flow of financial transactions and insurance for Iranian trade was halted. As European businesses were not bound by US sanctions, secondary sanctions had the effect of discouraging European importers and logistics providers from withdrawing and being neutral towards Iranian supplies (Doraj and Blanchard, 2020). Although Iran had relatively low levels of direct exports to Europe before 2018, Iran's involvement in its neighbours' supply chains and its ability to influence regional prices from afar have influenced European purchasing strategies. Cement exports from Iran fell by almost 40 per cent between 2017 and 2019, according to data from the International Trade Centre (ITC) (Meidan et al., 2023). At the same time, European importers have turned to alternative Middle Eastern sources, notably Turkey and Egypt, which have increased production to cover the deficit.

The course of the Syrian civil war is another excellent illustration of the disruption caused by conflict. Before the war, Syria had a small cement industry that supplied parts of Lebanon, Jordan, and Iraq. However, the destruction of domestic infrastructure not only eliminated Syria as a source but also altered regional trade flows, causing port congestion and increasing import demand from external trading partners in neighbouring countries (Neset et al., 2023). European companies that were contractually obligated to carry out reconstruction work in the Levant suffered "severe delays" and "cost overruns" due to supply chain problems, security concerns, and insufficient local manufacturing capacity. Moreover, the fact that militant groups have taken control of cement plants – as in the Lafarge scandal, in which the French cement manufacturer was accused of providing financial support to fighting organisations to maintain operations in Syria – highlights the ethical and operational difficulties that arise when operating in conflict areas (Pochat, 2023). These risks are not only reputational and legal risks for European businesses but also operational disruptions that can be transmitted through the supply chain.

The impact of these events can also be seen in the statistics on cement supplies to the EU. Eurostat data from 2015 to 2023 show that domestic cement production in the EU has remained relatively stable in the meantime, while the respective share of imports from third countries has increased from 6.7% to 11.2% of total cement consumption. Notably, countries such as Spain, Italy and Greece have seen cement imports exceed 30% since 2018 as they sought to keep their domestic producers under the stricter regulations of the EU Emissions Trading System (ETS) (Azad, 2024). This increase in outsourcing has increased exposure to external political risks. Relying on countries such as Turkey, which has experienced significant political and economic changes, including currency devaluation and the rise of authoritarianism, creates an additional layer of uncertainty.

Another quantifiable consequence of the impact of geopolitical tensions and escalating costs on the supply chain is that, based on construction cost indices published by Euroconstruct and the OECD, the prices of cement and concrete in Europe increased by 19% between 2020 and 2023. Part of this increase can be attributed to inflation following the COVID-19 pandemic and rising energy prices. However, a regional case study (Bhattarai and Yousef, 2025) shows that imported cement exhibits

higher price volatility. For example, the resumption of hostilities between Israeli forces and Iranian-backed militias in Syria in 2022 triggered higher shipping and insurance fees in the Eastern Mediterranean. Shipping companies then passed on the burden to importers, who then shifted it to the construction industry.

The data also shows that corporations, on the other hand, are addressing these risks by expanding their sourcing policies. There is a growing trend among European companies to invest in domestic recycling of construction waste, aiming to reduce their reliance on imported clinker. The shift that has occurred here aligns with EU sustainability goals and represents a step in regional geopolitical risk management (Biazzi, 2022). Meanwhile, companies have come to rely on politically stable, albeit geographically distant, countries, including Vietnam and Indonesia, which have increased shipping distances and, consequently, carbon emissions. This trade-off between strategic resilience and environmental performance presents a new challenge for policymakers and business leaders in the construction industry.

Another issue is the key vulnerability created by narrow maritime transport hubs. All lie at the heart of the global supply chain for bulk construction materials from the Middle East to Europe. Disruptions to these routes – whether through combat, piracy or sabotage – have the most significant impacts anytime, anywhere, with their ripple effects on schedules and prices (Pradhan, 2020). For example, the Horthy attacks on merchant ships in the Red Sea in 2023 resulted in temporary diversions of shipping, leading to long-term delays in deliveries and increased shipping prices. Even short-term closures in these corridors can hinder large-scale infrastructure projects across Europe, particularly those reliant on just-in-time supply chains.

Research findings indicate that geopolitical uncertainty has not only disrupted short-term logistics but also led to permanent changes in the supply of cement and concrete in Europe (Şahmaran et al., 2020). The shift towards diversification, localisation, and technical innovation in construction materials can be partly attributed to these disruptions. However, such measures have not led to an accelerated elimination of the conflict but rather to its displacement to other regions and channels. The ongoing conflict in the Middle East and the ongoing uncertainty around Iran's integration into the global system mean that Europe's exposure to geopolitical supply chain risk is likely to be long-term.

4.2. Trade Policy and Sanctions Analysis

The impact of trade policies and international sanctions on the European construction sector – particularly regarding imports of cement and concrete from the Middle East and Iran – is vast, multi-layered, and closely linked to political issues (Alshareef, 2023). This section critically examines the function of trade-related interventions – particularly the sanctions imposed on Iran – and how they have reorganised material objects, distorted markets and worsened procurement strategies in Europe. The analysis also examines how more general trade agreements and tariff regimes have influenced the availability, price, and sourcing lists of construction materials, demonstrating that the political economy and the resilience of the construction industry are intertwined and inseparable.

Iran is a prime example of how targeted sanctions can yield unintended consequences, often with a profound impact. With a historical production of over 80 million tons per year, Iran was once one of the world's leading cement producers, boasting a competitive advantage in providing affordable cement to markets in the Middle East, Central Asia, and, to a lesser extent, Eastern Europe (Stošić, 2023). However, the imposition of US sanctions following the withdrawal from the Joint Comprehensive Plan of Action (JCPOA) in 2018 drastically disrupted Iran's participation in world trade. Although the European Union initially sought to maintain its presence at the negotiating table on the JCPOA, the risk of secondary US sanctions ultimately persuaded European companies to refrain from trading with Iranian products, including cement (Valadbaygi, 2025). This discreet withdrawal was not due to the EU directive on the embargo on Iranian cement but rather a courtship indirectly caused by the risks of dealing with sanctioned parties or limiting compliance in overlapping jurisdictional frameworks.

The real effects of these sanctions have been severe. In 2016, Iranian cement exports were recorded at over 18 million tonnes, which have fallen sharply in the following years. As of 2020, total exports have declined to just under 11 million tonnes, with almost no imports to Europe (Acevedo and Lorca-Susino, 2021). It has led to a supply deficit in regional markets, and countries such as Iraq, Afghanistan, and Syria have sought alternative sources from Middle Eastern producers. This shift in

demand has strained existing exporters such as Turkey and Egypt, whose surplus production has increasingly been directed to these nearby markets, further tightening the availability of cement for Europe.

The knock-on effect has also been reflected in pricing. Although European countries were not heavily dependent on large volumes of Iranian cement, the collapse of a major regional power led to a shift in supply and demand dynamics across the MENA region (Akhtar et al., 2024). Clinker and bulk cement prices, especially in Mediterranean ports, also became more volatile. Export-oriented firms in Turkey, Egypt, and Algeria have begun to experience an increasingly volatile pricing environment, primarily due to higher freight demand and longer delivery times resulting from diverted trade (Alzawawy, 2022). Additionally, increased pressure on Turkish and Egyptian producers led to lower export volumes for EU consumers, favouring more gradual local partnerships.

The shift in supply was only one aspect of the broader impacts of sanctions on logistics, insurance, and financing. Shipping companies were wary of entering Iranian ports or transporting goods diverted from their routes due to concerns about losing insurance coverage or disputes with US authorities. They began to withdraw their support for processing payments or issuing letters of credit covering operations from Iranian companies, making trade impractical despite the complete absence of an EU trade embargo. This financial exclusion had the deterrent effect not only of banning Iranian cement from European sources but also of reducing the competitiveness of the entire market and diversifying supplies. In addition, the sanctions regime extended to the broader logistics infrastructure of Iranian operations, including the diversion of port use, customs protocols, and multiple trade routes. China's Belt and Road Initiative (BRI), a transcontinental project in development, has increasingly highlighted the country's economic isolation (Wrobel, 2023). European suppliers that sought to expand their import techniques by relying on inland routes or a combination of shipping and rail through Iran had to reassess these strategies due to operational challenges and concerns about sanctions enforcement.

In addition to sanctions, European trade policy instruments have also significantly affected the supply situation for construction materials. The implementation of the EU's Carbon Border Adjustment Mechanism (CBAM), which aims to redress the uneven playing field faced by domestic producers operating under strict emission controls and lower published limits that competing producers from other countries continue to apply, will soon shake up the balance of cement imports (Alzawawy, 2022). Cement is among the first sectors to be affected by the CBAM; it imposes a carbon tariff on the level of emissions-related tariffs on imported goods. Although this policy is environmentally friendly, it functions as a trade barrier by imposing environmental costs on imported cement from countries without an equivalent carbon pricing regime – specifically, countries in the Middle East and North Africa.

The result of this accumulation of trade policies, sanctions, and diplomacy is high volatility and fragmentation. European construction companies are increasingly exposed to international political risks, including those related to procurement methods (Erixon et al., 2022). Importers must undoubtedly consider costs and logistics, as well as the legal and other aspects of purchasing from specific regions. For smaller construction companies, which have limited access to the legal framework and geopolitical lobbying knowledge of multinationals, this complexity presents an obstacle, leading them to more expensive suppliers with lower risk and domestic production that may not meet production requirements or be cost-effective.

In this regard, we reflect the growing European interest in autonomy in the acquisition of materials – a reflection of ambitions in energy policy – which is all the more understandable. Policymakers need to consider how to mitigate risk not only through diversification but also by investing in low-carbon cement substitutes, recycling technologies, and reducing dependence on high-carbon imports. While such strategies are promising, they require time and significant financial investment. Meanwhile, construction remains vulnerable to political instability in its trading partners.

5. Discussion

This research reveals an intense and complex relationship between geopolitical events in the Middle East and Iran and disruptions in the supply of materials to the European construction industry. Cement and concrete, as essential components of infrastructure, and their dependence on the supply chain are good indicators of the vulnerabilities posed by international political instability (Stošić,

2023). The empirical evidence presented in the results section – from import statistics to cost volatility and case studies – tells a clear story about the growing shortages and costs of logistical uncertainty: The higher the political tensions in key supply regions, the bigger the wave that Europe once again has no access to, except for the fear that it is too small and therefore has to look for help everywhere. It is especially true when events occur in geopolitically significant areas or when countries that control Europe's external cement supply are involved.

The observed relationship becomes even more pronounced when there is an increase in conflict or the imposition of sanctions. The changes that have occurred, such as the re-imposition of sanctions on Iran in 2018, have been consistent with significant shifts in the behaviour of European suppliers, increased inflation in import costs, and alterations in regional trade flows (Valadbaygi, 2025). Additionally, maritime disruptions in the Suez Canal and the Red Sea have had a direct impact on delivery times and shipping rates. These political events are not isolated, but they exacerbate previous structural challenges in the EU as a market, such as carbon price pressures, limited supply capacity, and high demand in post-pandemic situations, thereby increasing overall machine heterogeneity.

Conceptually, these results are consistent with the existing literature, which has long argued that the construction supply chain is highly vulnerable to external shocks due to its high dependence on the transportability of bulk goods and its susceptibility to time-dependent procurement, as well as exposure to fuel and transportation costs (Wrobel, 2023). For example, Allen (2020) notes that construction is particularly prone to stubborn resistance to rate adjustments among industries due to its rigidity when projects are advanced and long. Pavlopoulos (2017) also points out in the context of coordination situations in global supply chains that cement logistics, unlike high-value manufactured goods, cannot easily absorb increased transportation costs that significantly impact final project budgets due to their low value-to-weight ratio. These vulnerabilities have been demonstrated in practice during recent Middle Eastern crises, corroborating the literature that construction supply chains are both economically and geopolitically exposed.

Furthermore, the findings confirm Charles (2023), who outlines a direct relationship between regional instability and the volatility of construction material intensity in the Middle East and Africa (MEA), with an impact that is not limited to the MEA but also extends to Europe. The geopolitical embeddedness of construction material flows – whether they involve individual countries or countries with secondary linkages, such as those in the Middle East – also means that even unintended proximity in conflicts or sanctions has measurable effects on distant markets. For example, the reallocation of surplus cement from Turkey and Egypt to more proximal reconstruction projects following the Syrian and Yemeni wars reduced excess supplies in the European market, consistent with the supply-side shift theory in international trade economics.

Where this research differs is in applying this theoretical understanding to the specific case of the EU construction industry within the context of specific regulatory frameworks, such as the EU CBAM, and evolving market practices. While previous literature has conventionally treated geopolitical instability and trade volatility as country-specific shocks or unpredictable add-ons, this appears to lead to a deeper institutionalisation of geopolitical risk into the structure of the European construction supply chain. It represents a shift from episodic disruption to a persistent state of uncertainty that necessitates transformation at the sector level.

5.1. Strategic Responses by European Firms

In response to these multifaceted challenges, European construction companies have begun implementing several key strategic measures to mitigate their vulnerability to geopolitically driven disruptions in the supply of materials (Azad, 2024). However, the most significant of these is probably the differentiation of supply sources. In response, many European companies are now seeking to increase their supply base from countries outside the traditional Middle East and North Africa (MENA) region and to minimise their dependence on a larger number of countries to avoid the risks of heavy dependence on relatively small countries – countries that are usually located in a geopolitically turbulent zone. For example, Eurostat data recently showed an increase in imports from Southeast Asia, specifically Vietnam and Indonesia, where companies are attempting to reroute goods away from the chaotic Mediterranean routes (Bhattarai and Yousef, 2025). Although alternatives to these means of transport involve higher transport costs and longer delivery times, they are considered more sustainable in the long term, especially given Europe's recent focus on supply chain sustainability. In

addition to geographical diversification, companies are currently investing in alternative materials and technologies to reduce their dependence on traditional forms of cement. The injection of expansion agents, which involves recycling construction and demolition waste (CDW) into second-generation products (secondary aggregates), on the one hand, and the introduction of low-carbon cement substitutes, such as fly ash, slag, and binders, on the other, are being developed (Biazzi, 2022). These innovations align with the EU's climate ambitions, as outlined in the EU-CVI, while also diversifying geopolitical risks by internalising a larger part of the supply chain within the national territory. However, these changes require significant investment in studies, infrastructure, and regulatory adjustments, making them a medium to long-term option, neither short-term nor easy.

Another strategic response is logistical adaptation. The disruption of major shipping routes, such as the Suez Canal and the Red Sea, has forced companies to reduce their dependence on transport and explore multimodal logistics that involve rail, road, and inland waterways (Erixon et al., 2022). For example, some operators from Central and Eastern Europe are starting to use land routes through the Caucasus or Central Asia; however, they are limited by capacity and infrastructure. In addition, more advanced digital logistics platforms are being introduced to better support forecasting, real-time shipment tracking and any delays that geopolitical tensions may cause.

Some of the largest construction companies and cement importers are also actively adopting vertical integration strategies – they have control over otherwise independent upstream and downstream suppliers to try to reduce external risks (Fattouh et al., 2021), (Horák, 2022). This strategy has become particularly attractive in the context of CBAM, as companies seek to manage the carbon content of their supply chains to remain competitive in an increasingly volatile regulatory environment. Production options within the EU or in neighbouring stable countries offer predictability of cost structures and mitigate any financial risks caused by tariffs, sanctions, or trade disruptions resulting from conflicts.

At the global policy level, industry trade associations such as Cembureau are calling for greater EU-level harmonisation in the provision of critical construction goods, including the creation of strategic storage facilities, strengthened trade agreements with stable supplier countries and fast-tracking permits for domestic low-carbon cement plants (Häfner et al., 2023). Green corridors, secure and decarbonised supply routes, and engaging in trade only between Europe and preferred partners would lead to increased interest in climate and security benefits.

Although these efforts are being made, the impact of strategic responses varies widely across firms and sectors. Large multinational suppliers, global supplier networks and deeper capital buffers can absorb shocks and changes. On the other hand, many small and medium-sized enterprises (SMEs), which comprise the majority of the industry, lack sufficient financial and logistical resources to easily switch suppliers or materials (Doraj and Blanchard, 2020). As a result, they remain disproportionately exposed to price volatility, delivery delays and contractual risk. This long-standing gap highlights the need for policy support, industry collaboration and knowledge-sharing platforms that can facilitate access to risk-reduction tools.

Conclusion

We find that the European construction sector will be more resilient to increasing geopolitical turbulence if policymakers adopt a holistic and forward-looking strategy similar to that found by Meidan et al. (2023). The reasons are as follows. First, there is an urgent need to create strategic stocks of materials, especially cement and clinker – a kind of energy reserve – to help mitigate short-term supply shocks resulting from sudden geopolitical events. These stocks could be coordinated at the EU level to ensure a fair distribution of shares and to avoid the risk of resources being dependent on a single supplier or location. Secondly, more investment should also be made in newly built domestic low-carbon cement plants. It can be achieved through subsidies for green innovation, facilitating the permitting of sustainable cement plants and offering incentives for the use of alternative materials – such as recycled aggregates as binders (Neset et al., 2023). These measures not only increase supply chain autonomy but also support the EU's decarbonisation objective. Third, trade diversification should be sought through new or more substantial commitments to politically stable countries that are less dependent on the Middle East and North Africa. Bilateral agreements could include provisions to support logistics cooperation, compliance with emissions regulations, and mechanisms for dispute resolution. Finally, international cooperation, particularly through multilateral institutions such as the

WTO and regional trade bodies, should focus on building robust and transparent trade practices. It includes financing protected shipping lanes, mutual digital trading platforms, and joint conflict response plans to protect cargo and the flow of materials.

Although this study presents a rigorous qualitative analysis, as it relies on secondary data and thematic analysis, conclusions about causality are not possible, which aligns with Alzawawy (2022). Furthermore, such studies are likely to become quickly outdated or context-specific due to the rapid changes and developments in geopolitical events.

Future research should focus on real empirical case studies, especially those that include interviews with industry insiders and policymakers, to gain a deeper understanding of how firms manage geopolitical risks. Additionally, we propose conducting quantitative modelling of supply chain disruptions and price elasticity in the context of conflicts. Chain-based supply tracking and predictive analytics in geographically exposed zones will strengthen the sector's strength. Furthermore, examining the role of emerging powers such as China and India in shaping global cement flows provides a more global perspective on supply chain changes in a multipolar geopolitical context.

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Progress in the Competitiveness of the Slovak Republic in the Context of Sustainability

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Abstract

Research background: The Sustainable Development Goals (SDGs) play a key role in enhancing a country's competitiveness by aligning economic growth with social and environmental sustainability. Incorporating the SDGs into national policies promotes innovation, attracts investment and improves overall economic resilience. There is a known positive correlation between the implementation of the SDGs and national competitiveness. The relationship between the various competitiveness indices and the SDGs suggests that sustainable practices can improve a country's global position.
Purpose of the article: The main aim of the paper is to investigate the progress in the selected SDGs goals in Slovak Republic. The analysed period is 10 years. According to main aim, there was set the research questions: What are Slovakia's strengths and weaknesses? Where has the most significant progress been made?
Methods: To solve these questions and investigate Slovakia's progress, we used the methods of analysis and synthesis, correlation, and other methods of descriptive statistics. For complex calculations, we used the Statistica software.
Findings & Value added: At the conclusions, progress in the competitiveness of the Slovak Republic were identified. There were set challenges and risks according to the SDGs for Slovakia, which must be considered to improve the current situation in the competitiveness.

Keywords: Sustainable development goals, Agenda 2030, Social dimension, Environmental dimension, Economic dimension

JEL classification: J11, O15, O44

1. Introduction

High competitiveness is now one of the main prerequisites for national economies to increase GDP per capita and to grow welfare, i. e. to improve the level and conditions for health, social protection and living standards. One of the classic definitions of competitiveness specifies it as the ability to produce goods and services that meet the demands of international markets while maintaining high and sustainable levels of income, or, more generally, the ability of regions to generate relatively high levels of income and employment, even when exposed to external competition. Competitiveness at a macro level, it should be noted, for example, at national competitiveness, which is associated with improved living standards, is determined by raising productivity that creates the competitive advantage of a country in international trade (Boikova et al., 2021).

Increasing the competitiveness of EU countries can be achieved by strengthening the regional development of EU regions and closing regional gaps. This is the focus of various EU initiatives aimed at raising up EU economies to a higher level, i.e. Europe 2020, Agenda 2030 and others. It should be noted that sustained, inclusive and sustainable economic growth is one of the Sustainable Development Goals to be achieved by 2030 under the 2030 Agenda, which is the work of the United Nations (Di Vaio et al., 2022). Nevertheless, the concept of competitiveness is constantly evolving, as are the drivers or determinants of competitiveness (Boikova et al., 2021).

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2. Theoretical background

Sustainable development is a widely accepted concept. It is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Carpentier & Braun, 2020). This definition underscores the fundamental balance between the three interrelated dimensions:

- environmental,
- social,
- economic (Carew & Mitchell, 2008).

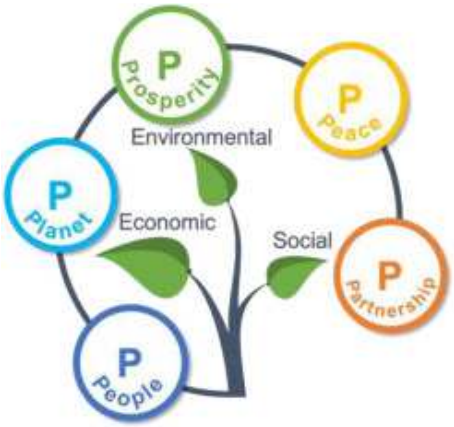

Figure 1. Five pillars 5Ps
Source: Khajuria et al. (2022)

Mentioned dimensions are structured around five pillars (5Ps) - people, planet, prosperity, peace, and partnership with the aim of shifting the world onto a sustainable and resilient development path and leaving no one behind. The first pillar People targets to end poverty and hunger, the second pillar Planet defines to protect the planet from degradation, the third pillar Prosperity ensures that all human beings can enjoy prosperous and fulfilling lives, the fourth pillar Peace dictates to foster peaceful, just, and inclusive societies and the fifth pillar Partnership helps to establish a network and mobilize the means to implement this agenda (Khajuria et al., 2022).

Environmental Sustainability - this dimension focuses on the conservation and responsible management of natural resources and ecosystems (Piwowar-Sulej et al., 2023). It aims to ensure the long-term availability of natural resources and the health of the planet for future generations (Tóthová & Heglasová, 2022), (Khajuria et al., 2022).

Social sustainability - this pillar seeks to promote inclusive societies, reduce inequalities and ensure long-term well-being and equity for all people, thereby maintaining social cohesion (Andrade et al., 2020). It addresses critical issues such as poverty, discrimination, social exclusion, lack of access to basic resources (such as education and health care), and the prevalence of insecurity and conflict.

Economic sustainability - this dimension focuses on creating long-term economic growth and development (Ricciolini et al., 2024) without depleting natural resources or undermining social equity, thereby not compromising the ability of future generations to meet their needs (Diaz-Sarachaga et al., 2018). It promotes a healthy balance between economic expansion and responsible use of resources.

Sustainability, encompassing environmental protection, social well-being and economic viability, is no longer a peripheral issue but increasingly recognized as a fundamental competitive advantage for nations and societies (Sorooshian, 2024). The Sustainable Development Goals (SDGs), adopted in 2015, provide a comprehensive and universal framework to address interconnected global challenges, from poverty and hunger to climate change and biodiversity loss, guiding nations towards sustainable development (Montanari et al., 2020), (Adamišin et al., 2022). At the national level, commitment to environmental sustainability, including internalizing the costs of pollution and responsible natural resource management, drives efficiency, reduces waste, and stimulates innovation. In total, 17 of these are specified, each with a different number of indicators to quantify it.

Figure 2. Sustainable Development Goals
Source: Focus 2030

The SDGs are not just a set of targets, but represent a holistic, integrated performance metric for national well-being and long-term viability, transcending the limitations of GDP as a single measure of progress (Montanari et al., 2021). Achieving these goals requires a systems approach (Carpentier & Braun, 2020), where progress in one area can create multiplier effects in other areas, strengthening a country's overall resilience and competitive position.

3. Methods

The main aim of the paper is to investigate the progress in the selected SDGs goals in Slovak Republic. To achieve the main objective, we have set the following subsidiary objectives:

- to analyse the development of Slovakia in selected indicators,
- to compare the development of Slovakia with the EU 27 average,
- to compare the development of Slovakia with the average of the countries, that joined the EU in 2004 (EU 2004) – it is the year, that Slovakia also joined the EU,
- predict the trend of development of Slovakia for the next period,
- identify the relationship between competitiveness and selected SDG.

According to main aim, there was set the research questions:

- RQ1: What are Slovakia's strengths and weaknesses?
- RQ2: Where has the most significant progress been made?
- RQ3: Do the fulfilments of SDGs affect the competitiveness?

To answer these questions, we have chosen to compare Slovakia with the EU 27 average as well as with the average of EU 2004. The EU 2004 countries were chosen, because they joined the EU in the same year as Slovakia, so they had similar conditions and comparable levels of economics at that time. Therefore, we were interested in their progress and whether any differences have developed between the countries. To answer the RQ3 we have chosen the EU 2004 countries and GSCI index.

The GSCI index was selected to assess the competitiveness area. This index was chosen because it also takes into account the area of sustainability. Also because results are also available for the years 2023 and 2024, so it is possible to compare them with the SDG results achieved in that period (not all selected SDGs had data available for 2024).

The GSCI Index (Global Sustainable Competitiveness Index) from Solability is a comprehensive index that measures the sustainable competitiveness of countries. It was first published in 2012 and serves as an alternative to traditional metrics (Almos, 2022). The GSCI assesses the sustainable competitiveness of countries based on more than 200 quantitative indicators The indicators are grouped into six core pillars that define the competitiveness of a national economy:

- Natural Capital,
- Resource Efficiency,
- Social Capital,
- Intellectual Capital & Innovation,
- Economic Sustainability,
- Governance Performance (Solability, 2025).

The analysed period is 10 years. We have used the methods of analysis and synthesis, as well as prediction using linear trends. Among the SDG targets we chose 6 indicators. For each sustainability dimension we set 2 indicators. These, as can be seen below, are the content of SDG 1, SDG 8, SDG 12, SDG 13. Selected indicators within the SDG dimensions:

- Social
  - *Persons at risk of poverty or social exclusion (SDG_01_10),*
  - *In work at-risk-of-poverty rate (SDG_01_41).*
- Environmental
  - *Circular material use rate (SDG_12_41),*
  - *Domestic net greenhouse gas emissions (SDG_13_10).*
- Economic
  - *Real GDP per capita (SDG_08_10),*
  - *Employment rate by sex (SDG_08_30).*

4. Results and discussion

In the following section we present the results from the analyses of the selected indicators. We will look for answers to RQ1 and RQ2.

Slovakia has maintained a significantly lower percentage of people at risk of poverty or social exclusion compared to the EU27 average over the 2015-2024 reference period. In each year, the difference has been substantial, ranging from almost 7 percentage points in 2015 to more than 6 percentage points in 2024. From 2015 until the Covid-19 pandemic, both in Slovakia and in the countries that joined the EU in 2004 (EU 2004), there was a decline and then, from 2020 onwards, an increase in the number of people at risk of poverty. Based on a linear trend, we expect a slight increase in this indicator for Slovakia in the next period as well.

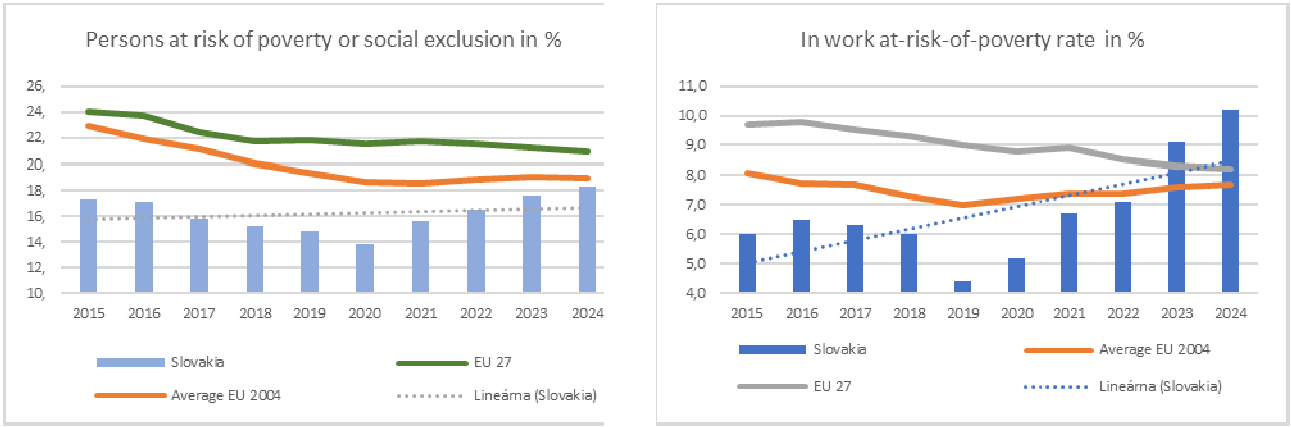

Figure 3, 4. Selected SDG goals from social dimension
Source: own processing (2025)

Between 2015 and 2022, Slovakia had a significantly lower risk of poverty after social transfers compared to the EU27 average. The lowest value was reached in 2019 (4.4%), which was almost half the EU27 average. From 2022 onwards, the situation in Slovakia started to worsen. From 7.1% in 2022, the risk of poverty rate rose to 9.1% in 2023 and to 10.2% in 2024. This increase is significant and in 2024 Slovakia surpassed the EU27 average (8.2%). Similarly to the EU27, Slovakia has

outperformed the average of EU 2004 compared to the EU average in the years 2023 and 2024, suggesting that the effectiveness of social transfers in combating poverty in Slovakia has declined in recent years, or the sensitivity to poverty risks has increased.

Slovakia shows a very positive trend in the use of recycled materials. At the beginning of the reporting period (2015 - 2018), Slovakia's recycling rate was well below the EU27 average. It was even lower than the EU 2004 average (6.6%). After 2019, the situation has changed dramatically. Slovakia has significantly surpassed the EU 2004 average and has moved closer to the EU 27 average. In 2022, Slovakia has peaked with 11.5% equal to the EU 27 average. Although it has slightly declined in 2023, the overall development is very encouraging and indicates a shift towards a circular economy.

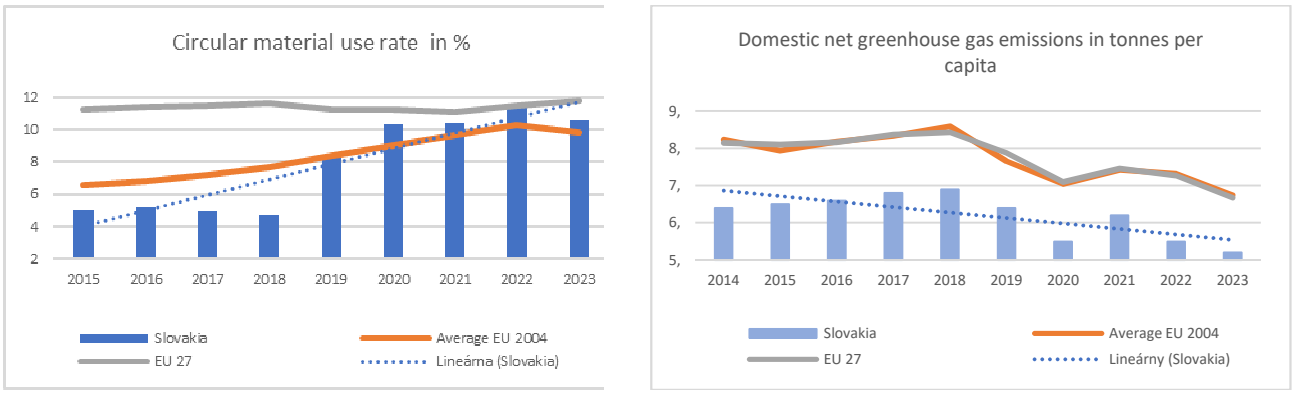

Figure 5, 6. Selected SDG goals from environmental dimension
Source: own processing (2025)

The development of emissions in Slovakia was quite volatile in the analysed period. While emissions were slightly lower in 2014 - 2015, there was a significant increase in 2018 and since then they have remained at a higher level, also with slight decreases. However, the overall trend for Slovakia is downwards, which is a positive in this situation. There has also been a fluctuating trend in this indicator in the EU27 and EU 2004 averages. Slovakia basically followed the development line of the whole EU.

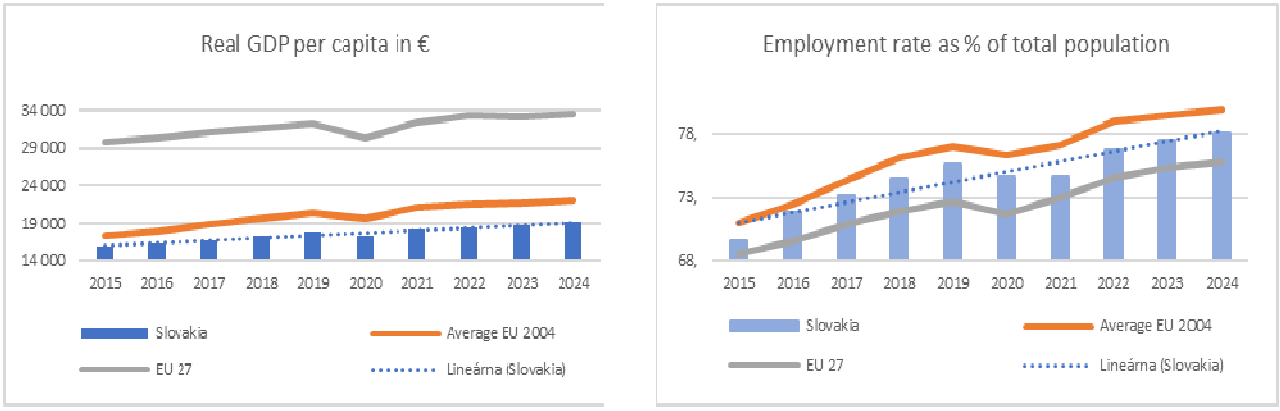

Figure 7, 8. Selected SDG goals from economic dimension
Source: own processing (2025)

GDP per capita in Slovakia has shown an increasing trend in the period under review. Despite a slight decline in 2021, probably due to the Covid-19 pandemic, GDP per capita growth accelerates again in 2022 - 2024. Overall, GDP per capita in Slovakia increases significantly from € 17,990 in 2015 to € 25,380 in 2024. Throughout the analysed period, GDP per capita in Slovakia has been significantly lower than the EU 27 average as well as the EU 2004 average. Although Slovakia shows growth, the gap in absolute terms remains significant. In 2024, GDP per capita in Slovakia was approximately € 8,150 lower than the EU 27 average.

The employment rate in Slovakia shows a clear and stable upward trend over the analysed period. From 59.2 % in 2015, it has increased to 69.5 % in 2024, indicating an improving labour market situation and increasing labour force participation of the population. The EU 27 average also shows an increasing trend in employment rates. Developments in Slovakia, and in the EU 27 and EU 2004 averages follow the same trajectory, with a slight decline in this indicator in 2020. Overall, the employment rate in Slovakia is at a higher level than in the EU.

We examined competitiveness on the basis of the GSCI index. We chose only EU countries to analyse which of the economies was the best ranked in 2023.

Figure 9. GSCI score in EU in 2023
Source: own processing (2025)

As can be seen from the Figure 9, the best are Nordic countries. With the highest score of 59.6, Sweden came in first place, confirming its position as the leader. Sweden is followed closely by Finland and Denmark, confirming the general trend that the Nordic countries are often at the top of rankings on sustainable development, innovation and quality of life. Estonia, with 56.7 points, is ranked fourth, an excellent result for this Baltic country, which belongs to our EU 2004 group. Slovakia, with a score of 51.9, is in the bottom third of the analysed countries. It was overtaken by countries such as the Czech Republic, Slovenia, Lithuania, as well as Croatia. This result suggests that Slovakia has opportunities for improvement compared to countries with a similar history or economic development.

To validate RQ3, we used statistical software Statistica to examine the correlation between a country's competitiveness and selected SDG targets. We verified this for the year 2023, because some SDGs had data available only for 2023, on a sample of EU 2004 countries. Competitiveness was represented by the GSCI (score for 2023).

Table 1. Correlation analysis

Variable	Correlations (Spreadsheet1) Marked correlations are significant at p < ,05000	Correlation
	GSCI	
sdg_01_10	0,278726	positive
sdg_01_41	0,049118	positive
sdg_08_10	- 0,32893	negative
sdg_08_30	- 0,12144	negative
sdg_12_41	0,061471	positive
sdg_13_10	0,206341	positive

Source: own processing according to Eurostat and Slobality (2025)

The correlation results suggest that there are only very weak or negligible linear relationships between the GSCI and these particular SDG indicators. A negative correlation was identified for SDG 8

indicators, which formed the economic dimension in our analysis. For the remaining SDGs a positive correlation was identified. The most important finding is that none of these correlations are statistically significant.

Conclusion

Slovakia has maintained a significantly lower percentage of people at risk of poverty or social exclusion in the 2015-2024 period compared to both the EU 27 average and the EU 2004 average. In the second indicator, Slovakia showed a significantly lower risk of poverty after social transfers compared to the EU 27 average at the beginning of the reference period, i.e. 2015 - 2022. From 2022 onwards, the situation in Slovakia started to worsen.

For a deeper understanding of Slovakia's position in selected SDG social targets, it is necessary to analyse the reasons for the recent increase in the risk of poverty after social transfers. These could be factors such as inflation, insufficient valorisation of benefits, changes in social transfer policies or rising unemployment in certain segments of the population. Monitoring these trends and taking appropriate measures will be key to maintaining and improving the social situation in Slovakia.

Slovakia has made huge progress in the use of recycled materials and is rapidly catching up with the EU 27 average. As of 2019, it has also surpassed the EU 2004 average. This positive development indicates a growing awareness and implementation of circular economy principles. Also, in terms of greenhouse gas emissions per capita, Slovakia has better, lower values than the EU 27 average, reflecting the efforts made to reduce the carbon footprint.

Of the economic sustainability indicators analysed, Slovakia performs best in employment. Throughout analysed period, it was higher than the EU 27 average, but still lower than the average of the EU 2004 countries. The trend in this indicator is upwards, which is indicative of a well-adjusted employment policy.

To answer the research questions, we can say that Slovakia is on a good trend in terms of sustainable targets, but the year-on-year increase is still low. Slovakia has the best competitive position in environmental goals. The most striking is the comparison with the average of the EU 2004 countries. Countries that had a similar starting position when they joined the EU are now in different positions and Slovakia is among the weakest of them. Employment in Slovakia is good, but there is still a problem with social targets. It is necessary to identify the causes and work to eliminate the problem areas.

The GSCI provides a clear picture of the relative performance in competitoveness of countries in 2023. It confirms the leading position of the Nordic countries and suggests that Western and Central European countries are in a stable position, while Southern and some Eastern countries have greater challenges ahead. For Slovakia, this means the need to identify specific areas where it is lagging behind comparators and leaders in order to move up in the sustainability and competitiveness rankings.

This research has its limitations. In the future, it is possible to extend the sample of countries to the whole EU 27, or to add a longer time period for the research. Of course, the Covid-19 pandemic also had a significant impact on countries' economies and some countries are still recovering from this crisis today. Therefore, the results may be different and still affected by the negative impact of this pandemic.

In conclusion, nations that strategically integrate the SDGs into their national development strategies are better prepared to achieve long-term competitiveness that is not only economically strong, but also socially just and environmentally responsible.

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Digital Performance and Sustainable Competitiveness of EU-26 Countries in the Context of a Multidimensional Assessment

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Abstract

Research Background: In the era of accelerated digital transformation and increasing emphasis on sustainable development, assessing the performance of national economies faces significant challenges. Traditional macroeconomic indicators fail to capture the full complexity of a country's readiness to respond to technological, environmental, and societal changes. Particularly in the context of the heterogeneity among EU-26 member states, there is a growing need for an analytical approach that reflects not only economic output but also the level of digital maturity, the quality of public governance, and the sustainability of development trajectories. Internationally recognized composite indices such as DESI, NRI, and GSCI provide a suitable foundation for multidimensional evaluation that captures both current performance and long-term developmental potential.
Purpose of the Article: The aim of the article is to analyze and compare the level of digital performance, network readiness, and sustainable competitiveness of EU-26 countries during the period 2017–2022 using selected global indices (DESI, NRI, GSCI). The paper further seeks to identify structural relationships between the dimensions of these indices and reveal the key factors influencing national performance in the context of digital and environmental transformation.
Methods: The analysis employed a comparative evaluation of the average scores of the selected indices, along with correlation analysis using Kendall's Tau coefficient. Relationships were assessed between the overall index scores and their individual dimensions/pillars, as well as the interconnections among DESI, NRI, and GSCI.
Findings and Added Value: The results confirm statistically significant correlations between digital performance, network readiness, and sustainable competitiveness. The most influential determinants included digital skills (DESI_DIM_1), digitalization of public services (DESI_DIM_4), and the quality of digital governance (NRI_PIL_3), all of which showed strong associations with social and intellectual capital (GSCI_PIL_3 and GSCI_PIL_4). A moderate correlation was found between DESI and GSCI ($\tau = 0.4439$), and between NRI and GSCI ($\tau = 0.3635$), indicating that countries with more advanced digital and network infrastructures also tend to achieve higher levels of sustainable competitiveness. The comparative evaluation of DESI and NRI highlighted their complementary nature while DESI reflects the current state of digital performance, NRI provides a more strategic perspective on countries' readiness to face digital challenges.

Keywords: Digital Economy and Society Index (DESI), Network Readiness Index (NRI), Global Sustainable Competitiveness Index (GSCI), European countries (EU-26)

JEL classification: O33, O57, F63

1. Introduction

The different levels of competitiveness in different economies, not only within the EU but also elsewhere in the world, are mainly due to differences in the drivers of competitiveness. These factors determine a country's ability to achieve sustainable growth and improve economic welfare. A key

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question in the relationship between competitiveness and economic growth is which criteria among the main competitiveness factors are the most important and to what extent they determine economic growth. From a macroeconomic point of view, it should be stressed that different combinations of these factors influence the creation of economic resilience and thus countries can increase their long-term competitiveness and thus induce the most effective economic growth (Boikova et al., 2021).

Macroeconomic performance is influenced by a variety of interrelated factors that can significantly impact a country's economic growth. Traditionally, macroeconomic performance has been measured by indicators such as gross domestic product (GDP) per capita, employment rates and productivity growth. However, a more holistic view recognises that true macroeconomic performance should also reflect improvements in living standards, well-being and overall societal well-being. Key determinants include capital formation, government spending, foreign direct investment (FDI), inflation, and trade openness. Understanding these factors is crucial for policymakers aiming to enhance economic stability and growth (Makur, 2023). While these factors are generally recognized as vital for macroeconomic performance, it is important to note, that the interplay between them can vary significantly across different countries and contexts. For instance, while FDI is beneficial, its effectiveness can be diminished in environments with high political instability or poor governance (Chirwa & Odhiambo, 2016).

Digitalisation is changing the global economy and society at an unprecedented pace. Its impact on macroeconomic performance is wide-ranging, bringing both significant opportunities and new challenges. Digitalisation is the process of using digital technologies to transform business models, create new sources of revenue and generate opportunities for value creation. It is a broader shift towards a digital business or society that goes beyond simple digitisation (converting analogue information into digital form) and involves a fundamental change in processes and systems. It involves adapting systems to work with computers and the internet, as well as developing and transforming business processes using technologies such as the Internet of Things (IoT), big data, artificial intelligence (AI) and cloud computing (OECD 2019). Digitalization influences macroeconomic performance through enhanced productivity, innovation, and competitiveness, while also requiring robust digital infrastructure and skilled workforce to maximize its benefits (Bacho et al., 2019). Investment in digital infrastructure and ongoing skill development are essential to fully leverage the advantages of digitalization, fostering sustainable economic growth and improved quality of life for the population. These elements collectively contribute to a more resilient economy, capable of adapting to changes and challenges in the global market, ultimately benefiting society at large.

There are several studies that have analysed the impact of digitisation on the economic growth. Chenic et al. (2023) pointed out, that digitalization leads to increased labour productivity by integrating advanced technologies such as artificial intelligence and big data into production processes. A strong correlation was found between digitalization and value-added in economic activities, indicating that digital tools enhance the efficiency of resource utilization. According to Boikova et al. (2021) digitalization is a critical determinant of national competitiveness, influencing long-term economic growth rates and living standards. Countries, that invest in digital infrastructure tend to experience higher foreign direct investment and trade openness, further boosting economic performance. Another approach, represented by Asma et al. (2024) claims, that the integration of digital technologies can create new job opportunities while also necessitating a shift in workforce skills, impacting labour force participation rates positively. Enhanced communication and technology access can help integrate previously marginalized populations into the economy, fostering inclusive growth.

The interplay of these factors underscores the necessity for strategic policies that promote digitalization, ensuring equitable access and addressing potential disparities in the digital economy to foster inclusive growth and mitigate the risks associated with the digital divide, thereby enhancing overall economic security and stability (Khaustova, 2024).

While digitalization presents numerous benefits for macroeconomic performance, it also poses challenges, such as the risk of job displacement and the need for continuous skill development to keep pace with technological advancements. Balancing these factors is crucial for sustainable economic development. One of these is the so-called "productivity paradox". Despite rapid progress in digitisation, overall productivity growth has been slowing steadily in recent decades, contrary to expectations. This suggests that its benefits have not yet been fully realised, potentially as a result of the time it takes businesses to adopt complex software and make complementary investments (Chernenko et al., 2021). Another challenge is labour market disruption and skills shortages. Digital technologies can lead to job

losses, especially in routine tasks. While new opportunities are being created, there is a shift in labour demand towards new skill sets, which has a more negative impact on less educated workers and specific occupations. This requires investment in digital skills training and retraining of the workforce (Huseynli & Huseynli, 2022). Digitalisation can also lead to market concentration and inequality. Highly digital-intensive industries can be more dynamic and grow faster, but at the same time have seen a significant decline in business dynamism and an increase in market concentration. This can lead to excessive profits for technology companies and potentially widening income inequality (OECD, 2019).

Digitalization has become a critical factor for competitiveness recently. There is a rapid development of ICTs, which pressures enterprises to conduct business within the framework of the Fourth Industrial Revolution (Industry 4.0). With global markets and strong competition, some traditional manufacturing firms are implementing new maintenance innovations and policies, based on digitalization and a data-driven approach. This further indicates that the application of modern information–communication technologies (ICTs) by enterprises is an important factor in sustainable development. The enterprises must evaluate their business processes and identify which can be improved via ICT solutions such as information systems, cloud infrastructure, etc. (Boikova et al., 2021)

Sustainable development significantly influences a country's macroeconomic performance through various interconnected factors. These factors encompass innovation, human capital, foreign direct investment (FDI), and the overall business environment, which collectively contribute to economic growth while ensuring environmental and social sustainability. We can find several studies that deal with sustainability. Šofranková et al. (2021) highlight that innovation activity is essential for increasing productivity and competitiveness, leading to sustainable economic growth. According to Mumtaz et al. (2023), investment in human capital promotes a more competitive workforce, which is necessary to adapt to changing economic conditions and changes in markets caused by progress. The impact of FDI has been studied by Doloan (2024). According to him, FDI plays a key role in technology transfer and job creation, thereby contributing to higher economic performance.

Digital transformation is a process that requires certain skills regarding the use of new innovative digital technologies to increase economic performance and improve the quality of life. At the same time, quantifying the influence of digital technologies on economic development is one of the important concerns of scientific studies and analyses. Between digitization and economic growth, there is a direct relationship, as were analysed by Chenic et al. (2023).

To assess digital performance and sustainable competitiveness, we have selected the following indices: Digital Economy and Society Index (DESI), Network Readiness Index (NRI), and Global Sustainable Competititveness Index (GSCI). The choice of these three indices is based on their ability to comprehensively cover key dimensions: specific digital performance within the EU (DESI), digital readiness (NRI), and sustainable development in a global context (GSCI). Their combined use enables the identification of not only the technical readiness of countries for digital transformation but also its socioeconomic and environmental impacts, thus providing a foundation for a comprehensive and internationally comparable assessment.

The **Digital Economy and Society Index (DESI)** is a composite index created by the European Commission that monitors Europe's overall digital performance and tracks the progress of EU Member States in terms of digital competitiveness. It has been published annually through DESI reports since 2014. The main purpose of the DESI is to serve as a key tool for Member States to identify areas requiring priority investment and action in their digital transformation journeys. It provides country profiles and thematic analyses to inform policy decisions to accelerate digitalisation, increase resilience and reduce external dependencies within the EU (European Comission, 2025).

The **Network Readiness Index (NRI)** is a comprehensive indicator of countries' digital readiness, measuring their ability to leverage information and communication technologies (ICT) to support inclusive growth, innovation, and competitiveness. The index was first published in 2002 as part of the *Global Information Technology Report* under the auspices of the World Economic Forum. Since 2019, following a major methodological revision, the NRI has been managed by the independent research organization Portulans Institute, which focuses on advancing sustainable digital development. The primary objective of the index is to provide a comprehensive and internationally comparable **overview** of the state of digital readiness across countries in the context of sustainable development. The NRI also serves as an analytical tool for designing national digital strategies, identifying structural weaknesses, and monitoring progress in digital transformation and the knowledge-based economy (Dutta & Lanvin, 2025).

The **Global Sustainable Competitiveness Index (GSCI)**, developed by Solability, measures the competitiveness and sustainability of countries. First published in 2012, the GSCI defines sustainable competitiveness as the ability to generate and maintain inclusive wealth without reducing the future ability to maintain or increase current levels of wealth. The GSCI aims to provide a comprehensive alternative to traditional GDP measurements for assessing country performance, recognising that GDP alone is insufficient as it excludes key factors such as environment, health, education, security, governance and quality of life. It is used to assess country-specific risks and challenges for operators and investors, and to check countries' progress on their path to sustainability and competitiveness (Solability, 2025).

All three indexes (DESI, NRI, and GSCI) agree that gross domestic product (GDP) is not a sufficient indicator of national progress. They aim to provide a more comprehensive assessment that includes qualitative, non-economic, and long-term sustainable aspects of development. DESI focuses on the digital performance of European Union member states and provides detailed data on digital skills, digital infrastructure, the level of business digitalization, and the functioning of digital public services. NRI expands this perspective to a global context by assessing countries' readiness to leverage digital technologies in support of innovation, socio-economic development, and societal resilience to technological and social challenges. Compared to DESI, it has a global scope and a universally applicable methodology. GSCI differs in its emphasis on sustainable competitiveness. It evaluates countries based on environmental, economic, innovation-related, and institutional indicators. It applies the concept of a sustainable competitiveness pyramid, which posits that long-term economic growth and prosperity are conditioned by responsible use of natural capital, effective resource management, and social stability. The index provides a long-term and systemic perspective on countries' ability to remain competitive without compromising the prospects of future generations.

1.1 Digital Economy and Society Index

The Digital Economy and Society Index (DESI) serves as a tool of the European Commission (European Comission, 2025) for monitoring the digital performance of EU Member States and assessing their progress in the field of digital transformation. Since 2014, DESI has been published annually, and as of 2023, it has become an integral part of the broader State of the Digital Decade report, which reflects the EU's strategic objectives for 2030 outlined in the Digital Decade framework.

DESI enables the comparison of countries based on quantifiable indicators and provides individual country profiles that help identify areas requiring priority action. The annual DESI reports are complemented by thematic analyses of key areas of digital development at the EU level, thereby supporting the formulation of targeted digital policies.

From a methodological perspective, DESI has undergone several modifications to reflect the evolving nature of digital technologies as well as the need for alignment with the strategic goals of the EU's digital transformation. The current structure of the index is based on four main dimensions, in accordance with the EU's Digital Compass: Digital skills, Digital infrastructure, Digital transformation of businesses, and Digital public services. Each of these areas is assessed through multiple quantitative indicators, with an emphasis on measurable outcomes linked to progress toward the 2030 Digital Decade targets.

The relevance of DESI as both an analytical and policy-making instrument lies in its connection to the EU's financial mechanisms. The results of the index serve as a foundation for shaping national digital strategies and contribute to the strategic allocation of investments aimed at advancing the European digital transformation.

Overall, DESI functions not only as an evaluative framework but also as a strategic tool that facilitates informed decision-making, continuous progress monitoring, and the reduction of digital disparities within the European Union.

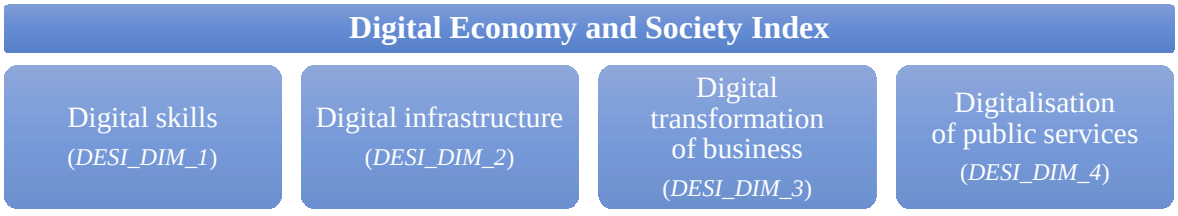

Figure 1. Structure of DESI
Source: own processing by European Commission (2025)

1.2 Network Readiness Index (NRI)

The Network Readiness Index (NRI) is used to measure countries' capacities to leverage opportunities offered by ICT and to assess their level of digital readiness. The NRI is one of the most significant indicators reflecting the digital development of nations, providing a much broader view of global digital preparedness (Bánhidi & Dobos, 2024). It is a composite index designed to capture the multifaceted impact of ICT on society and development.

Within the framework of the Network Readiness Index, countries are assessed in terms of infrastructure, innovation, and technology availability. It is a holistic framework that measures the impact of ICT across four key dimensions of society: technology, people, governance, and impact. Its aim is to integrate people with technology in a way that enhances the effectiveness of government strategies for the economy, society, and the environment, making it a reliable tool for measuring a country's e-readiness (Dutta & Lanvin, 2023).

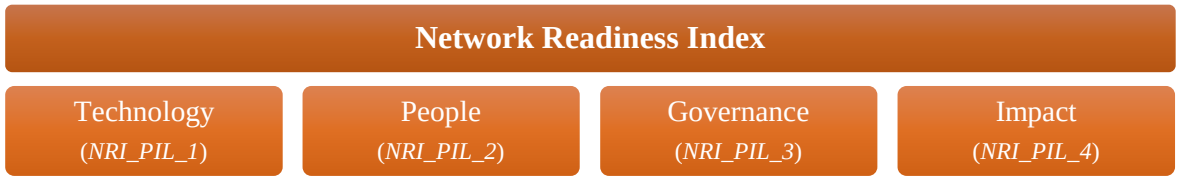

Figure 2. Structure of NRI
Source: own processing by Dutta & Lanvin (2025)

The NRI evaluates countries' digital maturity through four main pillars: technology, people, governance, and impact. These are further divided into twelve sub-pillars and approximately sixty indicators, combining both quantitative and qualitative data. The indicators cover areas such as the availability of digital infrastructure, the development of digital skills, the quality of regulatory frameworks, institutional effectiveness, and the broader socio-economic impact of digitalization.

1.3 Global Sustainable Competitiveness Index

The Global Sustainable Competitiveness Index (GSCI) measures the true competitiveness of nations. The GSCI is based on 120 purely quantitative indicators, derived from reliable sources (World Bank, UN agencies, the IMF), grouped in the 6 pillars of national competitiveness : Natural capital, Resource efficiency, Ssocial capital, Intellectual capital, Econoic Capital and Governace. The GSCI is the most comprehensive measurement of the competitiveness of nation-states and their future potential (Solability, 2025). GSCI is based on a pyramid system, i.e. each level of the index (pillar) affects the immediately following one and is necessary to support the higher level.

Figure 3. Structure of GSCI
Source: own processing by Solability (2025)

The Global Sustainable Competitiveness Index (GSCI) is constructed based on six main pillars that reflect the most important areas of sustainable development and long-term national competitiveness. These pillars encompass environmental, economic, social, innovation-related, and institutional dimensions. The index assesses the extent to which a country efficiently utilizes its natural resources, ensures social stability, promotes education and innovation, maintains a healthy business environment, and demonstrates effective governance of public policy. Each pillar is based on a set of quantitative indicators, and the index as a whole includes more than 180 indicators drawn from internationally recognized databases. This approach enables the comparison of countries in terms of their long-term ability to generate sustainable wealth and prosperity.

2. Methods

The main objective of this study was to investigate the interrelationships between digital performance, network readiness, and sustainable competitiveness across the EU-26 member states over the period 2017– 2022. To achieve this, the analysis was based on secondary data derived from three internationally recognized indices: the Digital Economy and Society Index (DESI), the Network Readiness Index (NRI), and the Global Sustainable Competitiveness Index (GSCI). The data sources included annual reports published by the European Commission (DESI), the Portulans Institute (NRI), and SolAbility (GSCI). Due to the incompleteness of specific datasets, two countries were excluded from the analysis (Malta and the United Kingdom). In addition, the Economic Capital pillar (GSCI_PIL_5) was omitted from the GSCI structure as it lacked complete time series data across the full sample of countries.

The main objective was fulfilled through two partial objectives, which were defined in a logical sequence as follows:

- *Partial Objective 1* → To compare the EU-26 countries based on the average scores of selected global indices (DESI, NRI, and GSCI) over the period 2017–2022;
- *Partial Objective 2* → To identify the existence of mutual relationships and interdependencies between the overall scores and the dimensions of the selected global indices for the EU-26 countries using correlation analysis.

For Partial Objective 2, we formulated the following hypotheses, which were tested using appropriate statistical tools:

- H1: *We assume the existence of statistically significant relationships between the overall scores and the dimension/pillars scores of the DESI and NRI indices for the EU-26 countries during the period 2017–2022;*
- H2: *There is a statistically significant impact of the dimension scores of the DESI and NRI indices on the overall GSCI score and its dimension scores for the EU-26 countries over the period 2017– 2022.*

To verify the research hypotheses, the non-parametric Kendall's Tau correlation test was selected. The choice of this coefficient was based on the results of normality tests (Kolmogorov-Smirnov test, Lilliefors test, and Shapiro-Wilk test), which indicated that the assumption of normal distribution was not met for some variables in the secondary dataset of the analyzed indices. The interpretation of the correlation coefficient is often problematic, as there are no universally accepted threshold values. Based on the absolute value of the correlation coefficient, Chajdiak (2013) defined the following three levels of dependency strength: low dependency (0.1–0.39), moderate dependency (0.4–0.79), and strong dependency (0.8–1). This scale served as the basis for evaluating the intensity of the correlation relationships.

3. Results

In the following section of our contribution, we focus on the analysis of the results related to the assessment of digital performance and sustainable competitiveness of the EU-26 countries for the period 2017 to 2022, structured according to the predefined partial objectives.

3.1 Development of the average score of the analyzed indices in the EU-26 countries

As part of the analysis of the digital and sustainable performance of the European Union member states, the average values of three complementary indices were compared: the Digital Economy and Society Index (avg_DESI), the Network Readiness Index (avg_NRI), and the Global Sustainable Competitiveness Index (avg_GSCI). These indices provide an integrated perspective on the level of digital readiness, network infrastructure, and long-term competitiveness based on the principles of sustainable development.

The Digital Economy and Society Index (DESI) assesses the progress of countries in terms of digital transformation and digital capabilities, including digital public services, connectivity, human capital, and the integration of digital technologies into business. The average DESI score for 26 EU member states reached 42.23 points, with the highest scores recorded in Northern European countries as Finland (57.26), Denmark (56.30), and Sweden (54.65). Conversely, the lowest values were observed in Romania (24.21), Greece (28.40), and Bulgaria (29.65), indicating persistent digital disparities across regions.

The Network Readiness Index (NRI) measures the ability of countries to leverage information and communication technologies for economic and social development. It considers factors such as access

to technology, regulatory environment, quality of infrastructure, population skills, and socio-economic impact. The average NRI score for the analyzed countries reached 66.32 points, with top positions again held by Sweden (79.43), the Netherlands (79.00), and Finland (78.47). On the other hand, below-average scores were recorded in Romania (54.37), Bulgaria (54.47), and Greece (55.10).

The following graphic shows a comparison of the digital performance of EU-26 countries using the DESI and NRI indices.

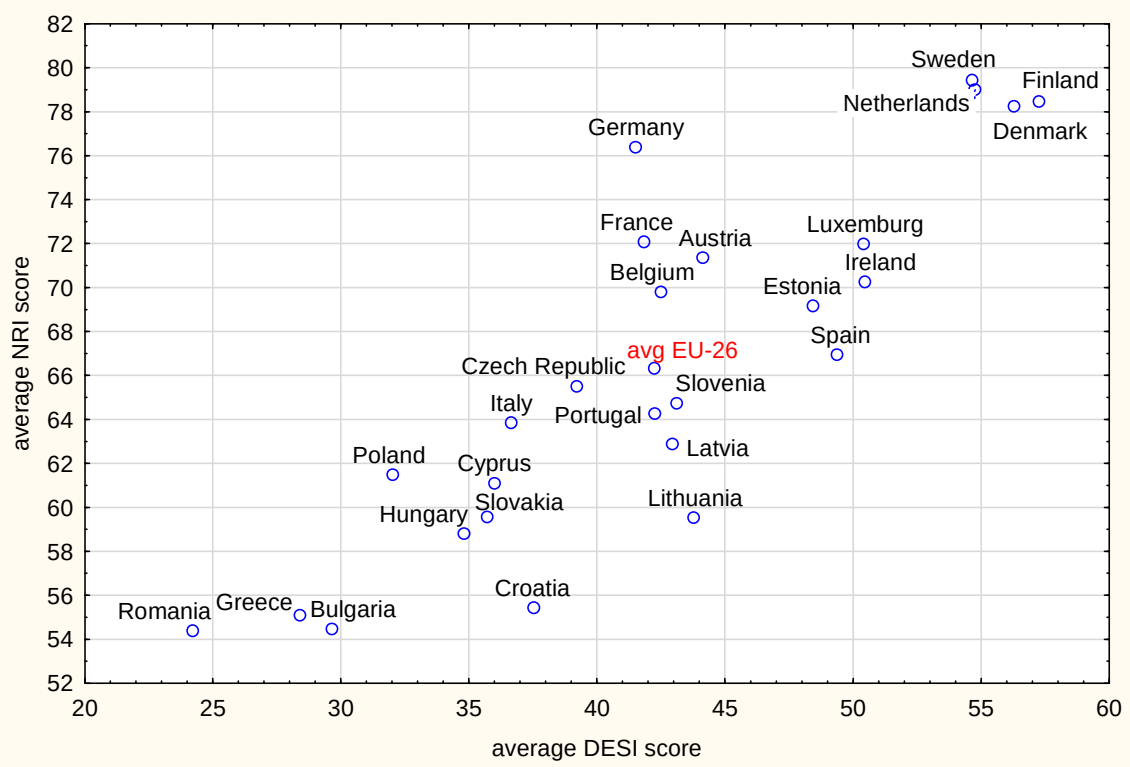

Figure 4. Relationship between avg DESI score and avg NRI score in EU-26 (2017-2022)
Source: own processing

The final index analyzed is the Global Sustainable Competitiveness Index (GSCI), which assesses a country's long-term potential in terms of environmental sustainability, economic stability, innovation, and social cohesion. The average value for the EU-26 countries reached 53.25 points, with the highest scores once again recorded in the Nordic countries such as Sweden (61.07), Finland (59.31), and Denmark (58.44). The countries with the lowest performance included Cyprus (45.57), Greece (48.40), and Bulgaria (48.82).

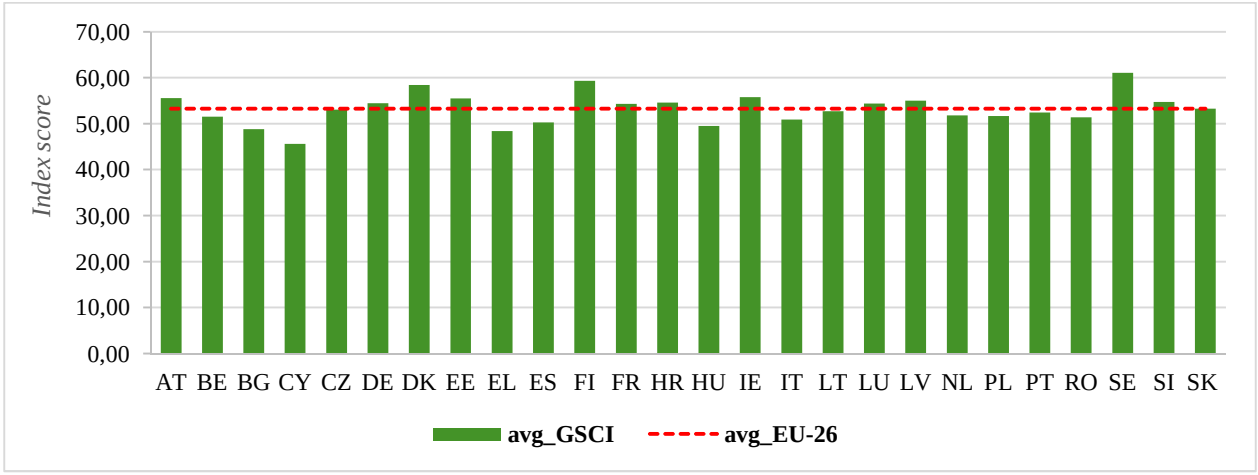

Figure 5. Comparison of the average GSCI index scores of the EU-26 countries (2017-2022)
Source: own processing

The results indicate that Northern and Western European countries achieve above-average performance across all three indicators, reflecting their high level of digital maturity, innovation potential, and commitment to sustainable development. In contrast, Southeastern European countries face systemic challenges related to digital infrastructure, skills availability, and the implementation of sustainable policies. This disparity highlights the need for targeted cohesion policy at the EU level aimed at strengthening the digital and environmental resilience of the least performing regions.

3.2 Results of the correlation analysis between the selected indices of the EU-26 countries

In this part of the paper, we focused on the results of the correlation analysis, which is directly linked to the second partial objective and the associated hypotheses (H1 and H2) defined within that objective.

The results of the correlation analysis using the Kendall coefficient, aimed at examining the relationships between the overall scores and the individual dimensions/pillars of the DESI and NRI indices, are presented in Table 1 and indicate several statistically significant moderate and weaker associations ($p < 0.05$).

Table 1. Results of the correlation analysis between the overall scores and the dimensions of the DESI and NRI

Variable	Kendall Tau Correlations MD pairwise deleted			Marked correlations are significant at p <0.05	
	NRI	*NRI_PIL_1* *Technology*	*NRI_PIL_2* *People*	*NRI_PIL_3* *Governance*	*NRI_PIL_4* *Impact*
DESI	0.3658	0.2514	0.2237	0.5815	0.4100
DESI_DIM_1 *Digital skills*	0.5238	0.4106	0.3719	0.6307	0.5465
DESI_DIM_2 *Digital infrastructure*	0.0701	-0.0032	-0.0350	0.2774	0.1282
DESI_DIM_3 *Digital transformation of business*	0.3614	0.2554	0.2234	0.4766	0.4469
DESI_DIM_4 *Digitalization of public services*	0.3617	0.2450	0.2412	0.5843	0.3785
Note: *0.1 - 0.39 → low dependence*		*0.4 - 0.79 → medium dependence*		*0.80 - 1.00 → higher dependence*	

Source: own processing

In the first part of the correlation analysis, the internal relationships between the overall DESI score and its individual dimensions were examined. The results reveal that the strongest association (τ = 0.8161) was observed between the overall DESI score and DESI_DIM_4 (*Digitalization of public services*), underlining its critical role in shaping the digital performance of countries. A moderate level of correlation was identified for DESI_DIM_3 (*Digital transformation of businesses*) with value of τ = 0.6905 and DESI_DIM_1 (*Digital skills*) with value od τ = 0.6292. The weakest moderate positive correlation (τ = 0,5769) was found between the overall DESI score and DESI_DIM_2 (*Digital infrastructure*), which may suggest that during the 2017–2022 period, infrastructure alone ceased to be a key differentiating factor among EU member states.

In the case of the NRI index, the strongest moderately positive association (τ = 0.7771) between the overall NRI score and the individual pillars was observed for NRI_PIL_1 (*Technology*), followed by NRI_PIL_4 (*Impact)* with τ = 0.7646, and NRI_PIL_2 (*People*) with τ = 0.7515. The weakest correlation, though still moderately positive, was recorded for NRI_PIL_3 (*Governance*), with τ = 0.6686.

In the third step, relationships between the overall DESI and NRI scores, as well as between their dimensions and pillars, were analyzed. A positive correlation was identified between the overall score of the DESI index and the overall score of the NRI index, with a Kendall's Tau value of 0.3658, which represents a low dependence according to the interpretation scale. This correlation is statistically significant ($p < 0.05$), indicating a demonstrable positive relationship between the level of digital performance measured by DESI and the overall digital readiness as assessed by NRI across the EU-26 countries. In practical terms, this suggests that countries with higher DESI scores tend to also achieve higher values in the NRI, although the relationship is not particularly strong, likely due to methodological and conceptual differences between the two indices.

From a structural perspective, the strongest pozitive correlation was observed between DESI_DIM_1 (*Digital skills*) and NRI_PIL_3 (*Governance*) (τ = 0.6307), confirming that the population's digital skills significantly contribute to the quality of digital governance. Moderately strong associations were also identified between NRI_PIL_3 (*Governance*) and DESI_DIM_4 (*Digitalization of public services*) (τ = 0.5843), as well as with DESI_DIM_3 (*Digital transformation of business*), which showed a correlation of τ = 0.4766. Additionally, two other moderately positive relationships were observed between DESI_DIM_1 (*Digital skills*) and NRI_PIL_4 (*Impact*) with τ = 0.5465, and NRI_PIL_1 (*Technology*), with a correlation coefficient of τ = 0.4106. On the contrary, correlations for DESI_DIM_2 (*Digital Infrastructure*) and the total NRI score and two NRI pillars, namely for NRI_PIL1 (*Technology*) and NRI_PIL_2 (*People*), were not confirmed.

In the next phase of the analysis, we focused on examining the relationships between digital performance (as measured by the DESI and NRI indices) and sustainable competitiveness (as captured by the GSCI index) of the EU-26 countries, considering not only the overall scores but also the individual dimensions and pillars of these composite indicators. Due to the incompleteness of available secondary data, the *Economic Capital pillar* (GSCI_PIL_5) was excluded from the GSCI index analysis.

Table 2. Results of the correlation analysis between GSCI, DESI, and NRI indices

Variable	Kendall Tau Correlations MD pairwise deleted *GSCI*	Marked correlations are significant at p <0.05 *GSCI_PIL_1* *Natural capital*	*GSCI_PIL_2* *Resource Efficiency*	*GSCI_PIL_3* *Social capital*	*GSCI_PIL_4* *Itellectual Capital*	*GSCI_PIL_6* *Governance*
DESI	0.4439	0.1065	0.1921	0.5350	0.2603	0.2031
DESI_DIM_1	0.4838	0.1228	0.2139	0.3899	0.3459	0.1752
DESI_DIM_2	0.2680	0.0852	0.1413	0.4480	0.0590	0.1929
DESI_DIM_3	0.3734	-0.0128	0.1789	0.5430	0.3220	0.1360
DESI_DIM_4	0.4238	0.1652	0.1830	0.4508	0.2108	0.2149
NRI	0.3635	-0.0359	0.1753	0.2281	0.5204	0.0775
NRI_PIL_1	0.2502	-0.1023	0.1611	0.1121	0.4777	0.0012
NRI_PIL_2	0.2646	-0.0024	0.1266	0.1203	0.4377	-0.0215
NRI_PIL_3	0.4773	0.0763	0.1757	0.3907	0.4582	0.1762
NRI_PIL_4	0.4139	-0.0416	0.1966	0.3031	0.5132	0.1790

Note: 0.2 - 0.39 → low dependence | *0.4 - 0.79 → medium dependence* | *0.80 - 1.00 → higher dependence*

Source: own processing

In the first part of this analysis, the relationship between the overall GSCI score (Global Sustainable Competitiveness Index) and two key digital indices – DESI and NRI – was examined. The results revealed a moderate positive correlation between GSCI and DESI (τ = 0.4439), and a weaker but statistically significant correlation between GSCI and NRI (τ = 0.3635). These findings suggest that countries with higher levels of digital performance, as measured by DESI, as well as greater digital readiness according to NRI, also tend to achieve better outcomes in terms of sustainable competitiveness.

From the perspective of the GSCI components, the strongest correlation was identified with DESI_DIM_1 (*Digital skills*) (τ = 0.4838), indicating a strong relationship between digital skills and the level of sustainable performance and competitiveness among European countries. In the case of the NRI, the strongest correlation was observed with NRI_PIL_3 (*Intellectual capital*) (τ = 0.4773), confirming the importance of the link between digital readiness and a country's innovation potential.

Relationships between DESI dimensions and GSCI pillars

An analysis of the relationships between the DESI index dimensions and the NRI pillars reveals that only three cases demonstrated a moderately strong positive correlation. Specifically, these include the relationships between GSCI_PIL_3 (*Social capital*) and DESI_DIM_3 (*Digital transformation of business*), DESI_DIM_4 (*Digitalization of public services*), and DESI_DIM_2 (*Digital infrastructure*). The remaining Kendall's tau values fell within the range of 0.1–0.39, indicating weak associations.

In three specific cases, no statistically significant correlation was confirmed: namely, between GSCI_PIL_1 (*Natural capital*) and both DESI_DIM_2 (*Digital infrastructure*) and DESI_DIM_3 (*Digital transformation of business*), as well as between GSCI_PIL_4 (*Intellectual capital*) and DESI_DIM_2 (*Digital infrastructure*).

Relationships between NRI pillars and GSCI pillars

In the analysis of individual pillars of the GSCI and NRI indices, a moderate correlation was confirmed between GSCI_PIL_4 (*Itellectual capital*) and all pillars of the NRI. Two pillars, GSCI_PIL_2 (*Resource Efficiency*) and GSCI_PIL_3 (*Social capital*), exhibited weak correlations, while GSCI_PIL_6 (*Governance*) showed a Kendall's tau coefficient above 0.17 in its relationships with NRI_PIL_3 (*Governance*) and NRI_PIL_4 (*Impact*). It is also worth noting that no statistically significant relationship was identified between GSCI_PIL_1 (Natural capital) and the overall NRI score, nor with any of its individual pillars. The highest observed Kendall's tau value was 0.5132, reflecting the relationship between GSCI_PIL_4 (*Itellectual capital*) and NRI_PIL_4 (*Impac*t).

These findings highlight that sustainable competitiveness is not solely driven by the existence of digital infrastructure, but more importantly by investments in human capital, innovation, digital public services, and the quality of governance. A key insight is that the DESI index demonstrates more consistent links with the GSCI compared to the NRI, suggesting higher sensitivity to current digital performance. In contrast, the NRI better reflects the strategic foundations of digital readiness, although some of its components such as technological infrastructure did not prove to be critical drivers of sustainable development.

The results indicate that the most significant relationships between GSCI and the digital indices are concentrated in the areas of social and intellectual capital, with digital skills, digital services, and the quality of digital governance emerging as key factors of sustainable competitiveness. The DESI index shows more consistent associations with GSCI than the NRI, but both indices confirm that advanced digital infrastructure alone is not sufficient and investments in people, innovation, and the public sector are essential.

4. Discussion

The results of the analysis of average scores and interrelationships between the DESI, NRI, and GSCI indices for the EU-26 countries over the 2017–2022 period provided important insights into the links between digital performance, digital readiness, and sustainable competitiveness. The findings clearly highlight regional disparities in digital and sustainable performance, with Northern and Western European countries consistently achieving above-average results, while Southeastern Europe continues to face persistent challenges.

The comparative analysis revealed a statistically significant yet moderate positive correlation between DESI and NRI scores. This confirms that digital performance and digital readiness are related but conceptually distinct dimensions. While the DESI focuses more on the practical implementation of digital solutions, the NRI reflects a broader capacity of countries to adapt to digital transformation, including institutional and societal factors.

The detailed correlation analysis showed that the key determinants of digital performance are primarily digital skills, the digitalization of public services, and the digital transformation of business. Within the NRI, the most influential pillars were Governance and Impact, highlighting the importance of effective public administration and a country's ability to translate digital investments into tangible social and economic benefits.

Regarding the relationship with sustainable competitiveness (as measured by the GSCI), the results indicate that digitally advanced countries also tend to achieve higher levels of social and intellectual capital, confirming the relevance of soft factors such as trust, education, innovation, and quality of life. Conversely, technological infrastructure and access to technology alone showed limited or no significant connections to long-term competitiveness, emphasizing the need for a holistic approach to digital development.

In conclusion, the results support the validity of Hypothesis H1, confirming the existence of statistically significant relationships between the overall scores and the dimensions of the DESI and NRI indices. Hypothesis H2 was also confirmed, as a statistically significant relationship was found between digital indices (especially DESI) and the overall sustainable competitiveness score (GSCI).

Conclusion

The results of the analysis of digital performance and sustainable competitiveness across the EU-26 countries for the period 2017–2022 revealed significant regional disparities within the European Union. Northern and Western European countries consistently ranked at the top across all analyzed indices (DESI, NRI, and GSCI), while Southeastern European countries lagged behind, particularly in areas such as digital infrastructure, digital skills, and the quality of public governance.

The comparative assessment of the DESI and NRI indices revealed a high level of consistency in identifying digital frontrunners and laggards. However, key methodological differences exist between the two: DESI is primarily oriented toward measuring the practical outcomes of EU digital policies andthe implementation of digital solutions, thereby reflecting current performance in the digital economy and governance. In contrast, the NRI adopts a more forward-looking perspective, emphasizing institutional preparedness, regulatory frameworks, and the long-term impacts of digitalization. This distinction suggests that DESI is particularly suitable for evaluating the effectiveness of national and EU digital policies, while NRI provides a broader framework for understanding a country's potential to leverage digital technologies as a driver of economic and social transformation.

Correlation analysis confirmed that digital skills, quality of digital governance, digitalization of public services, and innovation capacity are critical factors for both high digital performance and sustainable competitiveness. Conversely, mere technological availability or infrastructure, without strategic implementation, does not significantly influence long-term national performance.

Based on the tested hypotheses, we conclude that there are statistically significant and substantively meaningful relationships between the dimensions of digital indices (especially DESI) and performance insustainable competitiveness (GSCI). These findings affirm the role of digitalization as a key driver not only of economic growth but also of socially and environmentally sustainable development.

We therefore recommend the combined use of the DESI and NRI indices in analytical practice, as their integration enables a more comprehensive assessment of both the current state of digitalization and its long-term sustainability and systemic resilience. These insights can serve as valuable input for policymakers at both national and EU levels when designing targeted support for less advanced regions and shaping the long-term digital strategy of the European Union.

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Flexibility in the Labor Market

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Abstract

Research background: The labor market faces new challenges, including slowing economic growth, the energy crisis, digitalization, migration, and the introduction of additional customs tariffs. These factors affect both employers and employees, making flexibility an essential aspect of the labor market. In recent years, there has been a significant rise in non-standard forms of employment, one of which is agency work.
Purpose of the article: The article examines the labor market and the factors prompting employers to adopt non-standard employment models, and analyzes the motivations influencing individuals to choose agency work. It also investigates the role of agency work in employing Ukrainian citizens seeking refuge and job opportunities in Slovakia due to the ongoing conflict.
Methods: The research is based on a questionnaire survey conducted with agency workers. The survey data were evaluated using methods of descriptive and inferential statistics.
Findings & Value added: Survey results indicate a strong demand for agency work in sectors such as the automotive industry, manufacturing, logistics, and retail work, and 62.7% wished to continue in such positions. Based on a questionnaire survey conducted among 376 agency workers in Slovakia, we can conclude that key motivations for choosing this type of employment include easy access to jobs, weekly wage payments, and the opportunity to earn additional income. Nearly 80% of respondents expressed satisfaction with agency. This article enhances the understanding of the flexibility of agency work, which will be particularly important in the face of future economic shocks, such as the introduction of tariffs by the United States, and provides valuable insights for employers and policymakers.

Keywords: Agency Employment, Flexibility, Labor Market, Slovakia

JEL classification: J20, J61

1. Introduction

In recent decades, the global labor market has undergone a series of transformative changes resulting from economic, technological, and geopolitical disruptions. Among the most prominent challenges are slowing economic growth, the global energy crisis, rising digitalization, the spread of artificial intelligence (AI), and increasing migratory movements due to armed conflicts. These dynamics have reshaped employment systems, prompting both employers and policymakers to reconsider how labor is structured, regulated, and mobilized (Chen et al., 2024; Palmer, 2024; Wiese et al., 2025).

One of the clearest indicators of this transformation is the rising prevalence of non-standard employment relationships (NSE). These forms of employment, which include temporary contracts, part time positions, platform based gig work, and agency mediated jobs, have increasingly replaced the previously dominant standard employment relationship (SER), which was defined by full time, open ended contracts with a single employer (ILO, 2023). NSEs offer flexibility in terms of time, location, and job duration, which aligns with the needs of an increasingly volatile economic environment and a diversifying workforce (Kalleberg, 2018; Klindzic & Marić, 2019).

For employers, NSEs serve as a strategic mechanism to reduce labor costs, manage workforce fluctuations, and avoid the regulatory constraints associated with permanent hiring. For workers, they may provide faster job access, short-term income, and flexibility in balancing work with personal

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obligations. However, these arrangements are often associated with job insecurity, reduced access to social protections, lower wages, and limited career advancement opportunities (Laß & Wooden, 2020; van Riemsdijk, 2024).

A particularly relevant form of NSE is temporary agency work, in which the worker is formally employed by a staffing agency but performs duties under the supervision of a user company. This triangular employment relationship introduces complex legal and institutional ambiguities regarding responsibility, protections, and rights (Hünefeld et al., 2020; Winkler & Mahmood, 2015). While this system allows employers to adjust their labor force efficiently, it also exposes workers to potential precarity and limited integration into the host company.

In countries facing labor shortages, particularly within the manufacturing, logistics, food processing, and retail sectors, agency employment has emerged as a critical mechanism for addressing workforce demands. In Slovakia, this trend has become especially pronounced due to the impact of the COVID-19 pandemic and the ongoing war in Ukraine, which have significantly altered labor supply and demand structures (Valaskova et al., 2024; Svabova et al., 2021). The war has displaced millions of Ukrainians, a large proportion of whom have sought refuge and employment in neighboring countries, including Slovakia.

Since 2022, Slovakia has granted temporary protection status to Ukrainian citizens, simplifying their access to the labor market and providing a fast-track employment route without the need for asylum or work permits (ÚPSVAR, 2023; Ministry of Interior SR, 2024). By early 2024, more than 138,000 individuals had registered for temporary protection in Slovakia, with women making up over 60% of this population. Although 58 percent of respondents on Profesia.sk reported holding a master's degree, the majority of Ukrainian refugees are employed in low-skilled positions due to language barriers, the non-recognition of foreign qualifications, and short-term integration expectations (SBA).

This mismatch between skills and job placement has made temporary agency work a dominant entry point into the Slovak labor market for refugees. While such jobs offer immediate income, they often lack stability and upward mobility. According to van Riemsdijk (2024), even highly skilled refugees frequently find themselves in precarious roles due to systemic governance gaps, resulting in limited long-term integration and diminished career potential. Furthermore, the overrepresentation of refugees in flexible and temporary roles reinforces existing labor market segmentation and inequality, particularly in times of crisis.

Agency work thus represents both a solution and a challenge: it provides a short-term answer to labor shortages and refugee integration, but it also introduces risks related to precariousness and unequal treatment. As Palmer (2024) points out, even high-wage migrant workers may encounter institutional limitations in claiming their rights, particularly in systems where labor protections are fragmented or dependent on employer mediation. For lower-wage migrants and refugees, this risk is further amplified by dependence on agencies that may also control access to housing, transportation, and other social services (McGauran et al., 2016).

The application of digital technologies and AI is also reshaping labor market dynamics. While automation and AI can enhance productivity, they often displace low-skilled workers and shift labor income towards capital income, exacerbating income inequality (Chen et al., 2024). In sectors such as manufacturing and services, AI implementation may improve overall efficiency but also erode the relative bargaining power of labor, especially in positions prone to automation. In this context, flexible forms of employment are not just an economic strategy but a structural outcome of broader technological transformation (Wiese et al., 2025).

2. Methods

In recent years, we have observed a rise in non-standard forms of employment on the Slovak labor market. One such form is agency employment. The aim of this article is to examine the factors that motivate individuals to work through employment agencies and to identify the sectors in which agency workers are employed.

In the first phase, a literature review of domestic and international authors was conducted based on the analysis of secondary sources. Scientific methods such as summarization, synthesis of knowledge, analogy, and deduction were used during this phase. The second phase focused on the analysis of primary data obtained from agency workers through a questionnaire survey.

To analyse the labor market and agency employment as one of the flexible forms of work, we formulated the following research questions:

- RQ1: What is the demographic structure of the respondents?
- RQ2: How long did the respondents search for work, and how difficult was their job search?
- RQ3: What are the reasons respondents chose to work through a staffing agency, what type of employment contract do they have, and what position do they hold?
- RQ4: How long has their employment lasted, how satisfied are they with agency work, and are they interested in continuing to utilize this form of work? Does the respondents' nationality influence their satisfaction with agency work?
- RQ5: What benefits do staffing agencies offer to employees?

To achieve the set objectives, we created an anonymous questionnaire. The survey was conducted among agency workers from March 4th, 2024, to May 31st, 2024. The questionnaire contained 14 questions, of which 11 were closed-ended and 3 were open-ended.

In the first part of our questionnaire, we focused on the demographics of the respondents. We collected information on gender, age, nationality, and current place of residence.

In the second part, we investigated the duration for which the respondent was unemployed before starting their current employment and how they rated the difficulty of finding their current job. We also inquired about the nature of the employment relationship the respondent entered into with the staffing agency, including its duration and the position they currently hold.

The third part of the questionnaire was aimed at identifying the factors that motivate respondents to become employed through a staffing agency. Simultaneously, we sought to determine whether they are currently satisfied with working through a staffing agency and whether they plan to continue in this type of employment in the future. At the end of the questionnaire, we examined the benefits provided by staffing agencies.

The questionnaire served as the main source of primary data for our study. Prior to data collection, we conducted a pilot test with a sample of 12 respondents. Based on their feedback, we made necessary adjustments to ensure the clarity and specificity of the questions and answers. The research sample was constituted through a convenience sampling technique. The questionnaire was administered in two formats, online and paper based, with staffing agencies assisting in the distribution among their temporarily assigned employees. Given the high number of Ukrainian citizens seeking temporary refuge in Slovakia, we also distributed the questionnaire in Ukrainian.

We carried out the analysis of the questionnaire survey using the methods of descriptive statistics and reliability analysis. Further, we used dependency analysis using Contingency tables. The Cramer's V was used to measure the strength of the relations. We analyzed the answers obtained using *IBM SPSS software*.

3. Results

In this section, we present the results of the questionnaire survey. The total number of respondents who participated in our survey reached 376. We began our data analysis with a reliability analysis. The Cronbach's Alpha coefficient was 0.67, indicating an acceptable level of reliability.

The first part of the questionnaire was designed to address RQ1. Interestingly, 50% of the respondents were women and 50% were men. The majority of respondents, 77.4%, were of Slovak nationality, followed by citizens of Ukraine (18.9%), the Czech Republic (3.8%), and Hungary (0.5%). Nearly 76% of the respondents were younger than 45 years. The least represented age group was those over 55 years, comprising only 6.38%.

In terms of educational background, the most represented respondents had secondary education with a school-leaving certificate (40%) or vocational training (26%). The smallest representation was among respondents with a bachelor's degree (9%) and those with a master's degree (7%). Highly educated individuals often prefer to seek employment outside of staffing agencies, as these agencies primarily fill positions that do not require a high level of qualification.

Responses to the question, "How long were you unemployed before starting your current employment?" can be seen in Figure 1.

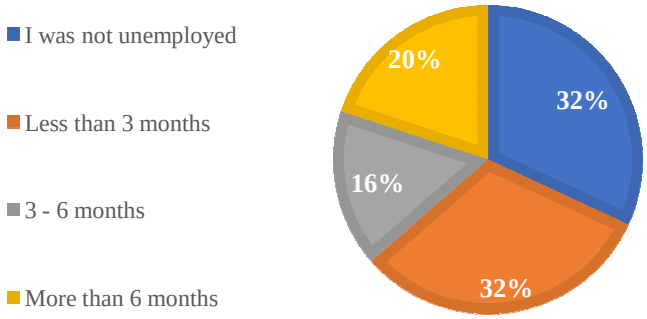

Figure 1. Duration of Unemployment Before Starting Current Employment
Source: own processing (2025)

We can conclude that up to 80% of respondents were unemployed for less than six months, indicating that agency work is not primarily sought by the long-term unemployed.

In the next part of the questionnaire, respondents evaluated the difficulty of finding employment. Only 22.87% of respondents found job searching to be challenging, predominantly those who had been unemployed for more than six months.

To determine the main reasons why people, choose to work through staffing agencies, we asked respondents about their motivations for selecting this type of employment relationship. Respondents could choose from the provided answers or write in other reasons. For 41% of respondents, the most important factor was the ease of obtaining work. An additional 17% indicated that the main reason was the opportunity to earn extra income, while 9% needed temporary work. The benefits provided by the agency, which often surpass those offered directly by employers, also played a significant role in their decision-making; this reason was mentioned by 9% of respondents (Table 1).

Table 1. Factors Influencing Motivation to Work Through a Staffing Agency

Reason for Choosing the Job via an Employment Agency	Number of Respondents	Percentage (%)
It was the easiest way to get a job	154	41%
In this company, it is only possible to work through an agency	6	2%
It is a stepping stone for me	28	7%
The employment agency can offer me another job, if I'm not satisfied	26	7%
The employment agency offers benefits that the employer cannot provide (accommodation/ wage advances/ transport to work, etc.)	33	9%
It helps with professional development	4	1%
I needed an additional income	63	17%
I needed a temporary job	32	9%
I needed to gain work experience	26	7%
Good experiences with a specific employment agency	4	1%

Source: author (2025)

Another question investigated the type of employment relationship respondents had established with the staffing agency and the positions they hold. The findings revealed that 70% of respondents had a full-time employment contract with the staffing agency, while 10% had a part-time contract. Additionally, 10% of respondents worked under a work performance agreement, and 9% had a student work agreement. Only one respondent indicated having a work activity agreement with the staffing agency.

Regarding the job positions held by respondents, the most represented group was that of production operators/production workers, comprising 74% of the total respondents. Conversely, the least represented positions were in the IT sector. Based on the results, we can conclude that staffing agencies primarily fill low-specialization positions with minimal educational requirements.

The results also show that 46% of respondents have been in their current employment for more than six months. See Figure 2 for more details.

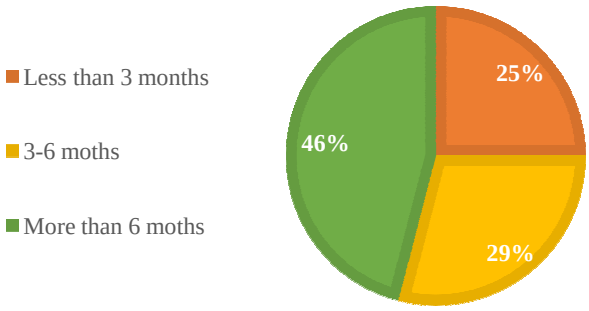

Figure 2. Duration of Employment Relationship
Source: own processing (2025)

In the next section of the questionnaire, we assessed respondents' satisfaction with agency work and their interest in continuing to work through staffing agencies. Responses were measured on a five-point Likert scale, ranging from "strongly agree" to "strongly disagree." The results can be seen in Table 2.

Table 2. Satisfaction with Agency Work

Response Category	Currently Satisfied (Number)	Currently Satisfied (%)	Future Interest (Number)	Future Interest (%)
Strongly agree	143	38%	122	32%
Agree	152	40%	114	30%
Neutral opinion	62	16%	96	26%
Disagree	17	5%	29	8%
Strongly disagree	2	1%	15	4%

Source: author (2025)

In terms of current satisfaction with agency work, 78% of respondents perceive their work through a staffing agency positively.

Finally, we were interested in whether nationality affects current satisfaction with the working environment provided by the staffing agency. To this end, we divided respondents into Slovak and foreign employees. To examine the dependency, we used Cramér's V, which equaled 0.082 with a p-value of 0.465. We can conclude that current satisfaction is not influenced by nationality. Our conclusion was assessed at a significance level of 0.05.

Regarding the interest in continuing agency work in the future, the results indicate a slight decrease in positive attitudes. 62% of respondents expressed interest in continuing to utilize the services of a staffing agency, while 12% disagreed with the idea of continuing agency work in the future.

RQ5 focuses on examining the benefits provided by staffing agencies. The results indicate (Table 3) that the most frequently mentioned benefit by respondents was the option for advance wage payments or weekly wage payments.

Table 3. Benefits Offered by Staffing Agencies

Benefit	Frequency
Professional counseling (preparation for a job interview, legal advice, assistance with permits)	126
Accommodation	82
Option to take salary advances / weekly salary payments	182
Transportation to work	143

Source: author (2025)

4. Discussion

Based on the analysis of empirical data, we were able to answer all the research questions. The majority of respondents in our study were of Slovak nationality (77.39%), while a significant portion consisted of Ukrainian citizens (18.88%), reflecting current migration trends. The primary reason respondents chose to work through a temporary employment agency was the relative ease of obtaining a job. For migrants, this form of employment facilitates entry into the labor market, a finding that is supported by international studies. For instance, Lamb, Banerjee, and Verma (2021) report that non-standard jobs often serve as an entry point to the Canadian labor market for many new immigrants.

In the case of Croatia, Strmota and Ivanda (2021) argue that the expansion of atypical forms of employment is more a consequence of the lack of full-time job opportunities than a reflection of employer-driven labor market flexibility.

Nearly 80% of our respondents expressed satisfaction with their agency employment, indicating a generally positive perception of this type of work. We found that nationality is not a key factor influencing satisfaction with agency work. However, interest in continuing this form of employment in the future was slightly lower, suggesting the need for further improvements in working conditions and the long-term prospects of agency-based employment.

The findings of this study highlight the significant role of temporary employment agencies in increasing labor market flexibility in Slovakia, particularly in the employment of temporary and low-skilled workers. These results are consistent with the findings of Zhang, Nardon, and Sears (2022), who point out the specific challenges and risks associated with non-standard employment among migrants, while also emphasizing its importance as a mechanism for labor market integration.

Conclusion

Labor market flexibility has become a necessity in today's dynamic environment. The COVID-19 pandemic, the energy crisis, and rising tariffs have demonstrated that the ability to adapt quickly to changing conditions is essential for the survival and success of businesses. In this context, temporary agency work represents a key instrument that enables companies to respond effectively while offering workers the opportunity to gain experience and access new employment opportunities during times of uncertainty.

The findings of the study provide valuable insights into the motivations and experiences of employees working through employment agencies in Slovakia. The results indicate that staffing agencies play a significant role in enhancing labor market flexibility, particularly by facilitating employment for temporary and lower-skilled workers. Temporary agency work helps these individuals acquire practical experience and access job opportunities during economically unstable periods.

Furthermore, the findings underscore the pivotal role of staffing agencies in facilitating the integration of foreign workers, particularly Ukrainian nationals, into the Slovak labor market, in accordance with contemporary migration patterns. The study also points to the potential for strengthening and expanding the benefits of agency employment, which could, in the long term, enhance its attractiveness. These findings may also serve as a useful resource for policymakers in the field of employment, as it enables them to develop informed and effective strategies that address employment challenges, support economic growth, and promote social cohesion. A thorough understanding of labor

market dynamics, such as employment trends, shortages of skilled labor, wage progression, and the demographic composition of the workforce, enables the formulation of targeted policy measures that address present challenges while anticipating future labor market needs.

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Trust in Economic Actors in the Czech Republic

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Abstract

Research background: Indicators of trust and credibility are increasingly recognized as important reflections of a society's capacity for economic adaptability and resilience.
Purpose of the article: The paper presents the results of a pilot questionnaire survey aimed at mapping the attitudes of members of the Czech Police force towards the trustworthiness of various actors within the economic environment.
Methods: Methodologically, the study is based on quantitative research conducted through an anonymous questionnaire (121 respondents, carried out between February and March 2025 at the Police Academy of the Czech Republic in Prague). The collected data are analysed using descriptive statistical methods and are complemented by a comparison of different groups of police officers.
Findings & Value added: The paper provides a unique insight into the perception of the economic sphere by law enforcement authorities, with implications for building cooperation between the police and the private sector. The results can contribute to the professional discussion within the security research of the Ministry of the Interior of the Czech Republic with applicability in the application sphere within the Resilient Society priority.
The main findings show a correlation between the perception of the government to positively influence the economic situation and the respondents´ trust in the societal system as a whole. The hypothesis that "Police officers who have greater trust in the government have more optimistic expectations regarding future generations was confirmed.

Keywords: Economic actors, Police, Police force, Resilience, Trust, Trustworthiness

JEL classification: H11, D73, P16

1. Introduction

The research on trust among police officers studying at the Police Academy of the Czech Republic in Prague has been inspired by the Edelman report, which publishes a global trust barometer. The findings were considered alarming and also constituted several debates during the World Economic Forum in Davos in January 2025.

1.1 Global view on trust: findings from the Edelman Report and the Eurobarometer

The report was published with the subtitle „Crisis of Grievance Puts Pressure on Trust" (Edelman, 2025). The name of the subtitle reflects well the main findings of the report. The research was conducted in 28 countries, with more than 33,000 respondents in total. The statistical findings were confirmed by t-test with a 99% confidence level. As it was the 25th report published, there is also the possibility to observe the development in time.

The main findings constitute different pictures of trust level among countries. It is disturbing that elections fail to provide trust, mostly in the Western countries, which boast of the desirability of their democratic processes. Globalization, economic and technological issues leads to widespread insecurity. "Artificial intelligence (AI) and cyber-physical systems (CPS) are bringing revolutionary changes to the functioning of society", and at the same time, "in the post-pandemic era, inequality continues to grow globally, as for the first time in 25 years, both extreme wealth and extreme poverty have increased

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simultaneously" (Entler, 2024, pp. 25-26). Employees trust less their employers to do what is right. This category reflects again different attitutes in different countries. Whereas in the countries with the highest growth rates (Indie, China, Indonesia) the trust is relatively high, it is the lowest in the Western countries, South Korea being the country with the smallest trust vis-à-vis employers. Other findings are no less worrisome. The belief that political leaders, business leaders and journalist lie to the public on purpose and mislead people is at an all time high. The wealthy are considered a group that does not pay their fair share and causes many problems. The most discussed issue was the proportion of people who agree that hostile activitism may be the right activity to drive change. From the age perspective it is the group aged 18-34, which is the most inclined to use such means to deliver a change to their situation.

It is the Western countries again, where people lack optimism for the future generations at most. People do not believe that the next generation will lead a better life than them. Respondents also expressed their fears of being discriminated (on the grounds of prejudice, or racism). 6 in 10 respondents reported grievances against the government, the business and the rich. Business is now more trusted than governments. Scientists and teachers were more trusted than institutional leaders.

Regarding trust there are further important sources that provide research on regular basis in standardized forms. The Eurobarometer offers regular findings regarding the trust in institutions, The Eurobarometer (2024) offers in some aspects diverging views compared to the Edelman Trust Barometer. According to the Eurobarometer the trust in EU is the highest since 2007, reaching 51 %. 69 % of respondents agree that the EU is a place of stability in a troubled world. 44 % Europeans believe that the highest positive benefit for their lives comes from ensuring peace and stability.

The findings for the Czech Republic (autumn 2024) show slightly less positive expectations than the EU average. The two most important domestic economic issues were identified as costs of living and immigration. Czech respondents were more critical of the EU, national parliament and national governments. Especially the national government gained very low trust among the respondents. Czech respondents showed high attachment to their towns and the state, but relatively much lower to the EU.

1.2 Trustworthiness of the Police of the Czech Republic and other institutions according to STEM

The trust in institutions is also regularly measured by STEM, the Centre for Empirical Research. The latest report comes from May 2025. It is the repressive forces, the Police and the Army that enjoy the highest trust by the public topped only by the Czech National Bank. "The credibility of the Police Force is a topical issue in security theory and practice" (Dinušová, Sabayová, 2024). In the report from 2024, the analyst by STEM, Jiří Táborský, emphasized that the trust in institutions reflects the trust in the state and in the system as such. The Police enjoys the second-highest level of public trust, reaching 73 %. Between 2024 and 2025, trust in the police in the Czech Republic fell by one percentage point to 72 %, see Table 1 Trust in the Police of the Czech Republic and selected institutions according to STEM.

There are long-term divergencies among the institutions. The low trust in government, indicated by Eurobarometer (2025), is supported by STEM as well. There are clear political cleavages regarding the trust in the government and Parliament. The president and the Constitutional court on the other hand enjoy higher trust. As shown in Table 1 Trust in the Police of the Czech Republic and selected institutions according to STEM, the trust in EU fell to 38 %, especially because of socio-economic issues and immigration. Regarding the survey from 2024, most institutions and organizations experienced a decline in trust.

Table 1. Trust in the Police of the Czech Republic and selected institutions according to STEM

Institution	Level of trust
Police of the Czech Republic	72 %
Army of the Czech Republic	68 %
Czech government	23 %
European Union	38 %

Source: own elaboration based on STEM data (2025)

The erosion of trust especially in the vertical form (Palmisano & Sacchi, 2024; Williams, 2020; Lonardo, 2021) is disturbing, as it had and will necessarily have a political impact. Vertical trust can be

defined as trust of individuals in a hierarchical structure. An example is the trust between a subordinate and their manager, a supervisor, or an organization/instituions as a whole.

As the Czech Republic was not included in the Edelman research, we decided to conduct our research on topics connected with trust, especially focusing on economic topics. Regarding the reported high level of trust in the repressive forces (the Police) in an environment with lowering trust levels, we chose to focus especially on this group.

The Police of the Czech Republic is a unified armed security corps established by the Act of the Czech National Council dated June 21, 1991. It serves the public, protects the safety of people and property, public order, and prevents crime. It also performs tasks under the Criminal Procedure Code and other tasks in the field of internal order and security assigned to it by laws, European Union regulations, and international treaties that are part of the legal system of the Czech Republic. The Police of the Czech Republic is subordinated to the Ministry of the Interior of the Czech Republic, and with 40,203 police officers (as of January 1, 2025) it is both the largest security corps and the largest state body in the Czech Republic. "The relationship between the police and the public is not unilateral, but bilateral, so on the one hand it is formed under the influence of factors affecting the activities of the police force, quality of work and ability to fulfill certain social functions, on the other hand the general credibility, security and the economic situation and the overall situation of the citizen and the public" (Dinušová, 2020). "The rationalized myth that the police organization is evaluated according to its effectiveness in reducing crime is not confirmed by any relevant research" (Sabayova, 2021). Police officers "are both representatives of the people as well as bearers of institutionalized values" (Rothstein & Stolle, 2008).Their behavior represents an important signal to citizens about the moral standards of the society in which they live (Kydd, 2000; Delhey & Newton, 2004).

2. The objective and methods

The main aim of this article is to find out whether there are significant divergences from the findings of Edelman trust report 2025 and STEM research regarding the specific group of Police force members, as they themselves enjoy the highest level of trust by the Czech public. Based on this, the following hypothesis was formulated: "Police officers who have greater trust in the government have more optimistic expectations regarding future generations".

To gain evidence on trust related topics a questionnaire was created. The questionnaire included 24 questions. The general questions (gender, age, education, location etc.) were accompanied by the duration of the membership in the Police force. The trust questions included trust towards institutions, business representatives, journalist and media, the employers, and the system as a whole.

The respondents could express their (dis)trust in percentage points, ranging from 1 to 100%. The attitude questions were scaled as following (do you agree, do you believe) – definitely yes, rather yes, rather no, definitely no.

The questionnaire was sent to members of the Police force, who are at the same time also students at the Police academy of the Czech Republic in Prague, both in the intra-mural form and extra-mural form. There are 963 students, who are also members of the Police force. These students were sent the questionnaire. We gained 121 completed questionnaires. The research was conducted between February and March 2025 via online questionnaire and processed in early May 2025.

The evaluation methods included coding the data and using correlation analysis to identify the main relations between variables.

3. Results

The sample consisted of 121 respondents. 83% of the respondents were aged 26-45 and had secondary education (and studying at the Police academy). The majority of respondents were male (82%). The biggest group of respondents has been serving in the Police for more than 16 years. The respondents were quite equally spread among the regions of the Czech Republic, however prevailing were Prague and the region of Central Bohemia.

3.1 Trust in economic actors and trustworthiness of the societal system

The findings regarding trustworthiness revealed the following. The trust in institutions remains relatively low, with the largest group of respondents expressing trust levels of up to 25% on a scale from 1 to 100 percentage points. Figure 1. Respondent´s trust in selected economic actors demonstrates

the results. The lowest levels of trust were observed for the Czech government, while the highest level of trust was recorded for the employer (The Police of the Czech Republic).

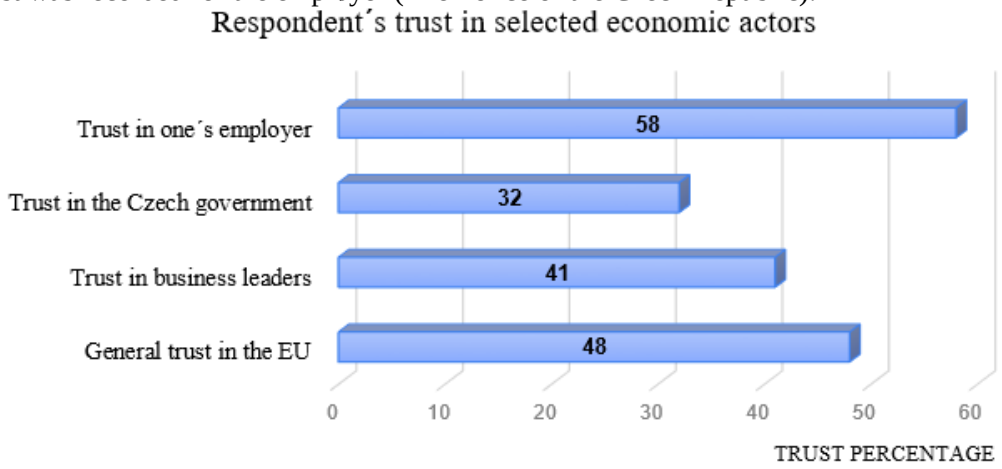

Figure 1. Respondent´s trust in selected economic actors
Source: own research (2025)

According to the above-mentioned Figure 1 Respondent´s trust in selected economic actors, the average level of trust among respondents was as follows: 58% for the employer, 48% for the EU, 41% for business leaders, and 32% for the Czech government.

As the Edelman trust barometer showed the importance of future expectations, a question regarding the living standard of the future generation was also included. The biggest group of respondents does not expect that the future generations will have the same standard (rather not).

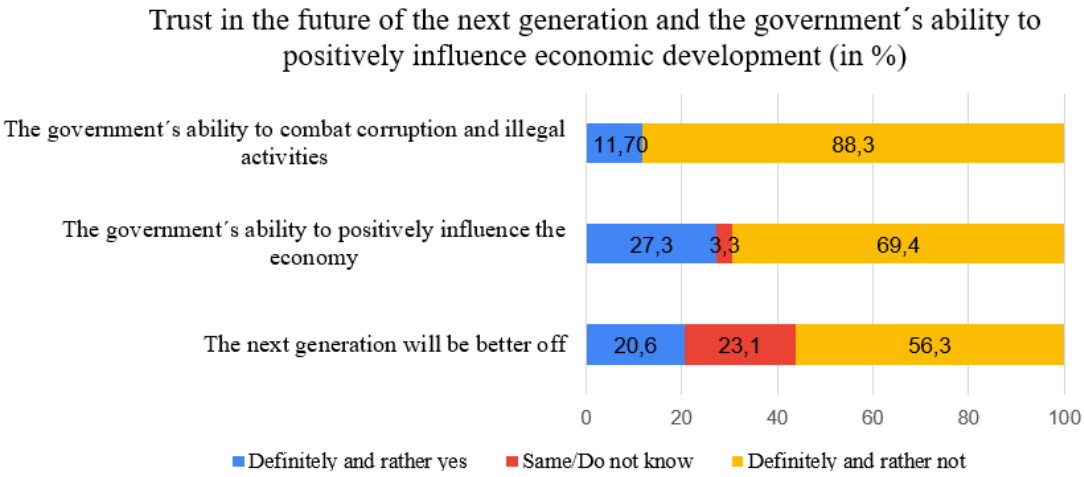

Figure 2. Respondents´ trust in the future of the next generation and government´s ability to positively influence economic development
Source: own research (2025)

According to the above-mentioned Figure 2: Respondents´trust in the future of the next generation and the government´s ability to positively influence economic development, the answers to the questions:

- Do you think the next generation will have a better future compared to the current situation? were as follows: 4,1 % of respondents answered “definitely yes”, 16,5% rather yes, 23,1% about the same as our generation, 41,4% rather no, 14,9% definitely not;
- regarding the government´s ability to positively influence the country´s economy and economic development, the responses were: 1,7% strongly agree, 25,6% rather agree, 3,3% don´t know, 32,2% rather disagree, 37,2% strongly disagree;
- regarding the government´s ability to fight corruption and illegal activities in public finances, the responses were: 11,7% rather agree, 47,5% rather disagree, 40,8% strongly disagree.

The final question contained also the issues of trustworthiness of the societal system. This time the respondents could grade (using a school grading scale 1-5; 1- excellent, 5 - insufficient). The most frequent "grade" was three, corresponding to average, followed by "4", as barely sufficient. The trustworthiness proved to be quite low towards all mentioned institutions, including the system itself.

Another important issue in the Edelman trust barometer was the inclination towards hostile activism. Our question was formulated as the understanding for protests. The majority of the respondents claimed they have no understanding for protests. This may be connected with the specific position of the repressive forces.

Although the sample may not be especially large, its benefits lie in the precise focus on the group of members of the Police of the Czech Republic. The relatively large data set enabled also correlations among important questions and categories.

3.2 Correlations, hypothesis verification, comparisons of trust

Correlations are strong among following categories:.the ability of the government to positively influence the country´s economic situation and development is connected with its ability of the government to fight corruption and illegal activites in the sphere of public finances. At the same time there is also correlation of the respondents´attitude towards the societal system as a whole. The trustworthiness of the government and the EU are correlated. Attitutes towards living standard of future generations are correlated with the respondents´attitued towards the societal system as a whole. The hypothesis was confirmed - respondents with more positive attitude towards the government and the societal system as a whole showed higher optimism towards the standard of living of future generations.

The hypothesis that "Police officers who have greater trust in the government have more optimistic expectations regarding future generations´ was confirmed. The results of the T-test for this hypothesis are as follows: t-statistic = 2,48 and p-value = 0,0168.

Table 2 Comparison of results in questions concerning trustworthiness in the Czech Republic offers comparison of trust categories by various institutions, in some case data were not available. As for the Edelman trust barometer, for illustration purposes Germany was chosen, as the Czech Republic was not included in the sample of countries. Due to relatively cultural vicinity to Germany the data are presented in the table, although interpretation should be conducted with caution. All survey share low trust in the government, which may be a connected with socio-economic situation. The data collected from the Police academy students show they have the highest trust in EU compared to other surveys (STEM and Eurobarometer). The time span overlaps, as all surveys were conducted in approximately the same time period.

Table 2. Comparison of results in questions concerning trustworthiness in the Czech Republic

Institution/Level of trust	**Edelman/Germany**	**STEM/Czech Republic**	**Eurobarometer/Czech Republic**	**Respondents at the Police academy of the Czech Repulic in Prague**
Data collected in	**Autumn 2024**	**April 2025**	**Spring 2025**	**February – April 2025**
The Government	35	23	29	32
The European Union	No data	39	43	48
Employer	69	No data	No data	58
Better prospects for the future generation	14	No data	No data	21
Business sphere	45	No data	No data	41

Source: own elaboration (based on own research, Edelman, STEM, Eurobarometer)

4. Discussion

The conducted survey among the members of the Police of the Czech Republic studying at the Police Academy of the Czech Republic in Prague offered some interesting results. The main findings show a correlation among the ability of the government to positively influence the economy, the fight against corruption and illegal activities and the attitude towards the societal system. Respondents viewing

positively the societal system are inclined to expect more positive results from the government, and also show more optimism towards future generations.

This pilot study provided important insights into the level of trust among police officers of the Police of the Czech Republic. Although the final sample consisted of 121 respondents out of 963 police officers contacted – representing only a small proportion of the overall police force – the targeted focus on police officers as a professional group offers a unique perspective.

The trust in government roughly corresponds to larger and more representative surveys like STEM and Eurobarometer, which were conducted in the same time period. It suggests that there are different cleavages determining the trust in the government than being a member of the police force. Further research, including the political preferences of the respondents is necessary to gain more information.

The authors acknowledge the limitations associated with this modest sample size and recognize that the findings may not fully reflect the views of the broader body of police officers in the Czech Republic. Moreover, the predominance of male respondents (82%) and experienced officers (more than 16 years of service) might have influenced the results towards a more positive evaluation of their own employer, i.e., the Police of the Czech Republic. Therefore, the results should be interpreted with caution and viewed as preliminary, with further research using a larger and more representative sample recommended. Future research plans regarding the highly important topic of trust thus include in-depth interviews, semi-structured interviews and larger sample questionnaires. Recent findings show, that there may be a link between the specific demands of a job and individual attitudes (Selenko, Schilbach, Brieger, Van Hootegem & De Witte, 2025), as police officers do not operate in a social vacuum. For example, Van Droogenbroeck, Kutnjak Ivkovic, and Spruyt (2022), in their large-scale study among Belgian police officers, found, that certain high-risk occupations, involving significant physical or psychological threats are associated with higher levels of ethnic prejudice, authoritarianism, and social dominance orientation. Although the number of such studies remains limited, they indicate that some professional environments – such as police work – may function as so-called “strong situations,” shaping attitudes and behaviors in specific ways and reducing the influence of personality traits (Cooper Withey, 2009). This perspective may be useful in further research on the mechanisms behind trust formation and attitudes among members of the Police of the Czech Republic.

Conclusion

The article was inspired by alarming findings of the Edelman trust barometer, which showed decreasing levels of horizontal trust especially among Western societies. As the police force has been enjoying high levels of public trust in the Czech Republic long term, they were chosen as the preferable sample of research. The survey conducted during February – April 2025 among the members of the Police of the Czech Republic at the Police Academy of the Czech Republic in Prague showed many interesting findings. A totl of 121 questionnaires were processed, using the method of coding and correlation.

The results indicate that members of the Police of the Czech Republic, even within this specific target group, share a low level of trust in key public institutions, particularly in the government. The hypothesis “Police officers who have greater trust in the government have more optimistic expectations regarding future generations” stated in this article was confirmed – respondents with positive attitudes towards the government´s capabilities showed higher optimism towards the living standard of future generations.

The survey also showed that the level of trust towards the government corresponds to levels gained by surveys conducted by STEM and Eurobarometer, where the time period overlaps.

The results highlight the need for a deeper analysis of trust within state security forces and the implications for their professional and civic attitudes.Further research will include larger samples of members of the Police of the Czech Republic, as well as in-depth interviews and semi-structured interviews.

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2. Management

Challenges for Social Responsibility of Organizations in Market Economy Conditions

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Abstract

Research background: This paper examines the theoretical foundations for applying social responsibility in market economies, the development of CSR concepts, their characteristics and principles, the benefits of CSR and sustainable development. The healthcare sector, in particular, holds significant potential for advancing sustainability through targeted operational and policy interventions. Paper addresses current challenges related to the implementation of social responsibility in organizations operating within a market economy, with a specific focus on Slovakia, where the concept is still developing.
Purpose of the article: The aim of this paper is to analyze the application of social responsibility in organizations under market economy conditions and to propose measures to improve organizational responsibility in Slovakia.
Methods: Primary data was collected via a two-part questionnaire. A total of 62 respondents from 62 organizations in Slovakia participated in the study. The results were analyzed using advanced statistical methods in the Statistics 12 software, particularly the Kruskal-Wallis test, to verify two hypotheses: (1) that larger organizations achieve a higher social responsibility index than smaller ones, and (2) that organizations in the industrial sector outperform others in CSR performance.
Findings & Value added: The findings highlight size as a primary determinant of CSR performance, likely due to greater resources, formalized systems, and compliance incentives in large organizations. Smaller enterprises, often resource-constrained, lag behind in structured CSR implementation. This supports the argument that CSR frameworks and incentives need tailoring based on organizational capacity rather than industry type. The added value of this research lies in its empirical contribution to the understanding of CSR dynamics in transitional economies. Based on the findings, the research results will be beneficial for work not only in business and industry, but also in healthcare facilities and will also help in setting up processes when working with employees.

Keywords: Social responsibility, Market economy, Business, Organization, Healthcare sector, Sustainability

JEL classification: J24, M12

1. Introduction

In recent years, the regulation of business, public oversight of business outcomes, and their environmental impact have been increasingly discussed due to the expanding role of business in social development and growing expectations for transparency. Scholars such as Albareda (2007), Bowen (1953), Bartol (2008), Davis (1967), Carroll (1991), Carty (2002), Kotler (2005, 2013), Porter (2003),

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Robert (2008), and Weber (2008) have explored the relationships between government, business, and society.

Key international CSR initiatives emerged in the 1990s, notably the UN Global Compact**,** which promotes ten principles, including support for human rights, environmental protection, anti-corruption, and non-discrimination (United Nations Global Compact, 2022).

1.1 Corporate social responsibility as a business concept in the modern era

The concept of corporate social responsibility (CSR) began to take shape in the 1960s (Skrynkovskyi, Kostiuk, Semchuk., Koropetskyi, 2016), evolving into a multi-dimensional framework by the 21st century. Today, CSR encompasses the stakeholder approach, corporate social initiatives, and business ethics. ESG reporting is increasingly recognized as a key element of corporate legitimacy in both Central and Eastern Europe and the healthcare sector **(**Hąbek & Wolniak, 2021; Trapp, 2023**).**

CSR is defined in various ways and can be analyzed through the lenses of EU policy, marketing strategy, or economic theory—as a means of profit generation. From the non-profit perspective, the theory of trust frames CSR as a mechanism that enhances public confidence in organizations compared to other less reliable sectors (Skovajsa, 2010).

CSR is broadly recognized as an ethical responsibility toward stakeholders, while also reflecting the broader societal impact of corporate behavior. Ideally, CSR represents "the responsibility of organizations to be ethical and accountable to the needs of their business as well as to the needs of stakeholders" (Kaufmann, 2014). From an economic perspective, Kotler and Keller (2013) describe socially responsible marketing as grounded in ethical, legal, and socially beneficial behavior. During crises, organizations tend to shift from traditional quality management toward anti-crisis and socially-oriented management concepts (Antoniuk, 2019).

Among the three dominant global management models—Anglo-American, Japanese, and German—the German and Japanese models, which emphasize social values, trust, and cultural cohesion, have gained prominence during global economic crises (Bochko, 2020). With growing pressure from investors, consumers, and regulatory bodies, CSR will likely become a standardized benchmark for long-term organizational legitimacy and competitiveness. As environmental and social criteria become embedded in business strategy and reporting (e.g., via the EU's CSRD Directive), the capacity of smaller firms and sector-specific institutions such as hospitals to adapt will require active public and private sector support.

The healthcare sector, in particular, faces unique operational and ethical challenges, making the implementation of CSR practices essential for long-term sustainability. Meyer et al. (2017) show that CSR strategies in healthcare can improve institutional trust and patient satisfaction. Kislinger and Richter (2020) demonstrate that stakeholder engagement and transparency in hospitals correlate with improved employee retention and public perception. Finally, Popa et al. (2019) argue that sustainability reporting and CSR adoption in public hospitals contribute to more efficient resource use and social accountability.

Recent scholarship has expanded CSR understanding across geographic and cultural contexts. For example, Aguinis and Glavas (2012) provide an integrative framework on CSR's psychological and organizational mechanisms; Jamali and Karam (2018) explore CSR in developing countries as an emerging research field; Maon et al. (2010) examine the organizational stages of CSR development; and Scherer and Palazzo (2011) highlight the political role of corporations in global governance.

2. Methodology for analysing the application of corporate social responsibility

The aim of this paper is to analyze the application of social responsibility in organizations under market economy conditions and to propose measures to improve organizational responsibility in Slovakia. Methods included a structured questionnaire and the application of statistical tools, particularly the Kruskal-Wallis test, to verify two hypotheses: (1) that larger organizations achieve a higher social responsibility index than smaller ones, and (2) that organizations in the industrial sector outperform others in CSR performance. Primary data was collected via a two-part questionnaire. The first part focused on determining the organization's size, industry, ownership form, headquarters region, and geographical scope—comprising five questions. The second part contained 25 questions divided into five categories: organization management, environment, labor-law relations, community

relations, and the business environment. A total of 62 respondents from 62 organizations in Slovakia participated in the study. The results were analyzed using advanced statistical methods in the Statistics 12 software.

In line with the main goal—analyzing the application of social responsibility in organizations under market economy conditions—hypotheses were tested using statistical methods with a significance level of $\alpha = 0.05$.

3. Results and evaluation of hypotheses

Hypothesis 1 – Relation to Company Size

H1: Large organizations achieve a higher value of the social responsibility index compared to smaller organizations.

To test this hypothesis, we used the Kruskal-Wallis test. The results are presented in tables and a box plot that displays the median, lower and upper quartiles, and range.

Management of the organization: The significance level achieved was $p = 0.0685$, based on the non-parametric Kruskal-Wallis ANOVA. Therefore, at the $\alpha = 5\%$ level, there is no statistically significant relationship between organization size and the social responsibility index in the area of organizational management.

Since it was not possible to confirm that larger organizations have a higher social responsibility index in management compared to smaller ones, only the graphical results for Hypothesis H1 are presented (Figure 1).

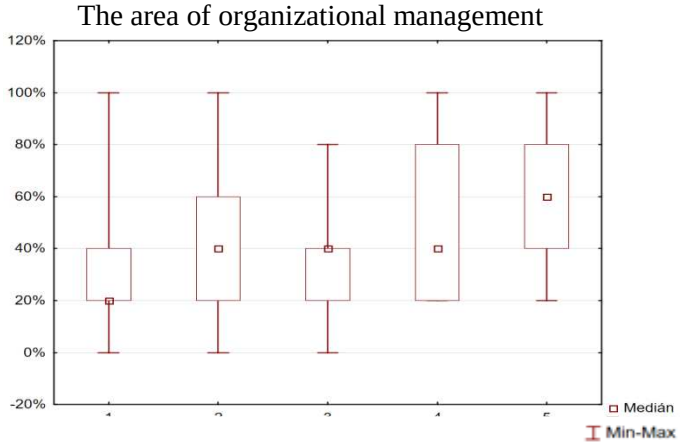

Figure 1. Results of testing hypothesis H1 in the area of organizational management
Source: Own processing. Calculated by the authors using the Statistics program

How many employees does your organization employ?
CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

It follows from Graph 1 that the lowest index of social responsibility in the area of organizational management, i.e., 20%, is observed in organizations with fewer than 10 employees, while the highest index, i.e., 60%, is recorded in organizations with 250 or more employees.

Environment: We also used the Kruskal-Wallis test to examine Hypothesis H1 in the area of environmental responsibility. The results of the test are presented in Tables 1 and 2, as well as in Graph 2.

Table 1. Results of testing hypothesis H1 in the field of environment

Dependent:	Kruskal-Wallis ANOVA based on delivery; 2. ENVIRONMENT (recoded questionnaire) Independent (grouping) variable: I. How many employees does your organization employ? Kruskal-Wallis test: H (4, N= 62) =26.63207, p =0.0000			
	ccode	Number of valid	Rank sum	Avg. Order
1	1	18	393.0000	21.83333
2	2	13	284.5000	21.88462
3	3	5	123.0000	24.60000
4	4	11	431.0000	39.18182
5	5	15	721.5000	48.10000

Source: Own processing

CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

At the significance level of $p = 0.0000$, obtained using the non-parametric Kruskal-Wallis analysis of variance (ANOVA), we can confirm the acceptance of Hypothesis H1. The testing demonstrated a statistically significant relationship between company size and the value of the social responsibility index in the area of environmental responsibility at a significance level of $\alpha = 5\%$ (Table 1).

We are interested in identifying which groups of businesses differ from each other. For further analysis, we performed a multiple comparison of *p*-values (Table 2), which revealed a statistically significant difference in the environmental social responsibility index between organizations with fewer than 10 employees and those with 250 or more employees, as well as between organizations with 10 to 19 employees and those with 250 or more employees.

Table 2. Multiple comparison of p values for testing hypothesis H1 in the field of environment

Dependent:	Multiple comparison of p values (two-sided); 2. ENVIRONMENT (recoded questionnaire) Independent (grouping) variable: I. How many employees does your organization employ? Kruskal-Wallis test: H (4, N= 62) =26.63207, p =0.0000				
	1 R:21,833	2 R:21,885	3 R:24,600	4 R:39,182	5 R:48,100
1		1.000000	1.000000	0.119852	**0.000312**
2	1.000000		1.000000	0.192707	**0.001258**
3	1.000000	1.000000		1.000000	0.116569
4	0.119852	0.192707	1.000000		1.000000
5	**0.000312**	**0.001258**	0.116569	1.000000	

Source: Own processing. Calculated by the authors using the Statistics program

CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

Considering the statistically significant differences that were confirmed, we assume that large organizations have well-developed plans and programs aimed at reducing their environmental impact. These organizations implement activities focused on establishing monitoring systems to measure key environmental impacts — particularly resource usage and greenhouse gas emissions — as well as on the effective implementation of recycling programs. Compared to small and medium-sized enterprises (SMEs), large organizations are more frequently certified according to various ISO standards. This is especially important when ecological production processes require systematic monitoring and reporting — for example, in the case of reporting quantifiable reductions in greenhouse gas emissions compared to previous years.

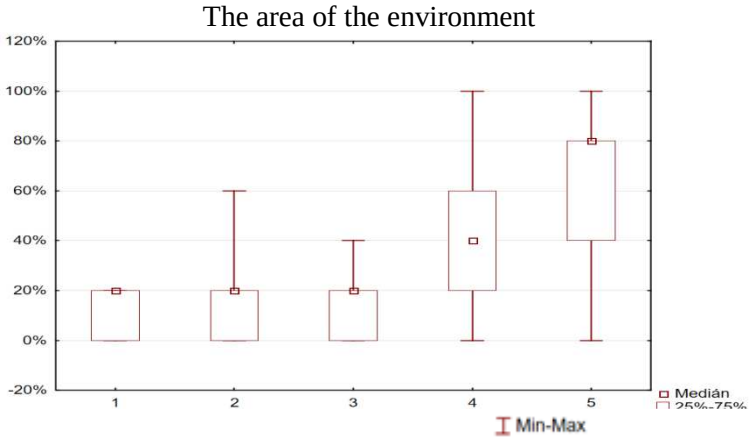

Figure 2. Results of testing hypothesis H1 in the area of the environment
Source: Own processing. Calculated by the authors using the Statistics program

How many employees does your organization employ?
CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

Graph 2 shows that the lowest index of social responsibility in the area of the environment is recorded for organizations with fewer than 10 employees, as well as for those with 10–19 and 20–49 employees — all reaching an index of approximately 20%. In contrast, the highest index of social responsibility, around 80%, is achieved by organizations with 250 or more employees.

Labour-Legal Relations: At a significance level of α = 5%, we tested hypothesis H1 in the area of labour-legal relations. The results of the Kruskal-Wallis test are presented in Tables 3 and 4, as well as in Graph 3.

Table 3. Results of testing hypothesis H1 in the area of labour-legal relations

Dependent:	Kruskal-Wallis ANOVA based on delivery; 3. LABOUR RELATIONS (recoded questionnaire) Independent (grouping) variable: I. How many employees does your organization employ? Kruskal-Wallis test: H (4, N= 62) =15.45624, p =0.0038			
	Code	Number of valid	Rank sum	Avg. Order
1	1	18	357.5000	19.86111
2	2	13	399.5000	30.73077
3	3	5	180.0000	36.00000
4	4	11	364.0000	33.09091
5	5	15	652.0000	43.46667

Source: Own processing. Calculated by the authors using the Statistics program

CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

Based on the achieved significance level of p = 0.0038**,** obtained through the non-parametric Kruskal-Wallis analysis of variance (ANOVA), we can state that hypothesis H1 is accepted. The results indicate a statistically significant relationship between the size of the company and the value of the social responsibility index in the field of labour-legal relations (see Table 3).

Table 4. Multiple comparison of p values for testing hypothesis H1 in the area of labour-legal relations

Dependent:	Multiple comparison of p values (two-sided); 3. LABOUR RELATIONS (recoded questionnaire) Independent (grouping) variable: I. How many employees does your organization employ? Kruskal-Wallis test: H (4, N= 62) =15.45624 p =0.0038				
	1 R:19,861	2 R:30,731	3 R:36,000	4 R:33,091	5 R:43,467
1		0.978708	0.768071	0.553562	**0.001822**
2	0.978708		1.000000	1.000000	0.624746
3	0.768071	1.000000		1.000000	1.000000
4	0.553562	1.000000	1.000000		1.000000
5	**0.001822**	0.624746	1.000000	1.000000	

Source: Own processing. Calculated by the authors using the Statistics program

CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

The chosen test (Table 4) revealed a statistically significant difference in the value of the social responsibility index between companies with fewer than 10 employees and those with 250 or more employees in the area of labour relations. We assume that this significant difference arises from the fact that large organizations tend to focus more on evaluating the quality of human resource management. Although both large organizations and SMEs typically maintain a zero-tolerance policy for workplace accidents, the differences are mainly reflected in the existence of formal action plans — particularly those concerning human resources management and its regular evaluation, as well as official employee representation within the organization. Large organizations are also more likely to have plans to mitigate the negative effects of job reductions, along with a more rigorously developed policy for responsible behaviour toward employees.

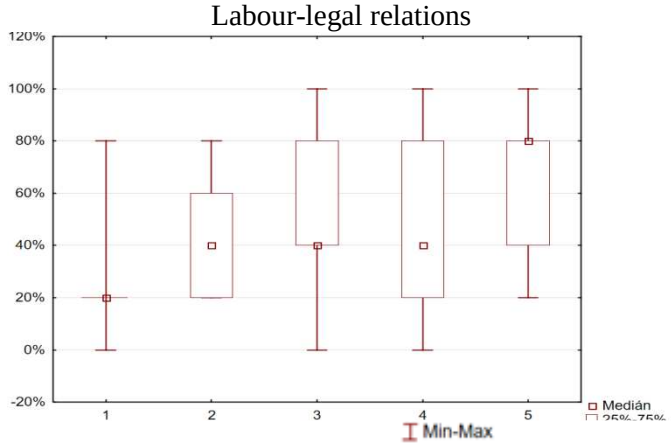

Figure 3. Results of testing hypothesis H1 in the area of Labour-legal relations
Source: Own processing. Calculated by the authors using the Statistics program

How many employees does your organization employ?
CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

It follows from Graph 3 that the lowest social responsibility index in the area of labour relations is recorded in organizations with fewer than 10 employees, i.e., 20%, while the highest index, i.e., 80%, is achieved by organizations with 250 or more employees. Organizations with 10 to 19 employees, 20 to 49 employees, and 50 to 249 employees all reach the same level of the social responsibility index — 40%.

Community Relations: We also used the Kruskal-Wallis test to test hypothesis H1 in the area of community relations. Tables 5, 6, and Graph 4 present the test results.

Table 5. Results of testing hypothesis H1 in the area of community relations

Dependent:	Kruskal-Wallis ANOVA based on delivery; 4. COMMUNITY RELATIONS (recoded questionnaire) Independent (grouping) variable: I. How many employees does your organization employ? Kruskal-Wallis test: H (4, N= 62) =12.98118 p =0.0114			
	Code	Number of valid	Rank sum	Avg. Order
1	1	18	465.0000	25.83333
2	2	13	332.0000	25.53846
3	3	5	138.5000	27.70000
4	4	11	341.5000	31.04545
5	5	15	676.0000	45.06667

Source: Own processing/ Calculated by the authors using the Statistics program

CODE: 1 – less than 10 employees, 2 – 10 to 19 employees, 3 – 20 to 49 employees, 4 – 50 to 249 employees, 5 – 250 or more employees

Influence of Organizational Size on CSR

The primary aim of this study was to examine whether there is a statistically significant relationship between the size of an organization—measured by the number of employees—and the achieved level of the social responsibility index in selected areas: namely, community relations, the business environment, and the overall corporate social responsibility (CSR) index. The Kruskal–Wallis non-parametric ANOVA test was used due to the relatively small sample size and the potential non-normality of the data distribution.

In the area of community relations**,** the analysis revealed a statistically significant relationship between company size and CSR index values (p = 0.0114). Organizations with 250 or more employees had the highest scores, while those with fewer than 10 or 10 to 19 employees scored significantly lower. This suggests that larger companies are more actively involved in community-oriented initiatives such as supporting civil society, cooperating with NGOs, participating in CSR-focused forums, and offering internships or training programs to develop local talent.

A similar trend was observed in the business environment domain, where the test also confirmed Hypothesis H1 with a high level of statistical significance (p = 0.0004). Organizations with fewer than 250 employees recorded the lowest CSR index scores, while larger firms achieved the highest values. This may indicate that large organizations are more likely to adopt ethical business practices, maintain internal governance structures for transparency, and integrate green procurement policies. These findings are consistent with Aguinis and Glavas (2012)**,** who highlight the role of organizational resources and institutional capacity in fostering CSR engagement.

The overall CSR index analysis yielded p = 0.0001, further supporting Hypothesis H1. The smallest organizations (under 20 employees) had the lowest scores, with CSR performance improving as organizational size increased. Firms with 250+ employees exhibited the highest levels of CSR, likely due to their structured, institutionalized approaches to managing social, environmental, and economic responsibilities—such as recycling programs, legal compliance, and internal ethics policies.

These outcomes align with the conclusions of Baumann-Pauly et al. (2013)**,** who found that larger companies are more likely to develop formal CSR strategies due to their broader stakeholder exposure and resource availability. Similarly, Gallo and Christensen (2011) emphasize that firm size significantly predicts the degree and sophistication of CSR involvement.

Hypothesis H1 was confirmed: *Larger organizations consistently achieve higher values of the social responsibility index compared to their smaller counterparts.*

Hypothesis H2: Industry-Specific CSR Differences

Hypothesis H2 posited that organizations operating in the industrial sector would achieve higher CSR index values than those in other sectors.

To test this, the Kruskal–Wallis ANOVA was applied across six dimensions: organizational management, environmental responsibility, labor-law relations, community relations, the business environment, and the overall CSR index.

In **organizational management**, the *p*-value was 0.1556, indicating no significant difference across sectors. Though the construction sector showed the highest score (80%), sectors like agriculture, transport, and business services scored much lower (20%).

For **environmental responsibility**, the *p*-value was 0.1735. The trade sector led with 30%, while agriculture, transport, and public services scored only 10%.

The **labor-law relations** category had a *p*-value of 0.2173, with trade showing the highest score (50%) and transport the lowest (10%).

In **community relations**, the *p*-value was 0.3830. The industrial sector scored up to 40%, but construction recorded a zero score.

In the **business environment** domain, the *p*-value was 0.4210, showing no significant variation. The industrial sector achieved 40%, but agriculture and construction remained low at 20%.

For the **overall CSR index**, $p = 0.1228$. The transport sector had the lowest average (14%), trade was highest (37%), and the industrial sector reached 32%.

Collectively, these results show no statistically significant differences in CSR performance by industry.

Hypothesis H2 was rejected. This outcome supports the view that organizational size, rather than industry, is a more critical determinant of CSR engagement. These results echo the findings of Jamali and Karam (2018)**,** who argue that contextual and institutional variables are stronger predictors of CSR practices than industry classification. Additionally, Miska, Stahl, and Mendenhall (2013) suggest that leadership, global CSR expectations, and organizational culture play a more influential role than sectoral norms in shaping CSR behavior.

4. Discussion

This study confirmed Hypothesis H1, showing that larger organizations consistently outperform smaller ones in all CSR domains—particularly in environmental practices ($p = 0.0000$), labor-law relations ($p = 0.0038$), community relations ($p = 0.0114$), and the business environment ($p = 0.0004$). Conversely, Hypothesis H2 was rejected: no statistically significant differences in CSR index values were observed across industry sectors ($p > 0.05$).

Key Findings:

- Small enterprises (fewer than 10 employees) demonstrate the weakest CSR performance, particularly in environmental and labor categories.
- Large organizations (250+ employees) achieve the highest CSR scores, in some cases up to 80%.
- Industry affiliation does not significantly affect CSR levels—highlighting the greater influence of organizational size and internal capacity.

Practical Implications:

These results suggest that CSR policies and support programs should be tailored by firm size rather than by sector**.** Policymakers should prioritize mechanisms that help small and medium-sized enterprises (SMEs) overcome barriers to CSR adoption, such as limited resources, lack of expertise, or regulatory burden. The healthcare sector, in particular, holds significant potential for advancing sustainability through targeted operational and policy interventions. Hospitals should prioritize energy efficiency, green procurement, and waste reduction while also engaging staff in sustainability initiatives. These measures can strengthen institutional resilience, reduce environmental impacts, and improve long-term health outcomes. To support this transformation, national health strategies should incorporate clear sustainability targets and dedicated funding schemes. In addition, hospital accreditation systems could integrate sustainability indicators to incentivize continuous improvement. Collaboration with local governments and communities can also enhance hospitals' social responsibility efforts and amplify their public health impact.

Future Research Directions and Outlook:

Looking ahead, future studies should explore:

- The longitudinal evolution of CSR practices within growing firms;
- The role of digitalization and ESG (Environmental, Social, Governance) reporting standards in CSR effectiveness;

- The cross-national variation in CSR outcomes among similar-sized firms operating under different institutional environments;
- Recommendations for the healthcare sector and hospitals in order to achieve their sustainability, particularly through the implementation of CSR strategies adapted to the specific operational, environmental, and societal challenges of the health sector.

Conclusion

With growing pressure from investors, consumers, and regulatory bodies, CSR will likely become a standardized benchmark for long-term organizational legitimacy and competitiveness. As environmental and social criteria become embedded in business strategy and reporting (e.g., via the EU's CSRD Directive), the capacity of smaller firms and sector-specific institutions such as hospitals to adapt will require active public and private sector support. Future research should also address recommendations for the healthcare sector and hospitals in order to achieve their sustainability, given their critical role in public well-being and their substantial environmental footprint. This includes investigating how hospitals can integrate CSR principles through energy efficiency, waste reduction, sustainable procurement, and stakeholder engagement.

The findings highlight size as a primary determinant of CSR performance, likely due to greater resources, formalized systems, and compliance incentives in large organizations. Smaller enterprises, often resource-constrained, lag behind in structured CSR implementation. This supports the argument that CSR frameworks and incentives need tailoring based on organizational capacity rather than industry type. The lack of industrial advantage in CSR performance suggests that external regulatory pressure or public expectations are uniformly applied or ineffective at distinguishing sector performance. Instead, firm-level strategies and resources appear more decisive.

The findings provide a basis for policymakers and managers to design more effective CSR strategies tailored to organizational size rather than industry affiliation.The healthcare sector, in particular, holds significant potential for advancing sustainability through targeted operational and policy interventions. Hospitals should prioritize energy efficiency, green procurement, and waste reduction while also engaging staff in sustainability initiatives. These measures can strengthen institutional resilience, reduce environmental impacts, and improve long-term health outcomes.

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An Analytical Perspective on Innovation in Recruitment & Selection of Employees

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Abstract

Research background: Recent advances in digital technologies have introduced new, innovative approaches to recruitment and selection (R&S) in human resource management. Despite their growing adoption, there remains a need to empirically evaluate how these methods influence organizational outcomes, particularly candidate satisfaction, in the Slovak business environment.
Purpose of the article: The aim of the paper is to investigate the relationship between the use of innovative recruitment & selection methods and the level of satisfaction with selected candidates in Slovak enterprises.
Methods: The research was conducted in March 2025 on a sample of 153 medium-sized and large companies operating in Slovakia. Two hypotheses were tested using the chi-square test of independence to determine statistical relationships between the adoption of innovative methods and satisfaction outcomes.
Findings & Value added: The findings indicate a statistically significant association between the use of innovative recruitment methods and higher satisfaction with selected candidates. In contrast, no significant relationship was found between innovative selection methods and satisfaction levels. The study contributes to the understanding of HR digitalisation by highlighting both its practical benefits and the need for ethical and technological considerations in implementation.

Keywords: Human resources, Recruitment&selection, Innovation, Digital transformation.

JEL classification: M51, O33

1. Introduction

Organisations today are confronted with an unprecedented pace of technological advancement and continuously evolving labour market trends, which are fundamentally reshaping how they approach recruitment, selection, and talent retention. Attracting qualified professionals has become a strategic priority that directly influences a company's competitiveness. The digital age has disrupted traditional human resource management models—particularly in the domains of recruitment and selection—bringing not only new opportunities, but also significant challenges for experts in HR, occupational psychology, and technological innovation (Rashma, Jenithakarthiga, Pavithra, 2024).

Historically, both research and practice within work psychology and human resource management have placed considerable emphasis on the development of effective methods for selecting, evaluating, and integrating employees (Ryan & Ployhart, 2014; Markoulli et al., 2017).

Traditional recruitment processes typically followed a linear sequence—from identifying staffing needs through to the conclusion of an employment contract—relying heavily on static applicant databases, which were often outdated and underutilised. In recent years, however, technology has permeated virtually every aspect of this process (Woods et al., 2020), fundamentally reshaping standard practices. Innovations such as automated CV screening, advanced data analytics, and digital assessment tools are increasingly being adopted, even for the most routine recruitment procedures.

A notable development in recent years is the emergence of electronic recruitment, which preserves the structure of the traditional recruitment process while transferring it to an online environment—typically through company websites, job portals, and social media platforms. This digital shift has

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considerably enhanced the efficiency of communication and candidate selection, particularly through algorithm-driven pre-screening based on qualifications. Simultaneously, organisations are increasingly prioritising proactive talent acquisition strategies, such as networking and direct outreach, in place of more passive methods of attracting candidates. Networking, in particular, has become a valuable recruitment tool, centred on the cultivation of professional relationships and the exchange of referrals. This relational approach has been shown to significantly improve the effectiveness of recruitment efforts (Tullier, 2006).

Another major driver of change is the growing integration of artificial intelligence (AI) into recruitment processes, bringing with it predictive analytics and automated decision-making capabilities. Contemporary application processing systems, such as HireVue and Pymetrics, employ video analysis and neuroscientific techniques to evaluate candidates' personality traits and cognitive abilities (Black & Van Esch, 2020). These tools are designed not only to enhance the precision of candidate assessment but also to reduce cognitive biases, thereby promoting greater objectivity in selection outcomes. Applicant Tracking Systems (ATS) further streamline recruitment by automating CV screening, identifying relevant keywords, and aggregating data from publicly available online sources—ultimately saving both time and human resources. In addition, many organisations are adopting AI-powered chatbots to provide real-time feedback to applicants, while simultaneously alleviating HR departments of repetitive administrative tasks (Upadhyay & Khandelwal, 2018).

In addition, novel approaches such as the gamification of selection processes and game-based assessment (GBA) are gaining traction, reshaping conventional testing methods into more interactive and dynamic formats. These tools immerse candidates in simulated environments, allowing for the observation of their responses to realistic workplace scenarios. This not only enhances candidate engagement but also improves the ecological validity of the data collected (Georgiou et al., 2019). Furthermore, gamification contributes to the organisation's appeal, particularly among younger applicants who increasingly expect a technologically advanced and interactive recruitment experience (Georgiou & Nikolaou, 2020).

However, the transformation of employee selection processes also presents a range of new challenges. While technology undoubtedly enhances efficiency, concerns persist regarding the validity and ethical implications of its use. For instance, although psychometric testing is increasingly common, it has been criticised for the potential over-objectification of human abilities (Michell, 2000). Equally significant is the ongoing need for the development and maintenance of applicant databases, which demands substantial investment in data management and cybersecurity (Goleji et al., 2023). In parallel, corporate career pages are assuming a more prominent role in employer branding. Visual content—such as employee testimonial videos and detailed portrayals of the working environment—not only enhances transparency but also helps to build trust among prospective applicants (Lievens & Slaughter, 2016). Moreover, these platforms enable the analytical tracking of job seeker engagement, website traffic, and interactions with content, thereby supporting the continuous optimisation of recruitment strategies.

Despite the growing array of innovative tools, empirical research on the effectiveness of e-recruitment methods remains relatively limited. As such, the selection of recruitment technologies should be guided not only by their technical capabilities, but also by the organisation's strategic objectives and cultural context. A critical factor in the successful implementation of digital tools is their alignment with the broader HR strategy, alongside ongoing evaluation of their impact on the efficiency, fairness, and ethical integrity of the selection process (Koivunen et al., 2022).

Digitisation is fundamentally reshaping the paradigm of human resource management. The future of recruitment & selection will depend on organisations' ability to integrate emerging technologies in a flexible manner, while preserving the human element in decision-making. Sustainable and effective talent acquisition strategies will be shaped by continuous outcome evaluation, procedural transparency, and a willingness to engage in interdisciplinary collaboration across fields such as information technology, data science, and behavioural economics.

2. Methods

A survey was carried out to examine the current use of modern recruitment & selection methods in Slovak organisations. One of the secondary aims of the study was to analyse satisfaction with candidates in relation to the use of innovative approaches within the recruitment and selection (R&S) process. The

research targeted companies operating in the Slovak Republic that qualified as medium-sized or large enterprises (employing 250 or more people), where a higher frequency of R&S activity could reasonably be expected. Data were collected through a questionnaire administered in March 2025. The sample consisted of 153 companies, which were categorised based on the independent variable: whether or not they made use of selected innovative R&S methods. As R&S represent distinct stages within the overall R&S process, the analysis treated them separately. The independent variable was defined as the use or non-use of innovative methods in each respective phase.

The paper presents the results of hypothesis testing conducted using the chi-square test of independence. Two hypotheses were examined:

H1: There is a statistically significant association between the use of innovative recruitment methods and the level of satisfaction with the selected candidates by recruitment.

H2: There is a statistically significant association between the use of innovative selection methods and the level of satisfaction with the selected candidates.

3. Results

One of the objectives of the survey, which focused on the use of innovative recruitment and selection (R&S) methods, was to determine whether companies employing such methods report higher levels of satisfaction with the applicants they ultimately select.

The first phase of the research examined innovative approaches used in the recruitment stage, that is, methods aimed at attracting suitable job candidates. Reaching a sufficient number of applicants who meet the desired criteria represents the initial step in securing high-quality hires. Although a wide range of methods is available for attracting applicants, the study focused on selected modern and innovative approaches. These included: (1) employer branding, (2) social recruiting (engaging candidates via social media platforms), (3) the use of mobile applications for initial contact (e.g., Messenger, WhatsApp), (4) experience-based recruiting, and (5) the use of artificial intelligence to analyse candidate profiles.

The results indicated that, out of the 153 participating organisations, 82 reported using at least one of the innovative methods listed, while 71 had no experience with any of them. The extent to which each of these methods is applied during the recruitment phase is illustrated in Figure 1.

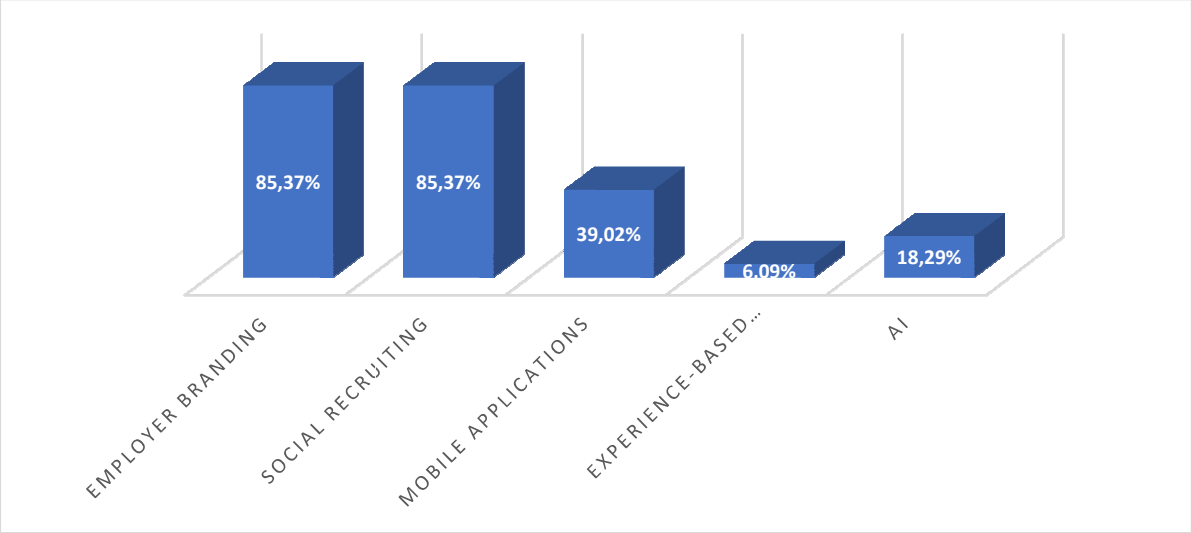

Figure 1. Use of innovative methods for recruiting employees
Source: own processing (2025)

H1: We hypothesise a statistically significant association between the use of innovative recruitment methods and the level of satisfaction with the selected candidates by recruitment.

Out of the total 153 companies participating in the study, 53.59% reported experience with at least one innovative recruitment method, while 46.40% had no experience with these methods. Table 1 presents the levels of satisfaction with the candidates invited to selection procedures over the past 12 months.

Table 1. Comparison of satisfaction with selected candidates according to the use of innovative recruitment methods

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied
Yes	64.6%	24.4%	0.00%	11.0%	0.00%
No	49.3%	18.3%	22.5%	9.90%	0.00%

Source: own processing (2025)

The results of hypothesis H1 testing are shown in Table 2.

Table 2. H1 testing

Test type	χ^2 (chi-square)	df	p-value	Significance
Chi-square test of independence	20.73	3	0.00012	**p < 0.001**

Source: own processing (2025)

Based on the test results, H1 is accepted, confirming that companies employing innovative recruitment methods report higher levels of satisfaction compared to those not using any such methods.

The second part of the study examined innovative employee selection methods designed to evaluate candidates' required attributes. The research focused on Online Assessment Centres, video interviewing, nonverbal analysis, gamification, and AI-driven predictive analysis. Among the 153 companies surveyed, 33.98% utilised one or more of these methods, while 66.02% did not. Figure 2 illustrates the frequency of use for each of the innovative candidate selection methods.

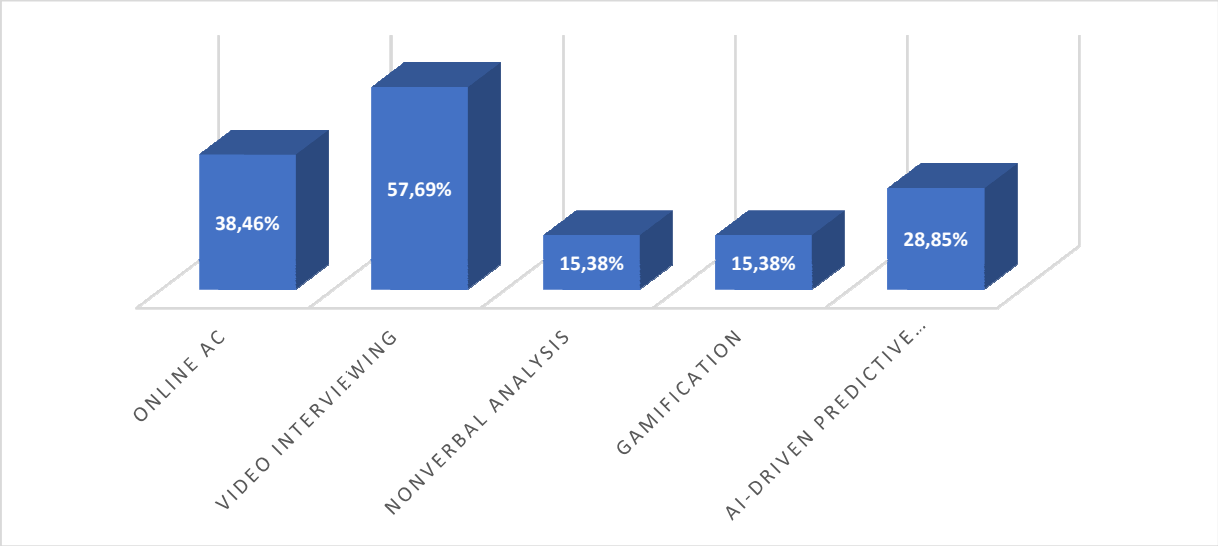

Figure 2. Use of innovative methods for selecting employees
Source: own processing (2025)

H2: We hypothesise a statistically significant association between the use of innovative selection methods and the level of satisfaction with the selected candidates.

Among the 153 companies surveyed, 33.98% reported experience with at least one innovative selection method, while 66.02% had no such experience. Table 3 presents a comparison of company satisfaction with selected candidates over the past 12 months, analysed in relation to the use of innovative staff selection methods.

Table 3. Comparison of company satisfaction with selected candidates by use of innovative staff selection methods

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied
Yes (n=52)	27.5%	5.2%	0.7%	0.7%	0.0%
No (n=101)	47.7%	13.1%	2.0%	2.0%	1.3%

Source: own processing (2025)

The results of hypothesis H2 testing are shown in Table 4.

Table 4. H2 testing

Test type	χ^2 (chi-square)	df	p-value	Significance
Chi-square test of independence	2.01	4	0.733	n.s. (not significant)

Source: own processing (2025)

Based on the statistical analysis, hypothesis H2 is rejected, indicating no significant correlation between the use of innovative employee selection methods and satisfaction with the chosen candidates.

4. Discussion

The findings reveal that employer branding and social recruiting are the most widely adopted methods. Employer branding serves as a contemporary HR marketing tool, employed not only to attract new employees but also as part of a broader strategic effort to consistently cultivate a positive reputation among both current and prospective talent. It represents a defining characteristic of modern organisations that recognise the importance of articulating their approach to human resources. Such efforts can influence not only prospective "freelance" candidates but also existing employees who may be contemplating a change of employer. This positions employer branding as one of the most important innovative methods for attracting talented candidates. Social recruiting is also widely employed, enabling companies to target specific candidate groups through sophisticated marketing techniques. Mobile applications for initial contact have become a standard communication tool, significantly facilitating and accelerating interactions, and their use is expected to increase. The use of artificial intelligence to analyse candidate profiles is still relatively new, which could explain its comparatively low adoption rate. Experience-based recruiting is a highly specialised method, applicable only to certain job roles, and is therefore rarely used within our context.

Video interviews are the most commonly used method, likely due to their ability to replace traditional face-to-face interviews while being conducted online, which also simplifies scheduling. Online Assessment Centres represent another innovative approach, valued for their ease of organisation and their capacity to assess candidates' technical skills. Predictive analysis powered by AI marks a significant advancement in candidate evaluation, as it is not only easier to implement than previous methods but also enhances objectivity and accuracy in selecting the most suitable candidates.

The results show that companies using innovative recruitment methods report higher satisfaction with selected candidates (64.6% very satisfied) compared to those using traditional approaches (49.3%). This difference was statistically significant ($\chi^2 = 20.73$, $p < 0.001$), supporting Hypothesis H1. In contrast, the use of innovative selection methods (e.g., video interviews, online assessment centres, AI tools) did not significantly impact satisfaction levels ($\chi^2 = 2.01$, $p = 0.733$), leading to the rejection of Hypothesis H2.

Conclusion

The findings of this study underscore the value of innovative approaches primarily during the recruitment stage, where a clear positive impact on candidate satisfaction was identified. Techniques such as employer branding and social recruiting emerged as effective strategies for attracting high-quality applicants. In contrast, the role of innovation in the employee selection phase remains inconclusive, possibly reflecting its limited adoption or inconsistent application in practice. These results highlight the importance of carefully aligning digital recruitment tools with an organization's overall strategy and core

values. Moreover, maintaining the human element in selection processes is crucial, as an overreliance on technology risks compromising the personalized evaluation of candidates. Future research should place greater emphasis on the qualitative aspects of employee selection and investigate the long-term effects of modern recruitment methods on employee retention and job performance.

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Work Engagement Among Healthcare Professionals: A Comparative Analysis of Key Influencing Factors

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Abstract

Research background: This paper examines the work engagement of healthcare personnel, a critical determinant of healthcare quality, staff performance, and patient satisfaction. Given the escalating demands and persistent staff turnover, exacerbated by the recent COVID-19 pandemic, understanding the drivers of engagement has become paramount

Purpose of the article: The purpose of this article is to critically analyse theoretical constructs and empirical findings pertaining to healthcare staff engagement. We achieve this through a secondary analysis of three distinct empirical studies presented herein. Our objective is to delineate shared factors that foster engagement and to propose actionable recommendations for healthcare management.

Methods: This paper synthesises established theoretical frameworks with a secondary analysis of three distinct quantitative studies. These comprise: (1) a systematic meta-analysis, (2) a study conducted within Slovenian primary healthcare, and (3) a study focusing on hospital nurses in Thailand. Crucially, all included studies utilised the standardised Utrecht Work Engagement Scale (UWES) and other validated questionnaires for their measurements.

Findings & Value added: Our findings indicate that engagement is primarily shaped by leadership quality, working conditions, team climate, and individual resilience. We also observed a strong negative correlation between engagement and burnout syndrome. Ultimately, fostering engagement through targeted organisational interventions can lead to enhanced staff satisfaction, diminished turnover rates, and a demonstrable improvement in healthcare quality

Keywords: Engagement, Health sector, Healthcare quality

JEL classification: J28, M12

1. Introduction

Whilst numerous authors have sought to define employee engagement, a singularly clear and universally accepted definition remains elusive, largely owing to its relatively nascent conceptualisation. Kahn (1990), widely credited with coining the term, initially characterised engagement as the degree of commitment and involvement exhibited by employees within their employing organisation. A similar understanding is advanced by Robinson et al. (2004), who describe engagement as "the positive attitude of employees toward their organisation and its value." They further elaborate that engaged employees demonstrate an acute awareness of the broader business context and readily collaborate with colleagues to enhance organisational performance. Rashid et al. (2011) contend that achieving a competitive advantage is imperative for any enterprise, positing that employee engagement represents the optimal strategy for securing such an edge. They suggest that fostering engagement can be achieved through various mechanisms, including involving employees in decision-making processes, promoting collegial cooperation, and implementing individual performance appraisals

1.1 Theoretical Basis of the Concept of Engagement

The organisation itself plays a pivotal role, as it must actively cultivate and sustain employee engagement, thereby necessitating a reciprocal relationship between employer and employee. A study

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undertaken by Jung et al. (2021) empirically corroborated the link between employee engagement and the propensity for staff turnover. Their findings indicated that heightened employee engagement positively influences productivity, work efficiency, and, ultimately, the overall success of an organisation.

Indeed, employee engagement serves as a salient positive indicator for a company's ability to achieve its strategic objectives. The prevailing style of employee management is also of considerable import, with Kumar and Israel (2012) asserting its substantial impact on engagement. Furthermore, the provision of benefits, the strengthening of professional roles, the offering of training and development opportunities, and the creation of both professional networks and avenues for leisure pursuits are all intrinsically linked to fostering employee engagement.

While employee engagement is extensively discussed within academic discourse as a mechanism for mitigating staff turnover, a precise, universally accepted definition and a clear demarcation of its core determinants remain somewhat elusive. Chanan (2021) conceptualises employee engagement as a workforce that is both loyal and fully participating, readily embracing organisational principles for motives extending beyond conventional incentives. Furthermore, Ranjan (2014) posits that a continuous, bilateral flow of communication is indispensable for cultivating and sustaining robust employee-employer relationships. He stresses the effective role of internal communication in fostering engagement, adding that any organisation aspiring to expand, retain its clientele, and maintain an engaged and satisfied workforce simply cannot afford to overlook internal communication as a pivotal aspect of effective human resource management.

Employee engagement signifies an emotional commitment an employee feels towards their organisation and its objectives. The endeavour to engage, motivate, and secure employee loyalty has long been a key concern for management across many companies. When staff demonstrate such commitment or loyalty, it yields a range of positive outcomes, as highlighted by Budriene and Diskiene (2020):

- A sense of control over their work environment.
- Confidence in the future stability of the organisation.
- Self-assurance in their capacity to instigate positive change within the organisation.
- An eagerness to learn and experiment.
- A strong inclination to remain with the company, leading to lower staff turnover and higher retention rates.

Many leading consulting firms, including Accenture, Concours, Gallup, Hewitt, Mercer, Towers Perrin, and Watson Wyatt, have undertaken extensive surveys on engagement. Drawing upon these findings, Storey et al. (2008) identified seven common factors that significantly foster employee engagement:

- Vision: A clearly articulated organisational purpose for the future instils a sense of pride among its employees.
- Opportunity: The provision of new work opportunities allows for both personal and professional development.
- Motivation: Offering a diverse range of tangible and intangible benefits acts as a powerful stimulus for engagement.
- Meaning: Emphasising the significance and importance of an individual´s contribution to the work.
- Community: Cultivating a healthy work environment and a positive corporate culture.
- Communication: Ensuring an effective, bidirectional flow of information throughout the organisation.
- Experimentation: Implementing flexible policies regarding working hours, dress codes, and other arrangements, designed to meet the needs of both the organisation and its employees.

Each of these factors offers a suite of options that leaders can leverage to enhance employee engagement. It´s crucial to recognise that individual employees may place varying emphasis on each factor. Furthermore, an employee´s perception of these factors´ importance can evolve throughout their career; for instance, early in their career, incentives or financial reward might hold greater significance than other elements. Collectively, these seven elements can form an employee value proposition, representing the holistic return employees receive in exchange for their commitment to their employer.

1.2 Engagement and its Importance in the Healthcare Sector

Employee engagement is demonstrably crucial for organisational success, particularly within the service sector where workers are directly responsible for fulfilling consumer needs (Bailey 2022).

In healthcare, effective human resource management necessitates considerable supper and commitment from employees who are expected to undertake continuous skills development and training throughout their careers to deliver a high standard of service in patient care environments. Consequently, achieving a high level of engagement stands as a strategic objective for organizations across numerous industries, not least within healhtcare.

Engaged employees exhibit dedication to their employer, express satisfaction with their work, and are prepared to exert discretionary effort to achieve the organization's objectives. Research indicates that engagement profoundly influences other critical human resource outcomes, including staff retention, job performance, absenteeism, and – indirectly, through the enhacement of employer reputation – recruitment efforts (Gibbons and Schutt 2010).

It is clear that managing issues related to healthcare personnel has become considerably more complex since the COVID-19 pandemic. Research examining employee engagement during crises indicates that traditional forms of remuneration, such as bonuses and merit-based reward, are often employed to boost engagement (Olds et al. 2022). However, it is crucial to acknowledge other significant factors that are proving essential for developing and retaining a modern workforce. These include a better work-life balance, opportunities for career growth, and training specifically designed to prepare employees for crisis situations (Gabriel and Auguinis 2021).Therefore, healthcare organizations must implement actions and measures that actively promote employee engagement and recognise the factors influencing and supporting both the mental and physical well-being of their workforce.

Historically, the focus has predominantly been on cultivation "healthier" workplaces. However, contemporary imperatives demand a comprehensive, strategically focused approach to measuring and reporting on the quality of the healthcare work environment. This signifies a crucial paradigm shift toward programmes that champion employee integration within a holistic framework for enhancing the quality of healthcare provision.

Furthermore, there is increasing discourse surrounding the positive correlation between staff satisfaction and patient satisfaction. This is underscored, for instance, by research demonstrating robust links between employee engagement and client (patient) satisfaction. Indeed, a number of studies in the field of healthcare management suggest that managers can demonstrably elevate the standard of patient care by fostering greater staff satisfaction and engagement (Collins et al. 2008; Sikorska-Simmons 2006).

2. Methods

The primary aim of this paper is to analyse and compare current knowledge regarding healthcare staff engagement. We achieve this through an examination of selected empirical studies that specifically investigate its connections to workplace factors, burnout syndrome, and individual personality traits, such as resilience. Our objective is to identify recurring determinants of engagement and to formulate practical recommendations for healthcare management.

Following this theoretical framework, we conducted a secondary analysis of selected empirical studies examining the work engagement of healthcare personnel across diverse contexts. Our selection process was targeted, focusing on quantitive research published in peer-reviewed scientific journals after 2020. These studies had to meet the following criteria:

- The target group comprised heatlhcare workers, with a particular emphasis on nurses.
- Engagement was measured using standardised tools, such as the Utrech Work Engagement Scale (UWES)
- The research design and statistical analysis were clearly articulated.

From the final selection, we chose three representative studies, each originating from a distinct geographical and systemic context; an international meta-analysis by Aguiar-Diaz et al. (2023), national research from Slovenia by Szilvassy & Širok (2022), and a study from Thailand by Nantsupawat et al. (2024). national research from Slovenia by Szilvassy & Širok (2022), and a study from Thailand by Nantsupawat et al. (2024).

3. Results

The first study subjected to our analysis is the meta-analysis by Aguiar-Díaz et al. (2023). This particular study aimed to synthesise existing research exploring the level of work engagement and its association with burnout among nurses. The authors specifically focused on three principal dimensions for each phenomenon: in the case of burnout, these were emotional exhaustion, depersonalisation, and reduced personal accomplishment, whilst work engagement was assessed via vigour, dedication, and absorption.

This particular study drew its evidence from a search of the PubMed and Scopus databased. It incorporated nine quantitative studies that adhered to stringent selection criteria, including the mandatory use of validated measurement tools such as the Maslach Burnout Inventory (MBI) and the Utrecht Work Engagement Scale (UWES).

The finding unequivocally confirm a strong negative correlation between work engagement and burnout. This suggests that as nurses´ work engagement increases, the likelihood of experiencing burnout syndrome significantly decreases. The most pronounces protective effect was observed in the "vigour" dimension of engagement when contrasted with "emotional exhaustion" – components that, perhaps unsurprisingly, are the most prominent characteristics distinguishing engaged from burned-out employees.

The authors also pinpointed several factors acting as mediators in this relationship. At an individual level, these primarily include personal resources like resilience, self-confidence, and effective coping strategies. On an organisational level, support from management, the autonomy to make decisions regarding one's own work, and a favourable work environment emerged as significant. According to the authors, these factors not only have the potential to boost engagement but also serve as crucial preventative measures against burnout.

The work engagement of healthcare personnel within the primary healthcare context was the focus of a study by Szilvassy and Širok (2022). Their research was fundamentally driven by the critical need to better understand the factors influencing employee motivation, retention, and indeed, overall performance in this sector. The study specifically aimed to ascertain the level of work engagement prevalent among staff in public primary healthcare facilities and to meticulously analyse how this engagement correlated with various selected aspects of their work environment.

The authors particularly honed in on the quality of leadership, the standard of internal communication, the efficacy of work organization, and the readily available support from the broader organization. The research itself was conducted using a robust, standardised questionnaire, which crucially incorporated the Utrecht Work Engagement Scale (UWES) to measure the three key dimensions of engagement (vigour, dedication, and absorption), alongside further questions meticulously designed to map the perceived quality of the work environment.

Data was collected within a representative sample of employees working in the Slovenian public health system. The findings corroborated that engagement is significantly shaped by the calibre of the organisational environment. The salient determinants of heightened engagemet were identified as a congenial work atmosphere, unambiguously defined work tasks, readily available managerial support, and transparent, reciprocal communication. Conversely, substandard management and deficient work organisation were demonstrably linked to a decrement in engagement and diminished satisfaction with servies.

The topic of the nexus between engagement and the mental well-being of healthcare personnel is further elucidated in a study by Nantsupawat et al. (2024), published in BMC Nursing. The topic of the nexus between engagement and the mental well-being of healthcare personnel is further elucidated in a study by Nantsupawat et al. (2024), published in BMC Nursing. This research, conducted on a sample of Thai hospital nurses, primarily aimed to explore the interrelationships between resilience, burnout syndrome, and work engagement.

A particular emphasis was placed on identifying factors that might serve as protective mechanisms within a demanding work environment. To collet the requisite data, three standardised questionnaires were employed: the Connor-Davidson Resilience Scale (CD-RISC-10) for the measurement of psychological resilience; the Maslach Burnout Inventory (MBI) for the assessment of burnout across its three dimensions; and the Utrecht Work Engagement Scale (UWES-9) for the measurement of work engagement. Data analysis revealed a significant negative correlation between resilience and burnout, alongside a positive correlation with engagement. This indicates that nurses exhibiting higher levels of

psychological resilience were less susceptible to emotional exhaustion and, concomitantly, demonstrated greater activity, commitment, and absorption in their work. Furthermore, a negative relationship between engagement and burnout was substantiated, a finding consistent with the broader body of existing literature.

4. Discussion

An analysis of selected studies confirms that the work engagement of healthcare personnel is complexly conditioned by both personal and organisational factors. While individual characteristics such as mental resilience, coping strategies, and self-confidence play a protective role, organisational conditions—especially the quality of leadership, communication, and the work environment—are also of decisive importance.

Based on this analysis, it can be posited that engagement can be systematically fostered through targeted interventions. These notably include the establishment of a supportive work culture, the active promotion of participation, the recognition of performance, the provision of opportunities for growth, and access to professional supervision.

These findings correspond with theoretical models that define engagement as the interplay between an employee's personal commitment and the support system an organisation provides. Simultaneously, it confirms that high engagement is not only desirable for employees themselves but also constitutes a strategic factor influencing the quality and effectiveness of healthcare.

Conclusion

Based on theoretical knowledge and an analysis of selected empirical studies, it can be concluded that the work engagement of healthcare personnel represents a multidimensional phenomenom. This phenomenon arises from the intricate interplay of individual predispositions and the characteristics of the work environment. The presented studies consistently confirm that engagement is significantly influenced by the quality of leadership, opportunities for participation in decision-making, perceived support, and personnel resilience to stress. The highlights the imperative for management within healthcare organisations to adopt a strategic approach to engagement. Such an approach necessitates the implementation of programmes designed to foster resilience, enhance communication, bolster teamwork, and adequately recognise the contributions of employees. These interventions hold considerable potential for significantly reducing burnout and concurrently increasing motivation and satisfaction among healthcare staff. Given the paramount importance of workforce sustainability in healthcare, it is therefore essential not only to quantify levels of engagement but also to actively address its determinants as an integral component of modern human resource management.

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Neuroscience in Leadership: An Integrative Framework for Optimizing Human Capital Performance

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Abstract

Research background: Contemporary organizational science increasingly recognizes the interconnectedness between relational leadership experiences and neurobiological performance optimization, representing a paradigm shift from traditional management models emphasizing individual competency or structural influences.
Purpose of the article: This study proposes an integrated framework for understanding optimal human capital performance by synthesizing findings from organizational psychology, neuroscience, and management theory domains examining manager-employee relationship dynamics, executive presence impacts, and adaptive organizational theory applications.
Methods: A systematic integrative analysis approach was employed to examine convergent themes across three complementary research domains through thematic convergence analysis, theoretical framework mapping, empirical evidence synthesis, and practical application integration following established protocols for business research integration.
Findings & Value added: Analysis reveals four major convergent themes: relationship quality emerges as the primary determinant of performance outcomes across innovation, engagement, and strategic execution domains; neurobiological mechanisms demonstrate consistency through amygdala-medial prefrontal cortex networks sensitive to leadership quality; state-dependent performance occurs through optimal "performance states" created by leadership interactions; and environmental design supports performance through organizational incubation concepts. The integrated framework demonstrates that emotional intelligence, secure organizational attachment, and adaptive environmental responsiveness operate through interconnected neurobiological, behavioral, and cultural mechanisms, with performance optimization occurring within relationship-based organizational environments where relational quality serves as a primary determinant of innovation, engagement, and strategic outcomes.

Keywords: Relationship-based leadership, Executive presence, Adaptive organizational theory, Human capital optimization, Neurobiological management, Organizational attachment

JEL classification: A10, J24

1. Introduction

Contemporary organizational science increasingly recognizes the profound interconnectedness between relational leadership experiences and neurobiological performance optimization (Siegel, 2020). This recognition represents a significant paradigm shift from earlier management models that emphasized either individual competency development or structural organizational influence as primary drivers of business performance. Recent research convergence across organizational psychology, neuroscience, and management theory suggests that human capital optimization operates through complex, dynamic systems where relationship quality fundamentally shapes biological and psychological performance outcomes (Davidson & McEwen, 2012). This understanding challenges traditional dichotomous thinking about

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technical versus soft skills, instead proposing sophisticated models of leader-employee interaction that acknowledge the biological embedding of relational management experiences.

The present synthesis integrates three distinct but complementary research domains to propose a comprehensive understanding of optimal organizational performance. The first domain examines relationship-based management in professional settings, specifically exploring how manager-employee relationships influence innovation, engagement, and strategic execution (Dabur, 2025). This research tradition, rooted in organizational attachment theory and leadership psychology, provides empirical evidence for the transformative power of high-quality relational experiences in business contexts. The second domain investigates executive presence impacts on organizational performance through the lens of adaptive organizational theory, examining neurobiological mechanisms underlying leader-team interactions (Kefah & Fuchs, 2025). This research integrates contemporary neuroscience findings with organizational psychology to understand how executive presence creates specific biological conditions that either optimize or inhibit performance outcomes. The third domain presents a comprehensive theoretical framework for understanding organizational development as occurring within "adaptive reality" contexts that emphasize flexibility, connection, and conscious leadership practices (Fuchs, 2025).

The theoretical integration proposed herein addresses a critical gap in contemporary management science by providing a unifying framework that bridges individual performance optimization with broader organizational effectiveness. Current management theories often remain compartmentalized within disciplinary boundaries, limiting their practical application and strategic coherence (Bronfenbrenner, 1977). This synthesis offers a more comprehensive perspective that acknowledges the multidimensional nature of human capital performance while maintaining scientific rigor and business relevance.

2. Methods

This synthesis employed a systematic integrative analysis approach designed to examine convergent themes, complementary findings, and theoretical integration opportunities across three primary research domains. The methodological framework followed established protocols for business research integration while adapting to the specific challenges of bridging diverse disciplinary perspectives and research methodologies (Torraco, 2005).

The data integration process began with thematic convergence analysis, involving systematic identification of overlapping themes and concepts across the three studies. This analysis required careful attention to empirical findings that support similar conclusions through different methodological approaches, ensuring that apparent convergences reflect genuine theoretical and empirical alignment rather than superficial similarities. The thematic analysis examined both explicit convergences, where studies directly address similar phenomena, and implicit convergences, where different studies provide complementary perspectives on related performance processes (Braun & Clarke, 2006).

Theoretical framework mapping constituted the second major methodological component, examining how different theoretical perspectives complement and extend each other while identifying areas of convergence and potential integration. This analysis required careful examination of underlying assumptions, explanatory mechanisms, and scope conditions for different theoretical approaches. The mapping process identified points of theoretical tension or contradiction alongside areas of convergence, ensuring that the integration acknowledges complexity and nuance rather than artificially forcing theoretical coherence (Jabareen, 2009).

Empirical evidence synthesis involved integration of research findings across studies to identify robust patterns and relationships that emerge consistently across different organizational contexts. This synthesis required careful attention to methodological differences across studies while identifying findings that demonstrate consistency despite varying research approaches (Whittemore & Knafl, 2005). The empirical synthesis examined both direct replications, where similar findings emerge from similar methodologies, and conceptual replications, where similar conclusions emerge from different methodological approaches.

Practical application integration analyzed how findings from different studies can be combined to inform more comprehensive approaches to organizational performance optimization and leadership intervention. This analysis examined both individual study implications and emergent implications that arise from theoretical integration. The practical integration considered implementation challenges and opportunities while maintaining grounding in empirical evidence and theoretical coherence (Gough et al., 2012).

3. Results

3.1 Convergent Theoretical Foundations

The synthesis reveals three converging theoretical perspectives that collectively illuminate organizational performance processes in ways that individual approaches cannot achieve independently. These convergent foundations represent a sophisticated integration of established leadership theories with contemporary scientific understanding of neurobiological and behavioral mechanisms (Champagne & Curley, 2009).

Attachment-based leadership theory provides the foundational substrate for understanding how relational management experiences create templates for lifelong performance patterns. Bowlby's (2008) seminal work on attachment security, when applied to organizational contexts, establishes theoretical groundwork for comprehending how secure professional relationships create optimal conditions for performance. This theoretical foundation extends beyond simple emotional support to encompass cognitive performance, strategic competence, and organizational resilience. Contemporary organizational attachment research demonstrates that secure manager-employee relationships facilitate optimal brain function through multiple mechanisms, including stress regulation, neuroplasticity enhancement, and the establishment of healthy neurobiological performance patterns (Ainsworth, 1989). The attachment framework proves particularly valuable in understanding how professional relational experiences become biologically embedded through epigenetic mechanisms and neural pathway optimization.

3.2 Core Convergent Themes

The analysis reveals four major convergent themes that emerge consistently across the three research domains, providing robust empirical and theoretical support for an integrated understanding of organizational performance as fundamentally relational and neurobiologically embedded.

Relationship quality emerges as the primary determinant of performance outcomes across all three studies, with evidence spanning innovation, engagement, and strategic execution domains. The manager-employee relationship research demonstrates how emotional intelligence and supportive leadership significantly influence team performance, resilience, and competitive success through multiple pathways (Dabur, 2025). Leaders who provide consistent emotional validation create organizational environments where employees feel secure enough to take strategic risks, explore innovative possibilities, and develop authentic professional expression. The research reveals that this leadership support operates not simply through encouragement but through sophisticated processes of attunement, responsiveness, and co-regulation that help employees develop internal capacities for emotional regulation and strategic engagement (Hamre & Pianta, 2001).

Neurobiological mechanisms underlying leadership effects demonstrate remarkable consistency across research domains. The amygdala-medial prefrontal cortex network emerges as particularly sensitive to leadership quality, with direct implications for emotional regulation, strategic cognition, and performance function (Callaghan & Tottenham, 2016). Positive leadership experiences enhance the development of this crucial neural network while adverse experiences can disrupt its optimal functioning. The research reveals that leadership quality influences neural performance through multiple pathways, including stress hormone regulation, neurotransmitter balance, and synaptic plasticity enhancement.

State-dependent performance mechanisms reveal how performance outcomes depend on the creation of optimal "performance states" through leadership interactions. These states involve sophisticated integration of neurobiological, psychological, and organizational factors that create conditions either conducive to or inhibitive of optimal performance (Kefah & Fuchs, 2025). Parasympathetic activation emerges as a crucial component, as quality leadership promotes nervous system states that support learning, innovation, and adaptation (Porges, 2011). This activation facilitates enhanced neuroplasticity, enabling the brain to adapt and perform more effectively in response to business challenges and strategic opportunities.

Environmental design for performance emerges as a crucial theme across all studies, with emphasis on creating organizational environments that support optimal performance states. The "organizational incubation" concept provides a sophisticated framework for understanding how physical and relational environments can be designed to support continued performance optimization (Fuchs, 2025). This concept suggests that optimal environments maintain the nurturing, protective qualities of focused development while gradually introducing appropriate challenges that promote growth and strategic adaptation.

3.3 Integrated Performance Optimization Model

The synthesis suggests a comprehensive integrated model where optimal performance occurs through dynamic interaction of multiple interconnected organizational systems operating across different levels of analysis. This model transcends traditional approaches that focus on individual factors or simple cause-effect relationships, instead proposing a sophisticated understanding of performance as emerging from complex organizational system dynamics (Capra & Luisi, 2014).

At the individual level, the model encompasses neurobiological optimization, emotional regulation capacity, and cognitive function as interconnected aspects of personal performance. Neurobiological optimization includes brain architecture enhancement, neural network optimization, and physiological regulation system maturation (Shonkoff et al., 2009). The relational level incorporates leadership attachment security, emotional intelligence quality, and responsive management as fundamental components of performance context. Leadership attachment security provides the foundational trust and psychological safety necessary for innovation and strategic risk-taking (Bowlby, 2008).

4. Discussion

4.1 Theoretical Implications

The synthesis reveals several significant theoretical implications that advance understanding of organizational performance while challenging existing paradigms and assumptions within management science.

The integration transcends traditional individual-organizational dichotomies by demonstrating how leadership experiences directly influence genetic expression and neurobiological performance through sophisticated epigenetic mechanisms (Moore, 2015). This finding supports more nuanced models of leader-employee interaction that acknowledge the dynamic, bidirectional influences between biological and environmental factors. Rather than viewing individual capabilities as fixed determinants of performance outcomes, the research supports understanding individual factors as providing potentials that are activated or suppressed through leadership experiences.

The research collectively supports understanding performance as fundamentally co-regulatory, occurring through dynamic interactions between performing individuals and their leadership environments rather than through autonomous individual processes (Tronick, 2007). This co-regulatory perspective challenges traditional performance models that emphasize individual achievement and self-sufficiency as primary business goals. Instead, the research suggests that optimal performance involves learning to engage effectively in co-regulatory relationships that support mutual growth and strategic adaptation.

While supporting the importance of leadership experiences in establishing performance foundations, the findings suggest greater neuroplasticity throughout careers than traditionally assumed, with significant implications for intervention and support across organizational levels (Doidge, 2007). The research demonstrates that while early career experiences create important performance trajectories, these trajectories can be modified through subsequent high-quality leadership experiences.

4.2 Practical Applications

The integrated framework generates numerous practical applications across leadership development, organizational design, and strategic management domains that address current challenges in supporting optimal human capital performance.

Leadership development implications emphasize prioritizing relationship quality in leadership training as a fundamental prerequisite for effective performance management and strategic execution. This prioritization requires moving beyond traditional technical focus to recognize relationship development as a core leadership competency (Ferreira et al., 2021). Training leaders in attachment-informed practices becomes essential for creating organizational environments that support optimal performance states.

Organizational design applications emphasize utilizing attachment-informed organizational structures that recognize the relational foundations of performance optimization and strategic growth. Such approaches prioritize creating organizational relationships that provide corrective relational experiences while addressing specific performance challenges or strategic objectives. Creating organizational environments that promote optimal performance states involves attention to both physical

organizational spaces and relational organizational processes that support innovation and growth (van der Kolk, 2014).

Strategic management considerations emphasize supporting leader-employee relationships through organizational strategy as a fundamental investment in competitive advantage and sustainable performance. Such support includes leadership development policies, team quality standards, and organizational support services that enable leaders to provide high-quality relational experiences (Shonkoff & Phillips, 2000).

4.3 Limitations and Future Research

This synthesis, while comprehensive in its integration of available research, relies primarily on three related studies and would benefit from broader empirical validation across diverse industries and organizational contexts. The research base, while theoretically sophisticated and empirically grounded, represents a limited sample of the broader organizational research literature. Future research should expand the empirical foundation through systematic replication and extension studies that examine the proposed integrated framework across different industries, organizational sizes, and cultural contexts (Henrich et al., 2010).

Conducting longitudinal studies tracking performance outcomes across extended timeframes emerges as a crucial research priority for validating the proposed integrated framework. Such studies would examine how early leadership experiences influence performance trajectories across career development, leadership advancement, and organizational contribution. Longitudinal research would also investigate the persistence and modifiability of performance patterns established through early leadership experiences (Rutter & Maughan, 2002).

Conclusion

This comprehensive synthesis demonstrates remarkable convergence across diverse research domains, providing robust empirical and theoretical support for an integrated understanding of organizational performance as fundamentally relational and neurobiologically embedded. The evidence consistently indicates that optimal performance occurs when employees experience consistent, responsive leadership within environments designed to support growth and strategic contribution across multiple performance domains (Shonkoff & Garner, 2012).

The adaptive organizational theory framework provides a sophisticated unifying conceptual structure for understanding how leadership relationships create the conditions for optimal performance through neurobiological, psychological, and organizational mechanisms that operate in complex, dynamic interaction (Fuchs, 2025). This theoretical integration transcends traditional disciplinary boundaries while maintaining scientific rigor and business relevance.

The integration has significant implications for leadership development practice, suggesting fundamental shifts toward relationship-based approaches that prioritize psychological safety and co-regulatory capacity development alongside strategic achievement. Organizational design implications emphasize the importance of relationship-based optimization approaches that address both individual performance processes and relational capacity building.

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Intercultural Communicative Competence Development in the Context of Managerial Foreign Language Education

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Abstract

Research background: International contacts in business require specific skills among which intercultural communicative competence is of high importance. At present, cultural clashes can be seen in every aspect of social life. As tertiary education of future managers has to react to the current issues in society, intercultural communicative competence (ICC) development is also included in the process. ICC is frequently developed within foreign language courses. Longitudinal needs analysis among the students of the Faculty of Management and Business (FMB), University of Prešov, proved that the students do not fully understand the importance of intercultural training for the future.
Purpose of the article: The purpose of the article is to describe the importance of ICC for managerial education and describe the theories of Byram (1997) and Fantini (2000) as applied in the courses of English for Specific Purposes taught at the FMB.
Methods: A literature review was used to select two dominant theories of ICC development. Byram´s (1997) and Fantini´s (2000) models were described and applied in the qualitative analysis of the Learning Outcomes entry in the Course Description of Professional English Language for Master´s Degree to illustrate the reality of foreign language teaching of future managers enrolled in English for Specific Purposes (ESP) courses at the Faculty of Management and Business.
Findings & Value added: The results of the literature analysis and its application in the reality of teaching the courses of ESP at the Faculty of Management and Business showed that ICC teaching of future managers is dominantly focused on the target language proficiency aspect. It has further educational implications.

Keywords: Intercultural communicative competence, Culture, Managerial education, English for Specific Purposes, Managerial skills

JEL classification: M14, M53

1. Introduction

Intercultural communicative competence (ICC) is undeniably the ultimate goal of English language learning. As Byram (1997) claims language does not inherently contain cultural aspects, that is why a native speaker ideal should be replaced by an intercultural speaker. This belief is also reflected in the Common European Framework of Reference for Languages (Council of Europe, 2020). The CEFR is based on a sociocultural approach to foreign language learning and teaching and emphasizes the importance of intercultural competence as one of the key objectives of foreign language education (Martin, Nakayama & Carbaugh, 2012, p. 22). The current edition of CEFR „seeks to protect linguistic and cultural diversity, promote plurilingual and intercultural education, reinforce the right to quality education for all, and enhance intercultural dialogue, social inclusion and democracy (Council of Europe, 2025).

Martin and Nakayama (2022, p. 111-112) describe the relationship between communication and culture as „complex“ as „culture influences communication and is enacted and reinforced through communication". It is also the context that is important in communication:

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„It is the physical (or virtual) and social setting in which communication occurs or the larger political, social, and historical environment. Power is pervasive and plays an enormous, although sometimes hidden, role in intercultural interactions."

That is why intercultural communication mastery is also part of the business world. It is necessary for the students of economics and management to be trained in intercultural encounters.

ICC is developed also within the language courses as foreign language proficiency is an integral part of it (Fantini, 2000). Wiseman (2002, p. 208) defines ICC as involving „the knowledge, motivation, and skills to interact effectively and appropriately with members of different cultures." It is not only about being able to communicate but also about being appropriate in the context of intercultural situations. That is why it is not enough to know the vocabulary and the grammar rules of any foreign language, it is also necessary to understand what is polite, what are the taboo topics, and other aspects connected with culture. In business relations, it is also necessary to be able to negotiate effectively and appropriately and ICC can help it.

Tertiary education of future managers has to react to the current trends in business. ICC development is part of the training process. Longitudinal needs analysis among the students of the Faculty of Management and Business (FMB), University of Prešov, proved that the students do not fully understand the importance of intercultural training for future. The purpose of the article is to describe the importance of ICC for managerial education and describe the theories of Byram (1997) and Fantini (2000) as applied in the courses of English for Specific Purposes taught at the FMB.

2. Methods

Literature review and analysis of two dominant theories and approaches to ICC are applied in the context of foreign language teaching of future managers enrolled in English for Specific Purposes (ESP) courses at the Faculty of Management and Business as reflected in Course Descriptions to describe the reality of teaching and to highlight the possible problematic areas. As Randolph (2009) states, the literature review is useful in synthesizing different perspectives across disciplines to clarify conceptual frameworks. This method is particularly appropriate for interdisciplinary and methodologically heterogeneous research areas, such as intercultural communication. The selected literature was analysed using thematic coding to identify the most frequently cited and analyzed sources. Two primary sources of available text for literature review were selected as widely used for social networking and available to a wide scholarly audience: Academia and ResearchGate. The review was focused on the depth of analysis over exhaustive breadth.

Peng et al. (2020, p. 58) claim, based on their systematic literature review of intercultural competence research, that the most cited authors in the field are Michael Byram, Darla Deardorff, Claire Kramsch, Mitchell Hammer and Milton Bennett. The literature review of ICC models used in the context of English Language Teaching (ELT) and its assessment undertaken for this study showed that among the most cited are Michael Byram and Alvino E. Fantini.

A qualitative content analysis was then employed to examine the learning outcomes of a foreign language course through the theoretical lenses of intercultural communicative competence. The analysis was informed by two models selected by the literature review. The course description and learning outcomes were systematically coded and interpreted against the criteria established by both models. This dual-theoretical approach enabled a comprehensive evaluation of how the curriculum addresses ICC development in professional and educational contexts.

3. Results and Implications

Two dominant ICC theories were selected by a literature review to illustrate and give background to foreign language teaching at the Faculty of Management and Business. Byram (1997) and Fantini (2000) represent ICC researchers and practitioners who created models aimed at ICC development also within language courses.

3.1 Intercultural Communicative Competence: Byram´s and Fantini´s models

There still has not been agreement on the definition of ICC (Fantini, 2019; Jiang et al., 2022). It can be connected with the conceptualization differences, different academic backgrounds of researchers, or the context of its application. As Wiseman (2002, p. 211) says, ICC is not an innate or accidentally

occurring characteristic but rather a set of conditions that lead to being an interculturally effective communicator. As Byram (1997, p. 7) claims:

> „The concept 'communicative competence' was developed in the anglophone world by Hymes' critique of Chomsky and in the germanophone literature by Habermas. Hymes argued that linguists wishing to understand first language acquisition, need to pay attention to the way in which not only grammatical competence but also the ability to use language appropriately is acquired."

This approach put focus on sociolinguistic competence which led to communicative language teaching (Byram, 1997, p. 8). In the next decades, as Byram (1997) writes, there was a move from a sociolinguistic towards sociocultural competence which also resulted in the CEFR of 1996. Byram (1997, p. 11) points out that despite sociocultural focus, the learners of foreign languages tended to be viewed as „an incomplete native speaker." At present, the updated version of CEFR (2020) is even more focused on linguistic and cultural diversity and intercultural education.

Byram´s (1997, p. 57) model of ICC includes linguistic, sociolinguistic, discourse and intercultural components and involves factors, such as knowledge, skills, attitudes and critical cultural awareness. In a more detailed way, the teaching of foreign languages should focus on the following five factors:

- „knowledge of self and other; of interaction: individual and societal (savoir être)".
- „skills": „interpret and relate (savoir comprendre)"
- „education": „political education critical cultural awareness (savoir s'engager)";
- „skills": „discover and/or interact (savoir apprendre/faire)";
- „attitudes": „relativising self", „valuing other (savoir être)".

ICC components can be understood as „objectives," (Byram, 1997, p. 50-57). Attitudes are aimed at willingness and readiness to seek out, experience, and engage in intercultural settings, while being curious, open and ready to „suspend disbelief about other cultures and belief about one´s own" (Byram, 1997, p. 50). Knowledge aims at being aware of „the general processes of societal and individual interaction" (Byram, 1997, p. 51) and involves learning about one´s own and the other´s countries, their relationships, products and practices. Skills aim at the abilities of interpreting and relating and of discovery and interaction (Byram, 1997, p. 52-53). Education is aimed at critical cultural awareness and identification, evaluation, mediation, and acceptance where necessary based on one´s knowledge, skills and attitudes (Byram, 1997, p. 53).

Byram (1997, p. 70) points out that the model of ICC is designed for educational context and aims at intercultural speaker. He also distinguishes between intercultural competence (IC) and ICC (Byram, 1997, p. 70-71):

> In the first case, individuals have the ability to interact in their own language with people from another country and culture, drawing upon their knowledge about intercultural communication, their attitudes of interest in otherness and their skills in interpreting, relating and discovering, i.e. of overcoming cultural difference and enjoying intercultural contact." ... „On the other hand, someone with Intercultural Communicative Competence is able to interact with people from another country and culture in a foreign language." ... „Their knowledge of another culture is linked to their language competence through their ability to use language appropriately sociolinguistic and discourse competence and their awareness of the specific meanings, values and connotations of the language."

The main difference then lies in the foreign language mastery and proficiency. It supports the idea of ICC development being connected with foreign language teaching and learning.

Fantini (2000, p. 27) believes that ICC development involves language as well as intercultural areas. He points out that most of the ICC researchers leave out the language competence development while language teachers do not include intercultural abilities development in their teaching approach, „despite wide acknowledgement that language and culture are dimensions of each other, interrelated and inseparable" (Fantini, 2000, p. 27). Fantini (2000, p. 27) believes that language not only reflects but also affects people´s worldviews based on which people perceive and interpret their view of the world.

Fantini (2000, p. 28) points out that ICC manifests itself via behavioural traits or attributes, such as „respect, empathy, flexibility, patience, interest, curiosity, openness, motivation, a sense of humor, tolerance for ambiguity, and a willingness to suspend judgment, among others." Fantini (2000, p. 28) identifies five dimensions of ICC:

- awareness,
- attitudes,
- skills,
- knowledge,
- host tongue proficiency.

Fantini (2000, p. 29) considers awareness different from the rest. It is the basis of effective and appropriate interaction. Attitude is connected with affect, knowledge with cognition and skills with behaviour. Fantini (2000, p. 29-30) stresses that the process of ICC development is not finite but rather a continuous and lifelong activity, which is also highly individual as people can progress differently. It is also interconnected with foreign language proficiency development, as without mastering a host tongue, it excludes an intercultural communicator from an important insight into differences in conceptualizations in foreign languages.

Fantini (2000, p. 30) describes the World Learning program context, in which the four levels of development of ICC level are identified as follows:

- „Level I: Educational Traveler — e.g., participants in short term exchange programs/4-6 weeks.
- Level II: Sojourner — longer cultural immersion, e.g., interns and participants in college semester abroad programs and intercultural internships of long duration, 4-8 months.
- Level III: Professional — staff who work in an intercultural or multicultural context; e.g., School for International Training and World Learning employees, alumni, project staff, EIL national directors.
- Level IV: Intercultural/Multicultural Specialist — individuals involved in training, educating, consulting, and advising international students, overseas directors, and cross-cultural trainers."

Later in his research, Fantini (2019, p. 35) reconceptualized ICC based also on an extensive literature review from the multinational and longitudinal point of view:

> „Whereas ICC is the superordinate term, it has multiple subcomponents. For this reason, the literary search also sought to identify precisely the components and aspects that comprise it. The following components emerged consistently from the survey: (1) various characteristics or attributes, (2) three areas or domains, (3) four dimensions, (4) host language proficiency, and (5) degrees of attainment that evolve through a longitudinal and developmental process."

Concerning characteristics, Fantini (2019, p. 35) distinguishes them from personal traits as being related to social and cultural contexts. The three domains are: „the ability to establish and maintain relationships, the ability to communicate with minimal loss or distortion, and the ability to collaborate in order to accomplish something of mutual interest or need" (Fantini, 2019, p. 36). The four dimensions were previously mentioned: attitudes/affect, skills, knowledge, and awareness. The target language proficiency clearly makes intercultural communication easier. The last component is aimed at the fact that ICC attainment is a continuous process and progress which can be measured, for instance, by the four levels of development mentioned previously (Fantini, 2019, p. 37-38).

3.2 ICC Development within ESP Courses

At present, much attention is paid to ICC development within ELT (Abid & Moalla, 2019; Szkudlarek et al., 2020; Morady Moghaddam & Tirnaz, 2022; Pondelíková, 2022; Liao & Li, 2023; Baker, 2024; D'Orazzi & Marangell 2025). Fantini (2019, p. 39) states that at present, the approaches to foreign language teaching are increasingly communicative and competency-based. English language teaching focuses on cultural aspects and the development of intercultural communicative competence is a significant part of language proficiency (Byram & Wagner, 2018; Harper, 2020; Jiang et al., 2022; Cuartas Álvarez, 2020). However, Jiang et al. (2022) claim that effective communication „requires Intercultural Communicative Competence (ICC), but it is often called a hidden curriculum in ELT because its significance is still not acknowledged." Fantini (2019, p. 40) also argues that languages are still taught without a communicative approach and relevant cultural context and there can be huge differences among institutions or countries. There is a need for redefinition of a foreign language teacher´s role as foreign language proficiency needs time and continuous effort (Fantini, 2019, p. 42).

Byram (1997, p. 43) writes that „much acquisition of Intercultural Communicative Competence is tutored and takes place within an educational setting.“ Byram (1997, p. 71) also points out that the location where ICC is developed is important. He identified three location categories with different teacher´s and learner´s roles and relationships: „classroom, fieldwork and independent learning“ (Byram, 1997, p. 71).

Byram (1997, p. 79-80) argues that planning an ICC development curriculum follows six stages:

- the geo-political context: situational factors;
- the learning context: learning locations;
- the developmental factor: cognitive and affective learner´s development;
- the identification of objectives;
- the ICC threshold: goal of ICC;
- sequence in the curriculum: objectives´ ordering.

In comparison, Fantini (2019, p. 40-44) describes the curriculum design as The Process Approach Framework with seven stages of lesson units development: “from presentation of new material to practice, grammar exploration, transposition or use, sociolinguistic exploration, culture exploration, and, finally, intercultural exploration.” Fantini (2019, p. 42) also claims that although ICC development can occur without the host language knowledge, but it is not of the same quality as it lacks direct experience. When a learner masters the host language, he or she can enter a new world with its own culture. The interaction and participation have a significantly different depth.

3.2.1 ICC Development at the Faculty of Management and Business

At the Faculty of Management and Business, foreign language courses are provided by the Department of Intercultural Communication which is responsible for the curricula design in line with the accredited study programmes´ context. English language courses are designed as ESP courses aimed at the development of foreign language communication skills part of which is intercultural communicative competence. There are differences among the study programmes, but at least two ESP courses are compulsory at the bachelor´s and one at the master´s levels of study. All courses at the University of Prešov are described in the Course Descriptions, which also include Learning Outcomes entry. These are to be found online at the university information system MAIS (Prešovská univerzita v Prešove, 2025a).

This section presents a qualitative analysis of course learning outcomes as described in the Course Description of Professional English Language for Master´s Degree. This course was selected as compulsory and attended by the students who had already been enrolled in bachelor´s degree intercultural management courses. The learning outcomes are aimed at equipping students with B2-level language proficiency in accordance with the CEFR (Council of Europe, 2020). The analysis draws on two models of ICC development, which were selected by the literature review: Byram's (1997) and Fantini´s (2000) models.

Attitudes such as openness, curiosity, and a willingness to engage with cultural otherness are partially addressed in the course. The stated competence to “work responsibly in a team on the assigned task of developing the learner's language skills and communicating with team members regardless of cultural diversity” (Prešovská univerzita v Prešove, 2025b) suggests a foundational orientation toward intercultural sensitivity. In terms of knowledge, the course emphasizes the acquisition of domain-specific vocabulary and procedures within the field of management through the target language. The ability to “search for, process and analyze professional information from foreign language sources” (Prešovská univerzita v Prešove, 2025b) opens pathways to cultural exposure, yet the outcomes lack an explicit reference to the cultural contexts of professional communication practices. As such, there is limited indication that learners will develop substantive cultural knowledge about the target language community, which is essential for nuanced and contextually appropriate communication.

The skills component is addressed more directly. The ability to “negotiate and argue in a foreign language” and “work in diverse teams” (Prešovská univerzita v Prešove, 2025b) implies some development of interactive competence. Furthermore, the inclusion of self-regulated learning and reflective practices – “critically evaluate their progress in the study of the relevant foreign language” Prešovská univerzita v Prešove, 2025b) – supports the development of meta-cognitive awareness, a key enabler of ICC. However, the outcomes do not explicitly reference the skills of interpreting cultural meaning or mediating across cultural boundaries, which are central to intercultural communicative acts. Critical cultural awareness, the most evaluative and reflexive component of ICC, is the least developed. While the course encourages

learners to monitor their linguistic progress and explore self-directed strategies for improvement, there is no explicit focus on evaluating cultural perspectives or questioning ethnocentric assumptions. This represents a missed opportunity to incorporate critical pedagogy that would prepare learners not only to use a language proficiently but also to engage with the sociocultural values and discourses embedded within it. Finally, from a linguistic and pragmatic competence perspective, the learning outcomes are relatively robust. Learners are expected to achieve functional proficiency across speaking, reading, writing, and grammar, aligned with CEFR B2 standards. However, there is minimal reference to the pragmatic variation that often characterizes intercultural communication, such as differing norms of politeness, hierarchy, and directness in professional discourse, which can lead to misunderstandings if not explicitly addressed.

Table 1 provides a summary evaluation of the extent to which the analyzed course learning outcomes address key components of intercultural communicative competence (ICC), based on Byram's (1997) framework. Each component is assessed for its presence and depth within the course description.

Table 1. Learning Outcomes Analysis in the Context of ICC Development – Byram´s Model (1997)

ICC Factors (Byram, 1997)	Course Description/ Learning Outcomes	Comments
Attitudes	Moderate	Emphasizes teamwork across cultures, but lacks focus on empathy/perspective.
Knowledge	Basic	Focus on language and content, but not on cultural knowledge explicitly.
Skills	Moderate	Encourages argumentation and teamwork, but lacks explicit cultural skills.
Education/Critical Cultural Awareness	Weak	Reflection is linguistic, not cultural.
Skills/Linguistic/Pragmatic Use	Strong (linguistic), Moderate (pragmatic)	Strong in language skills, pragmatic cultural variation not covered.

Source: Own processing

To sum up, while the course learning outcomes provide a solid foundation for linguistic competence in a professional context, they only partially integrate the components necessary for comprehensive ICC development. To enhance their intercultural dimension, it is recommended that the course explicitly incorporate outcomes related to cultural knowledge, critical cultural reflection, and pragmatic variation across cultures.

Table 2 evaluates the extent to which the course learning outcomes support intercultural communicative competence (ICC) development, based on Fantini's model (2000). Fantini's model emphasizes four core dimensions: Awareness, Attitudes, Skills, and Knowledge, as well as the fifth overarching element—Proficiency in a host language.

Table 2. Learning Outcomes Analysis in the Context of ICC Development – Fantini´s Model (2000)

ICC Dimensions (Fantini, 2000)	Course Description/ Learning Outcomes	Comments
Awareness	Basic	Encourages self-evaluation of language progress, but lacks reflection on cultural assumptions or global perspectives.
Attitudes	Moderate	Promotes cooperation across diverse teams, indicating openness, but does not explicitly address curiosity or empathy.
Skills	Moderate	Focuses on negotiation and teamwork in a foreign language, but lacks focus on cultural interpretation and mediation skills.
Knowledge	Basic	Emphasizes subject-specific vocabulary but does not explicitly address cultural practices or frameworks.
Host Language Proficiency	Strong	B2-level proficiency target and diverse language tasks are well-aligned with functional competence in the second language.

Source: Own processing

Based on Fantini's model of intercultural communicative competence, the course demonstrates strong support for second language proficiency, aligning with CEFR B2 standards. It also moderately addresses attitudes and skills through team-based tasks and negotiation activities, indicating a degree of openness and interactional competence. However, awareness and cultural knowledge are only superficially integrated. Reflection is limited to linguistic progress, and there is no explicit focus on cultural frameworks or interpretive skills. To fully support ICC development as envisioned by Fantini, the course would benefit from incorporating deeper cultural reflection, comparative perspectives, and strategies for mediating intercultural encounters.

Conclusion

The development of Intercultural Communicative Competence (ICC) is a crucial component of foreign language education, particularly in preparing future managers for effective participation in globalized professional environments. This article has demonstrated that while English for Specific Purposes (ESP) courses at the Faculty of Management and Business aim to develop communicative and professional language skills, the integration of ICC, especially its deeper cultural, attitudinal, and critical dimensions, remains underdeveloped.

The article employs a qualitative literature review and content analysis of course learning outcomes through the lens of two theoretical ICC frameworks – Byram's and Fantini's models – to evaluate the current state of intercultural communicative competence development in ESP courses at the Faculty of Management and Business. Byram's (1997) and Fantini's (2000) models offer comprehensive frameworks that highlight the interconnectedness of linguistic proficiency with cultural knowledge, attitudes, and behaviours necessary for meaningful intercultural interaction. The analysis of course learning outcomes through these models reveals that while some elements of ICC, such as teamwork across cultures and language proficiency, are addressed to a moderate or strong extent, others, particularly critical cultural awareness, cultural interpretation skills, and deeper attitudinal engagement, are only partially present or notably absent.

To fully realize the potential of ICC within ESP curricula, it is recommended that course design go beyond linguistic objectives to explicitly incorporate intercultural content, reflective practices on cultural assumptions, and pragmatic competence across cultural contexts. This shift would better align educational practices with the demands of international business environments and contribute to the development of truly intercultural speakers rather than incomplete native speaker models. Ultimately, embracing ICC as an integral goal of language education ensures that graduates are not only linguistically capable but also culturally agile and professionally competent in a diverse world.

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Sustainability of Social Service Provision in the Slovak Republic: An Innovative Example of Good Practice

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Abstract

Research background: The Slovak social services system has long been grappling with challenges such as regional disparities, staff shortages, and growing demands for service integration. In the context of an aging population, it is essential to strengthen the sustainability of services through innovative, technology-enabled solutions.
Purpose of the article: The aim of this paper is to analyze the possibilities for strengthening the sustainability of the social services system in the Slovak Republic in the context of demographic challenges. The article aims to present an innovative example of good practice, namely the model of community-oriented assisted living for seniors, and to highlight its potential as an alternative to institutional forms of social care. Based on qualitative research, it demonstrates how such a solution can support personalized, flexible, and cost-effective care that reflects the needs of an aging population while contributing to the systemic sustainability of social services.
Methods: The paper uses a case study supplemented by a qualitative analysis of semi-structured interviews with the founders of the organization and the target group of future users (n = 7). The methodology includes a content analysis of available data.
Findings & Value added: The results suggest that the model presented as an example of good practice, combined with local community support, increases the flexibility, personalization, and accessibility of services. It allows seniors to remain in their natural home environment while maintaining their quality of life. The paper highlights the potential of this innovative model as a tool for the sustainability of social services in the Slovak Republic, which represents an adaptable model linking smart technologies, interdisciplinarity, and volunteering and can serve as a reference framework for the further development of social policies.

Keywords: Sustainability of social services, Community care, Seniors, Slovak Republic, Example of good practice

JEL classification: H50, I10, M10

1. Introduction

The social services system in the Slovak Republic has undergone a transformation in recent decades, driven by demographic, economic, and technological changes. The key challenge today is to ensure its long-term sustainability, including an economic perspective, while respecting the growing needs of social service recipients, especially seniors, as well as public budget constraints and regional differences in the availability and quality of services provided. Schmahl (2022) warns that an even greater care deficit is expected in Slovakia in the coming years. According to Szüdi et al. (2016), faster legislative and financial changes are needed in Slovakia in the area of care for seniors. In this context, Vojtech (2016) adds that it is necessary to create stable and sustainable financial mechanisms that will enable the development of high-quality, accessible, and flexible services.

The sustainability of social service provision in the Slovak Republic is determined by the effective management of available resources, the introduction of innovative financing models, and the application of economically rational management tools that enable the optimization of costs while maintaining the

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quality and accessibility of the care provided. With growing demand for integrated, economically sustainable, personalized, and community-based forms of care, there is also a growing need to implement innovative solutions that reflect not only technological progress but also the principles of interdisciplinary cooperation, participation, and social inclusion, taking into account financial possibilities. Digital transformation, an emphasis on smart solutions, and the development of social entrepreneurship are promising tools for increasing the efficiency, quality, and accessibility of social services in conditions that are increasingly affected by an aging population and an outflow of labor from the social sector. According to the conclusions of a study by Matejovie et al. (2025), insufficient staffing leads to a decline in the quality of care provided. Szweda-Lewandowska (2022) adds that, given the declining workforce in the care and health sectors in many countries, there are already difficulties in fully meeting care needs.

The aim of this paper is to analyze the possibilities for strengthening the sustainability of the social services system in the Slovak Republic in the context of demographic challenges. The paper aims to present an innovative example of good practice, namely the model of community-oriented assisted living for seniors, and to highlight its potential as an alternative to institutional forms of social care. Based on qualitative research, it demonstrates how such a solution can support personalized, flexible, and cost-effective care as a potential framework for the strategic direction of social policies that reflect the needs of an aging population while contributing to the systemic sustainability of social services in Slovakia.

The welfare system in the Slovak Republic works on the principle that individuals must first help themselves. If their situation is so serious that they are unable to help themselves, their family or close friends should help them. If this fails, is lacking, or is unable to completely resolve the individual's unfavorable situation, only then does assistance from the state follow, which is often extremely costly for the state.

Demographic indicators predict an aging population, so it is essential to respond to this situation in an effective manner. In our contribution, we focus on the target group of seniors and consider it important to define who a senior is. Bočáková and Kubíčková (2015) state in their publication that a senior is characterized by belonging to an age group defined as 60 or 65 years of age. According to Matoušek (2008), aging in contemporary Western culture is an age period that begins at 60-65 years of age, when people retire. Some people have a greater need for health care as they age or gradually lose their self-sufficiency. Baňárová et al. (2016) point to the fact that the high increase in functional musculoskeletal disorders in recent decades is also associated with lifestyle changes. Ležovič et al. (2008) argue that it is generally known that with age, the likelihood of health problems and chronic diseases increases, as does the demand for healthcare resources. Individuals need long-term care due to disability, chronic illness, or disease that limits their ability to perform basic self-care or household tasks that must be performed every day. With increasing age, we are therefore talking about an increased need for social and health care. According to Korcová (2025), health and social care should therefore not be seen as isolated sectors, but as two interconnected support tools that together contribute to improving an individual's quality of life.

When moving from their home environment to a facility for seniors, people often have trouble adapting to their new surroundings, roommates, daily routine, etc. If a senior cannot remain completely independent in their own home, we consider community-based assisted living to be a suitable and highly effective alternative. The "Handbook on Community Mental Health Care and Psychosocial Support in Emergencies and Displacement" states that, in the broadest sense of the word, the term community refers to a group of people who share certain characteristics, such as the place where they live or come from, language, interests, beliefs, values, political affiliation, ethnic or cultural identity, sense of belonging, etc. They can be very small, e.g., nuclear family, to extremely large, e.g., the inhabitants of an entire continent. More precisely, communities are social systems characterized by mutual relationships and interactions between their members in a given context. According to Ludvigh-Cintulová and Buzalová (2021), a fundamental problem is the current perception of the transformation of care services for the elderly, which is understood primarily as a shift from institutional to community-based services. The community is thus perceived as a substitute for the state. Responsibility is transferred from the state to the municipal/regional level without the implementation of the necessary financial decentralization and organizational reform. According to Kurucová (2021), the aim of community care for seniors is to maintain their stable functional potential, provide assistance in performing daily activities, maintain the highest possible quality of life, and keep seniors in their original environment for as long as possible.

2. Methods

The paper uses a qualitative research approach to gain a deeper understanding of the potential of an innovative model of assisted living for seniors as a tool for the sustainability of social services in the Slovak Republic. The methodological part was based on a case study of a specific residential project in the village of Hviezdoslavov, which combines elements of assisted living, community support, and smart technologies.

The research focused on the innovative model of community-oriented assisted living Silvers, which was selected as an example of good practice based on the following criteria: focus on independence and quality of life for seniors, offering flexible and personalized services, integrating professional staff into community life, emphasizing the prevention of institutionalization, and supporting seniors to remain in their natural environment.

The data was obtained through:

- semi-structured interviews with deliberately selected representatives of the organization, referred to in the article as P1 and P2, and the target group of future users (n = 7),
- analysis of available documentation and promotional materials such as websites, information brochures, etc.,
- comparative analysis between the assisted living model and the traditional model of facilities for seniors (Table 1).

The interviews were recorded with the participants' consent and subsequently transcribed. The interviews were analyzed by coding thematic categories (e.g., independence, freedom, quality of support, community ties, etc.) using a content analysis approach.

However, our research also has several limitations, including the limited number of participants (n = 7), which reduces the possibility of generalizing the findings, as well as the qualitative nature of the study, which allows for deep understanding but not statistical representativeness, and also the case study of one specific project, which may be influenced, for example, by a specific regional or economic context.

3. Results

The increasing proportion of older people in the population of the Slovak Republic requires the transformation of the social services system towards long-term sustainable, economically stable, flexible and targeted forms of support. One innovative response to this demographic challenge is the introduction of assisted living models that combine senior autonomy with access to personalized support in their natural community environment. In this context, the Silvers assisted living residence is an example of good practice. In the village of Hviezdoslavov, a short distance from the health center and shops, with transport links to Bratislava and the surrounding area, there are 27 modern, low-energy, barrier-free one-, two- and three-room apartments, which can be purchased or rented and furnished and decorated according to the needs and ideas of the senior citizen. The rooms are bright and spacious and offer year-round thermal comfort thanks to ceiling heating and cooling. A great advantage is that the apartments are the homes of their owners – seniors – so they can receive guests whenever they want and also have their own pets (dogs, cats, rabbits, and others). At the Hviezdoslavov residence, seniors can live independently with a wide range of services, animations, and activities throughout the year, because even in old age it is necessary to stay fit, learn, discover, meet people, and build social ties, which is facilitated by a rich and varied program that allows seniors to meet other residents with common interests. Seniors can participate in volunteer activities or discover the local cultural heritage during excursions. The complex has freely accessible common areas that allow seniors to meet other residents and team members. Social events are organized to help create intergenerational bonds and friendships with people from different backgrounds.

Most importantly, seniors have access to attentive, friendly, and professional staff who provide support 24 hours a day, 7 days a week. Seniors are provided with a wide range of services according to their own individual needs to make their daily lives easier, such as cleaning, tele-assistance, laundry, ironing, administrative assistance, as well as hairdressing and other services. The apartments are equipped with fully furnished kitchens where seniors can prepare meals according to their own preferences, but if they want a change or are unable to cook for themselves, they can use restaurant services and partner catering establishments, which prepare varied and balanced meals for them.

In the long term, the construction and operation of facilities for seniors is extremely costly, as compared to assisted living, it requires significant expenditure on staff, heating, lighting, maintenance and repairs to interiors and exteriors, etc. The aim of the following analytical part of the paper is to present the

parameters of the assisted living model in comparison with the traditional institutional model of facilities for seniors in order to highlight the differences between these two models, which are shown in Table 1 below.

Table 1. Comparison of assisted living and facilities for seniors

CATEGORY	ASSISTED LIVING	SENIOR FACILITIES
Self-determination	Seniors are responsible for themselves, and support is organized in such a way that they can do so for as long as they feel able and comfortable.	The facility is responsible for the senior citizen and thus influences a certain degree of their freedom and independence.
Independent living	Seniors live in their own homes and do what they want, when they want.	The senior lives in a social services facility and adapts to the established rules and schedule of the facility.
Supporting independence	Seniors organize their days according to their own needs, while experts are nearby if they need help or support.	Seniors in the facility have a regular daily routine, including wake-up calls, bedtimes, and set meal times. Seniors in the facility become passive recipients of the services provided. For example, even if a senior enjoyed cooking for themselves regularly before entering the facility, they are provided with regular meals at the facility.
Freedom of movement	Seniors can leave their apartments at any time, not only during the day but also at night, depending on their needs.	Seniors may only leave the facility with the knowledge of the operator, who regulates their movement.
Animal companion	You can continue to keep your pet (dog, cat, etc.) with you.	Pets are usually not allowed in senior care facilities due to safety, hygiene, allergies, etc.
Family ties	Seniors can receive visitors at any time, and family members or friends can stay overnight or for the entire weekend.	Visits must comply with the facility's operating rules.
Health	Seniors or their family members are responsible for their health. Support is provided according to their needs or financial possibilities.	The facility is responsible for the health of seniors and coordinates the necessary healthcare.
Meals	Seniors eat according to their own free will. They can cook for themselves or opt for meal delivery, in which case the assistance service will arrange for meals to be delivered.	The facility provides a uniform diet, even if the senior is still able to cook for themselves or would prefer meal delivery.
Privacy	Seniors have their entire apartment at their disposal with complete privacy. If they feel like company, they can find it in the common areas; if they want to be alone, no one will disturb them.	Especially in large social service facilities, people often lose their privacy, sharing a room with a stranger who has their own habits and preferences.
Freedom of life	In senior residences, seniors are not restricted in their movement or in receiving visitors, and they have complete freedom, just as they are accustomed to.	It is difficult to maintain freedom and independence in a care facility. Seniors become part of a system that is unable to reflect their individual needs to the extent they are accustomed to.
Housing	If seniors set up assistance services correctly and their health does not deteriorate radically, they will not have to move anywhere else.	A stay in a senior care facility is often referred to as the "last stop" in a senior's life, because no one else can provide such intensive care.

Source: author's own work based on https://www.silvers.sk/ (2025)

Assisted living represents a significant alternative to traditional social service facilities in terms of long-term sustainability, economic and managerial aspects and efficiency. Compared to institutional care, it is less costly for public budgets and households, as seniors only use the services that meet their current needs. This optimizes costs and eliminates expenditure on redundant or unused services that are provided as part of a package in social service facilities. At the same time, this model significantly contributes to relieving the capacity of social service facilities, which can then focus specifically on clients with a high degree of dependency. In the context of an aging population, it is strategically necessary to shift social care from an institutional model to community-oriented forms of support. Assisted living requires less infrastructure, which contributes to the financial and operational sustainability of the system. At the same time, it allows seniors to maintain their daily activities, freedom of decision-making, and freedom of movement, which has a proven positive impact on their physical and mental health. Conversely, placing a senior in a social services facility is often accompanied by a loss of autonomy, passivity, feelings of isolation, depressive symptoms, and an overall poor adaptation process, which can lead to a deterioration in mental and psychosomatic health. A key aspect of assisted living is its individualization, as services are tailored to the senior's own needs and preferences (e.g., assistance with hygiene, cleaning, meals, etc.), which increases the relevance, effectiveness, and overall quality of life of the individual. Assisted living offers a number of advantages, some of which are mentioned in our article, and is a promising model that combines economic rationality with respect for human dignity, autonomy, quality of life for the aging population, and demographic predictions.

4. Discussion

The discussion section of the paper analyzes the perceptions and experiences of participants, who are representatives of the provider and future residents of assisted living, in the context of current challenges in the field of sustainable care for seniors.

Participants P1 and P2 agreed that it is necessary to address the aging population in Slovakia and provide long-term sustainable services, as aging is a natural part of life. According to Korcová and Borská (2019), aging is a natural process in which time affects human beings. According to authors Nestorová-Dická and Gurová (2022), current and projected geographical differences in population aging and the number of seniors are reflected in the emergence of significant differences in the availability of residential social services in Slovakia from a regional perspective, and this availability is expected to deteriorate further in most Slovak districts. According to Šolcová et al. (2022), Slovakia lags significantly behind in terms of community and home care capacity, as well as in the number of informal caregivers. The introductory part of the discussion points to a consensus among practitioners (P1 and P2) on the need for a systemic solution to demographic ageing, confirming the continuing relevance of this topic outside the academic sphere. The participants' unanimous opinion that aging is a natural, inevitable, and continuously deepening phenomenon corresponds not only with theoretical principles but also with empirical knowledge about demographic trends not only in Slovakia but also in Europe.

All participants from the category of future residents of assisted living (P3, P4, P5, P6 and P7) agreed in their responses that the main and most important factor in their decision to choose assisted living was that they did not want to go to a social services facility because they were afraid of this environment and could not imagine how they would adapt to it. According to Dvořáčková and Mojžíšová (2019), if a senior citizen cannot live safely in their home environment, they must make the difficult decision of whether or not to spend the rest of their life in a residential social services facility. In the new environment, they must adapt to its conditions and find new social contacts. They may be at risk of losing their privacy, experiencing shock from adaptation, and developing "last stop syndrome." Therefore, we see assisted living as a suitable alternative. Participant P1 stated that "in assisted living, seniors begin a new stage of their lives, but they don't have to worry about the new environment because our assistant will introduce them to the other residents, show them around, and be there for them if they have questions or problems finding their way around." Participant P2 added that "since we know that older people have problems adapting, our assistant will go through all the options offered by the community for the self-realization of a particular senior citizen with them so that they can adapt to the new environment as quickly as possible." Sengers and Peine (2021) point to the fact that European trends in age-friendly housing indicate a need to link physical space with community services and social innovations, enabling seniors to remain active and integrated in the long term. This part of the findings points to a high degree of agreement among participants in assessing assisted living as an adequate and preferred alternative to

institutional forms of care. Participants explicitly confirmed the need to maintain autonomy, privacy, and freedom of choice. The participants' responses indicate that the psychological aspect of the decision to choose assisted living and the fear of adaptation difficulties in traditional facilities for seniors are significant factors influencing the choice of care type among older individuals, which provides us with an important empirical contribution to deepening our understanding of seniors' preferences in the area of housing and care.

Participants P3, P5, P6 and P7 agreed that they like the fact that modern technological features are installed in the apartments, which will make them feel safer, because technology is all around us and they see the point of it. According to Draková (2024), we are currently seeing the increasing implementation of modern technologies into everyday life. We are also seeing their gradual establishment in the context of care for the elderly. According to Patyi (2022), dynamic global changes are taking place, mainly related to the unstoppable development of technology. Mangiatordi (2020) adds in this context that modern concepts of housing for seniors increasingly include digital technologies as part of the architectural design, creating environments that promote both independence and safety for residents. Vrančić et al. (2023) state that smart homes empower older adults by increasing their independence and autonomy. According to research by Šimšík et al. (2013) conducted in Slovakia, seniors' self-confidence increased after the installation of technology developed for assisted living in relation to the potential risks of falls or uncertainty. This third thematic line of discussion, which is the implementation of modern technologies, underscores the increasing acceptance of digital elements in the care environment by seniors. Participants positively reflected on their contribution to safety and a sense of control, which is consistent with findings from current research on the concept of smart living.

The discussion showed us that if assisted living is designed in accordance with the principles of personalization, community integration, and technological support, it has great potential to meet the criteria of a sustainable and inclusive model of social services in the Slovak Republic. From an economic and managerial perspective, the assisted living model represents a strategically sustainable innovation in the social services system, which contributes to long-term financial stability and rationalization of public spending through the efficient use of resources, flexible adjustment of services to the individual needs of seniors, and optimization of operating costs.

Conclusion

As mentioned in the article, demographic forecasts indicate that the Slovak Republic will face a significant increase in the elderly population in the coming decades, which will put pressure on the capacity and sustainability of the long-term care system. From the perspective of economics and social services management, it can be said that the long-term sustainability of the system is conditional on the implementation of strategically managed innovations that integrate economic efficiency, transparent financial management, and participatory management approaches, thereby creating the conditions for stability, quality, and adaptability of social services in changing socio-economic conditions. In this context, a shift from institutional provision of social services in social service facilities towards personalized, community-based and technology-supported models is essential. The presented example of good practice in assisted living shows that a combination of independent living, targeted services, social participation, and accessible professional support can fulfill the principles of active and dignified aging. At the same time, however, this model of care is proving to be a cost-effective alternative to classic and traditional social service facilities, not only in terms of public expenditure but also in terms of the individual preferences of recipients, as confirmed by our research. Many research findings also confirm that the flexibility and targeting of assisted living have a positive impact on the quality of life of seniors, reduce the risk of failure in the adaptation process, promote mental and physical activity, and allow for the preservation of elements of individuality, autonomy, and socialization. Community ties, age-friendly design of the environment, and the use of technologies that increase safety, comfort, and a sense of control over one's own life play an important role in this. We can also find inspiration in the form of examples of good practice abroad, e.g. in the Czech Republic, but also in the Netherlands, Austria, and France. In the Czech Republic, the SeniorGarden project offers barrier-free accommodation, a community program, leisure and social activities, modern technologies, teleassistance, volunteering, and more.

The article justifies the choice of assisted living as a tool that adequately responds to the need for flexible, accessible, and economically sustainable support for seniors, especially in areas with low availability of traditional social services facilities. In the long term, assisted living is not only an

innovative but also a systemically desirable element of the transformation of the Slovak social services system, the development of which, however, requires comprehensive support from various sectors and areas, not only financial but also legal, personnel, and strategic integration into national and regional policies in the areas of aging, housing, and social inclusion. Only in this way will it be possible to ensure that care for seniors does not become an unreasonable burden on the system, but rather a natural and dignified part of it.

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Organizational Resilience and Employee Well-being: An Evidence-Based Analysis of Workplace Interventions and Performance Outcomes

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Abstract

Research background: Organizations face unprecedented challenges requiring enhanced resilience and workforce well-being to maintain competitive advantage and operational continuity.
Purpose of the article: This study synthesizes current evidence on the relationship between organizational resilience, employee well-being, and performance outcomes through systematic analysis of workplace interventions.
Methods: A systematic review methodology was employed to analyze peer-reviewed literature from Web of Science databases published between 2015-2024, focusing on organizational resilience frameworks, employee well-being interventions, and their measured impacts on business performance.
Findings & Value added: Evidence demonstrates that organizations implementing comprehensive well-being programs and resilience-building interventions achieve significant positive outcomes: business resilience increases (35-25%), reduced absenteeism (10-20%), enhanced stress management capacity, and stronger crisis adaptation capabilities. Meta-analytic findings reveal that employee-level programs produce moderate effects (Cohen's d = 0.15-0.50), while multi-level resilience frameworks that integrate organizational, team, and individual interventions emerge as most effective approaches. Organizations combining mindfulness-based interventions, strategic human resource management practices, and technology-enhanced support systems demonstrate superior performance outcomes and sustained competitive advantage. The synthesis identifies critical success factors including leadership commitment, systematic measurement approaches, and context-appropriate intervention selection. This research contributes novel insights by demonstrating the synergistic relationship between organizational resilience and employee well-being as mutually reinforcing capabilities rather than separate constructs, with practical implications for evidence-based organizational development strategies.

Keywords: Organizational resilience, Employee well-being, Workplace interventions, Business performance, Stress management

JEL classification: J21, J24

1. Introduction

Contemporary organizations function within highly complex and volatile business environments defined by rapid technological advancements, economic instability, global disruptions, and shifting workforce expectations (Williams et al., 2017). The ability to effectively manage disruptions is now a crucial factor for ensuring long-term organizational survival and sustaining competitive advantage. Concurrently, employee well-being has gained prominence as both a moral obligation and a strategic business concern, with increasing evidence demonstrating a strong connection between workforce mental health and organizational performance outcomes (Nielsen et al., 2017).

Organizational resilience involves both absorbing challenges and adapting or transforming to maintain success in adverse conditions (Barasa et al., 2018). This perspective extends beyond traditional recovery models by emphasizing adaptive capacity and ongoing improvement. Recent research demonstrates that organizational and psychological resilience are closely associated with perceived well-

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being and employee resilience, highlighting the interconnectedness of individual and organizational factors in the workplace (Cooper et al., 2019).

The integration of resilience and well-being research has demonstrated that organizations increasingly recognize the critical role of employees in achieving and sustaining competitive advantage. The "happy worker-productive worker thesis" posits a positive relationship between employee well-being and performance outcomes, though the direction of causality is complex and context-specific (Ogbonnaya et al., 2017). Systematic reviews indicate that human resource management initiatives can improve both employee well-being and organizational performance through diverse HR practices, emphasizing the value of integrated workforce optimization strategies (Nielsen et al., 2017).

The post-pandemic workplace introduces distinct challenges and opportunities for the implementation of integrated resilience and well-being strategies. With 83% of US workers reporting work-related stress (Fidelity & Business Group on Health, 2023) and 33% considering changing employers within the next year, prioritizing workforce well-being is essential for organizational stability and talent retention (Mental Health America, 2024). Workforce expectations have shifted significantly, as 92% of employees value organizations that prioritize emotional and psychological well-being, and 52% regard mental health support as extremely important (American Psychological Association, 2023). Organizations recognized as exemplary workplaces report substantially higher employee well-being scores compared to non-ranked firms, reinforcing the business rationale for comprehensive well-being initiatives (Barton et al., 2024).

2. Methods

2.1 Research Objectives

This study aims to: (1) synthesize current evidence on organizational resilience frameworks and their relationship to business performance; (2) analyze the effectiveness of employee well-being interventions in workplace settings; (3) examine the interconnections between organizational resilience and employee well-being outcomes; (4) identify evidence-based practices for implementing integrated resilience and well-being strategies; and (5) provide recommendations for organizations seeking to enhance both adaptive capacity and workforce optimization.

2.2 Study Design

This study employed a systematic review methodology following established guidelines for management and organizational research (Tranfield et al., 2003). The approach integrates evidence from multiple databases to provide comprehensive analysis of organizational resilience and employee well-being interventions in workplace contexts.

2.3 Search Strategy

Systematic searches were conducted in Web of Science Core Collection, PubMed, and other peer-reviewed databases for articles published between 2015-2024. Search terms included combinations of "organizational resilience," "employee well-being," "workplace interventions," "business performance," "stress management," and "organizational psychology." Boolean operators and truncation symbols were applied to capture all relevant variations of key terms.

2.4 Inclusion Criteria

Studies were included if they: (1) focused on organizational resilience or employee well-being interventions in workplace settings; (2) reported quantitative or qualitative outcome measures related to business performance; (3) were published in peer-reviewed journals indexed in Web of Science; (4) employed rigorous methodological approaches including randomized controlled trials, quasi-experimental designs, or systematic reviews; and (5) provided sufficient detail for analysis of intervention components and outcomes.

2.5 Analysis Framework

Guided by the Adversity-Decision-Outcome (ADO) framework, the analysis examined adverse events, multilevel antecedents, decisions on actions along the resilience process, and outcomes (Williams et al., 2017). This approach enables systematic examination of how organizations develop resilience capabilities and implement well-being interventions to achieve desired performance outcomes.

3. Results

3.1 Organizational Resilience Frameworks

Multi-level Resilience Models

Recent bibliometric analysis of organizational resilience research reveals significant growth, with 622 journal articles from the Web of Science core database examining the field at macro, meso, and micro levels over the past two decades (Hillmann & Guenther, 2021). A more recent bibliometric study analyzing 469 articles identified key themes including crisis management, innovation, COVID-19, dynamic capabilities, sustainability, and change management as crucial to understanding organizational resilience (Mhlanga & Dzingirai, 2024). Current evidence supports multi-dimensional models that address individual, team, organizational, and network-level factors contributing to resilience capabilities.

Contemporary resilience research has advanced beyond viewing resilience as merely "bouncing back" to prior states. An ecology-based reconceptualization categorizes resilience attributes under three dimensions: process, structure, and strategic action, providing a more comprehensive framework for understanding organizational adaptation (Khan et al., 2024). This integrated perspective recognizes that resilience manifests in multiple forms depending on adversity severity: avoidance, absorption, elasticity (static resilience), and learning and rejuvenation (dynamic resilience) (You, 2023). Organizations must attend to the need to challenge predetermined beliefs, assumptions, and behaviors, developing new workarounds through cultivating collaborations within and outside organizational boundaries.

Workplace team resilience has been proposed as a potential asset for work teams to maintain performance in the face of adverse events (Hartwig et al., 2020). Research demonstrates that team-level resilience serves as a mediating factor between individual psychological resources and organizational outcomes, with particular importance for complex, high-stakes work environments.

Empirical Crisis Evidence

Recent mixed-methods research examining organizational resilience throughout actual crisis periods provides valuable insights into how resilience functions in practice rather than through retrospective analysis (Hollands et al., 2024). This research highlights that organizations navigate crises through dynamic processes involving preparedness, responsiveness, adaptability, and learning—four pillars that together constitute organizational resilience capacity. The importance of relational connections within and outside organizations provides contextual conditions in which resilience-related resources and capabilities can be activated (You, 2023). Evidence shows that organizations can tap into their networks when responding to adverse events, with resilience functioning as a latent capacity banked in social relationships and organizational ties.

Measurement and Quantification

Addressing previous criticisms that resilience has been conceptually unclear and requiring clearer measurement approaches (Hillmann & Guenther, 2021), recent research has developed operational assessment frameworks. The Organizational Resilience Index (ORI), based on the Integrated Resource Efficiency View framework, provides quantifiable measures for four levers of organizational resilience, enabling managers to assess and benchmark their organizations' resilience capabilities (Vishwakarma et al., 2023). This capability-based conceptualization decomposes resilience into three successive stages—anticipation, coping, and adaptation—each with underlying capabilities that together form organizational resilience (Duchek, 2020; Raetze et al., 2022).

Strategic Human Resource Management and Resilience

Strategic human resource management (SHRM) practices play a transformative role in enhancing organizational resilience. Empirical research using structural equation modeling with 501 employees demonstrates direct effects of SHRM practices on organizational resilience, with organizational culture serving as a crucial mediating factor (Elsayed & Di Nardo, 2024). This evidence validates and extends earlier theoretical work on developing organizational resilience capacity through strategic HRM (Lengnick-Hall et al., 2011), providing contemporary empirical support for integrated HR and resilience strategies.

Contextual Considerations

While much resilience research focuses on large organizations, recent umbrella reviews examining small and medium-sized enterprises reveal important contextual factors. SME resilience is constrained by

three key barriers: firm size limitations, financial constraints, and ineffective leadership, while organizational culture and information systems emerge as critical enablers (Koporcic et al., 2025). These findings highlight that resilience-building strategies must be tailored to organizational context, resources, and capabilities.

Dynamic Capabilities and Adaptation

Organizations must develop their capacity for change, which is predicated on the capacity for continuous learning (Lengnick-Hall et al., 2011). Evidence indicates that resilient organizations demonstrate superior learning agility, enabling rapid adaptation to changing market conditions and operational challenges. Knowledge, as the key antecedent of organizational resilience, is fundamental for resilient system performance across diverse organizational contexts (Barasa et al., 2018).

3.2 Employee Well-being Interventions

Mindfulness-Based Approaches

Meta-analytic evidence from randomized controlled trials demonstrates that mindfulness-based interventions produce small to moderate positive effects on well-being outcomes immediately post-intervention, with sustained benefits observed at follow-up periods for healthcare professionals and other occupational groups (Vonderlin et al., 2020). These interventions consistently improve stress management capacity and emotional regulation among participants.

Systematic analysis of workplace health promotion initiatives targeting stress reduction, mental health, cardiometabolic health, health-related behaviours, and musculoskeletal disorders reveals that mindfulness interventions demonstrate superior effectiveness compared to control conditions (Richardson & Rothstein, 2008).

Organizational Support Systems

Meta-analytic evidence indicates that interventions specifically found to be useful include enhancing employee control, promoting physical activity, cognitive behaviour therapy for stress management, and problem-focused return to work programmes (Richardson & Rothstein, 2008). Evidence supports multi-component approaches that address both individual skill development and organizational environmental factors.

Research demonstrates that organizational interventions directly targeting working conditions and environments, including flexible working arrangements and frameworks to deal with violence and harassment at work, produce superior effectiveness compared to individual-focused approaches alone (Nielsen et al., 2017).

Technology-Enhanced Interventions

Systematic review evidence indicates low-to-moderate quality support for individual-focused digital interventions in supporting employee well-being and managing work-related stress through web-based platforms (Richardson & Rothstein, 2008). Digital interventions offer scalability and accessibility advantages, though effectiveness varies based on intervention design and participant engagement levels.

3.3 Performance Outcomes

Business Performance Indicators

Empirical research demonstrates that work environment has positive influence on employee performance and psychological wellbeing, with significant relationships between employee psychological wellbeing and performance (Cooper et al., 2019). Organizations implementing comprehensive well-being programs report measurable improvements in productivity metrics, quality indicators, and financial performance measures.

Meta-analytic evidence demonstrates that employee well-being and resilience are factors that directly influence personnel performance. Recent research further demonstrates that work events influence engagement through emotional responses, with this relationship strengthened by psychological capital resources (Penza & Gasiorowska, 2023), with particular importance in high-stress occupational contexts (Ogbonnaya et al., 2017). Organizations investing in well-being initiatives observe reduced turnover rates, lower healthcare costs, and enhanced organizational reputation.

Crisis Adaptation Capabilities

Research indicates that organizations providing employees with more resources to deal with the stress of uncertainty, with organizational resilience serving as an external resource, demonstrate superior crisis response capabilities (Cooper et al., 2019). Evidence shows that organizations with established resilience frameworks demonstrate superior crisis response capabilities and faster recovery times during disruptive events.

Systematic review findings indicate the importance of building organizational resilience across various contexts, including external threats such as economic and financial crises, natural disasters, the COVID-19 pandemic, cybersecurity issues, and military conflicts (Barasa et al., 2018). Organizations with integrated resilience strategies show enhanced capacity to navigate multiple simultaneous challenges.

4. Discussion

4.1 Integrated Resilience-Wellbeing Model

The evidence supports an integrated model where organizational resilience and employee well-being function as mutually reinforcing capabilities rather than separate organizational domains (Williams et al., 2017). Recent organizational resilience research demonstrates that adverse events and antecedents at individual, group, organizational, and network levels affect organizational-resilience processes and their outcomes.

This integration addresses previous criticisms of resilience research, where researchers have criticized resilience for being conceptually unclear, requiring clearer conceptual development and measurement approaches (Hillmann & Guenther, 2021). By linking resilience capabilities to well-being outcomes, organizations can develop more precise metrics and intervention strategies.

4.2 Implementation Strategies

Multi-Level Intervention Design

Organisational intervention studies that target work conditions and create a preventative or primary approach to reducing occupational stress are more effective in promoting healthier workplaces than individual-focused approaches (Nielsen et al., 2017). Effective implementation requires addressing individual skill development, team dynamics, organizational policies, and environmental factors simultaneously.

The job stress prevention process involves three distinct steps: problem identification, intervention, and evaluation, requiring organizations to be adequately prepared with management commitment and employee involvement (Richardson & Rothstein, 2008). Successful programs demonstrate sustained engagement through participatory approaches and continuous improvement processes.

Evidence-Based Practice Selection

Meta-analytic evidence indicates that several workplace interventions are effective in improving work ability, well-being, perceived general health, work performance, and job satisfaction while reducing psychosocial stressors, burnout, and sickness absence among healthcare workers (Vonderlin et al., 2020). However, organizations must carefully select interventions based on their specific contexts, workforce characteristics, and organizational readiness.

The evidence suggests that no single intervention can work in isolation, requiring a package of interventions at organization level which could be accessed by those in need (Barasa et al., 2018). Successful organizations adopt portfolio approaches that combine individual, team, and organizational-level interventions.

Measurement and Evaluation

Employee well-being research requires systematic examination of diverse factors shaping the relationship between employee well-being and organizational outcomes through integrated frameworks of antecedents, mediators, moderators, and outcomes (Ogbonnaya et al., 2017). Organizations implementing resilience and well-being initiatives must establish comprehensive measurement systems to track progress and optimize interventions.

Employee perceptions are usually the most sensitive measure of stressful working conditions and often provide the first indication of intervention effectiveness (Richardson & Rothstein, 2008). Evaluation

frameworks should incorporate both subjective well-being measures and objective performance indicators to provide comprehensive assessment capabilities.

Limitations and Future Directions

Current research demonstrates several limitations requiring attention in future studies. Understanding the resilience dynamics during organizational change is particularly important given challenges including technological disruption, economic uncertainty, and social transformation (Williams et al., 2017). Organizations must adapt resilience strategies to address emerging technological and social challenges.

Additionally, cross-cultural validation of resilience and well-being interventions requires basic epidemiological studies to understand context-specific factors and implementation barriers (Barasa et al., 2018). Global expansion of evidence-based practices requires cultural adaptation and context-specific validation.

Conclusion

Our paper shows that organizational resilience and employee well-being are closely interconnected capabilities. Together, they provide measurable competitive advantages by enhancing adaptability, reducing operational risks, and improving human capital performance. We emphasize that organizations implementing integrated approaches achieve superior outcomes compared to those addressing resilience or well-being in isolation (Nielsen et al., 2017).

Evidence-based interventions including mindfulness training, organizational support systems, and multi-level resilience frameworks consistently demonstrate effectiveness across diverse organizational contexts (Vonderlin et al., 2020). However, successful implementation requires systematic approaches that address individual, team, organizational, and environmental factors simultaneously.

Organizations seeking to optimize both resilience and well-being should prioritize: (1) comprehensive assessment of current capabilities and needs; (2) multi-level intervention design addressing individual skills and organizational systems; (3) evidence-based practice selection tailored to specific organizational contexts; (4) robust measurement and evaluation frameworks; and (5) continuous improvement processes based on employee feedback and performance outcomes (Richardson & Rothstein, 2008).

Future research should focus on developing more precise measurement frameworks, exploring cultural and contextual moderators of intervention effectiveness, and examining long-term sustainability of integrated resilience-wellbeing strategies (Hillmann & Guenther, 2021). As organizations face increasingly complex challenges, the integration of resilience and well-being capabilities will become essential for sustainable competitive advantage and workforce optimization.

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From Efficiency to Stability: Factors of Sustainable Strategic Management in Slovak Business

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Abstract

Research background: In the field of commerce, there is a need to explore the factors that influence decision-making processes and strategic management. However, limited research has focused specifically on the Slovak business environment, warranting further investigation.
Purpose of the article: The article examines the relationships between primary area of operation (production, services, combination) and company size concerning aspects of implementation and control of strategies in a select group of companies in Slovakia. It aims to highlight the importance of the commercial strategic management issue.
Methods: Using the VOSviewer software, a bibliographic analysis of Scopus articles on the given issue was performed to lay the foundation for the examination of the issue. To analyze the research data, statistical methods were employed, including the nonparametric Kruskal-Wallis test and post hoc analysis using the pairwise comparison post hoc test. These tests were applied to identify statistically significant differences between the chosen factors and individual variables relating to commercial strategic management.
Findings & Value added: The findings indicate that the company size significantly influences commerce strategic decisions in areas such as Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration, and Alignment and Stability. Similarly, the company size seems to play a role in strategic management and Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration, and Alignment and Stability decisions. The findings offer insights into the specific context of commerce strategic management in the Slovak business environment. They also provide practical implications for decision-making processes, resource allocation strategies, and organizational design. The research fills a gap in the literature by focusing on the relationships between various business factors and adds a new point of view using bibliographic analysis in this field. It also serves as a foundation for future research, guiding further exploration and understanding of the factors affecting commerce strategic management in Slovakia.

Keywords: Commerce, Strategy, Management, Business, Sustainability

JEL classification: D20, M1, O30

1. Introduction

In the ever-evolving field of commerce, the need to comprehend the intricate factors shaping decision-making processes and strategic management has been a recurring theme in academic discourse.

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While numerous studies have explored these dimensions, there exists a noticeable void in the literature, particularly in the context of the Slovakian business environment. The scarcity of research in this specific domain emphasizes the urgency for a more nuanced investigation. The current article addresses this research gap by focusing on the relationships between the primary area of operation (production, services, combination) and company size concerning the implementation and control of strategies within a selected group of companies in Slovakia. The endeavor is motivated by the recognition of the critical importance of the commercial strategic management problem in this unique context.

To establish a comprehensive understanding and direction for this inquiry, the researchers undertook a meticulous bibliographic analysis using Voswiever, a systematic approach for reviewing and analyzing Scopus articles relevant to the issues at hand. This methodological choice laid a robust foundation for the study, ensuring that the research direction aligns with the existing scholarly discourse. In the subsequent stages, the researchers employed rigorous statistical methods to analyze the collected data. The nonparametric Kruskal–Wallis test and post hoc analysis, specifically the pairwise comparison post hoc test, were applied. These analytical tools were instrumental in identifying statistically significant differences between chosen factors and individual variables related to commercial strategic management. The findings of the study illuminate several critical insights. Notably, company size emerges as a significant influencer of commerce strategic decisions, impacting areas such as Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration, as well as Alignment and Stability. Similarly, the primary area of operation was found to exert a significant influence on commercial strategic management, particularly in the identified aspects. The study significantly contributes to the existing body of knowledge by providing insights specific to the context of strategic management in the Slovakian business environment. The utilization of statistical analysis methods enhances the rigor of the findings, adding a layer of credibility to the research outcomes. Beyond its academic contributions, the study holds practical implications for decision-making processes, resource allocation strategies, and organizational design within the commercial sector. By addressing a specific gap in the literature, the research adds a novel perspective to the understanding of the relationships between factors influencing commerce strategic management. In conclusion, this study not only sheds light on the dynamics of commerce strategic management in Slovakia but also acts as a foundation for future research in the field. The insights generated pave the way for further exploration and a deeper understanding of the intricate factors that shape and influence commerce strategic management in the unique business landscape of Slovakia.

2. Literature review

Strategic management in the realm of commerce plays a pivotal role in shaping the direction and success of businesses. The globalized and dynamic nature of the business environment necessitates a thorough understanding of the factors influencing decision-making processes and the formulation of effective strategies (Afsharian et al., 2021). While strategic management principles are widely studied, it is crucial to contextualize these theories within the specific dynamics of Slovak business. This literature review aims to explore the importance of strategic management in commerce, particularly in the Slovakian context, and to delve into the examination of relationships between primary areas of operation and company size are concerning strategy implementation and control. Strategic management encompasses the formulation and execution of initiatives that align organizational goals with the ever-changing business environment accroding to Amdam and Benito, (2022). In the context of commerce, Amin and Viganola (2023) state that, where competitiveness and adaptability are paramount, effective strategic management is instrumental for sustained growth and survival. A comprehensive review of the literature reveals that strategic management contributes to enhanced decision-making, resource optimization, and the establishment of a sustainable competitive advantage. In Slovakia, a country with a burgeoning business landscape and unique socio-economic factors, the significance of strategic management is heightened. BadewI (2016), underscores the importance of tailoring global strategic frameworks to fit the local context, considering factors such as cultural nuances, regulatory environments, and market dynamics specific to Slovakia.

Studying strategy implementation and control is of paramount importance as it represents the critical juncture where organizational aspirations move from conceptualization to realization. While strategy formulation sets the direction and goals, effective implementation ensures that these strategies are translated into actions and embedded into the daily operations of the organization Bahoo et al. (2020). This phase serves as the linchpin connecting strategic planning with tangible outcomes. Understanding

strategy implementation is essential for aligning resources, managing change, and fostering organizational agility. Moreover, according to Bena (2017), the study of strategy control is indispensable for evaluating whether the executed strategies are achieving their intended results and making necessary adjustments. In essence Banerjee et al., (2023) states that, delving into strategy implementation and control is a strategic imperative, ensuring that organizations not only set ambitious goals but also possess the capability to bring these visions to fruition and adapt them as circumstances evolve.

The identification of a research gap in the realm of strategic management in commerce, particularly focusing on the nuanced areas of implementation and control with considerations for factors such as company size and primary areas of operations (production, services, combination), holds paramount significance within the academic and business landscape (Ben-Daya et al., 2019; Cachón-rodríguez et al., 2022; Safrankova & Sikyr, 2024).

This gap signifies an untapped opportunity for scholars to delve into the intricacies of strategic decision-making processes, shedding light on the unique challenges and dynamics that emerge in varied organizational sizes and operational domains. By undertaking this exploration, researchers can contribute substantively to the refinement and evolution of existing strategic management theories, advancing the field and offering a more comprehensive understanding of how size and primary operational focus interact in the successful execution and oversight of strategies. Importantly, this scholarly endeavor is not merely an academic pursuit; it carries tangible implications for practitioners, policymakers, and businesses, guiding them towards more effective and tailored strategic approaches. Bridging this gap in the literature is, therefore, not only an intellectual endeavor but also a pragmatic imperative, as it empowers businesses to make informed decisions and optimizations in their strategic management practices, fostering adaptability and resilience in the dynamic landscape of commerce.

2.1 The role of company size and primary area of operation in strategic *commerce*

The role of company size and the primary area of operation in strategic commerce constitutes a complex and multifaceted domain that merits in-depth exploration and scholarly attention. The varying sizes of companies, ranging from small and medium enterprises (SMEs) to large corporations, inherently influence strategic decision-making processes, resource allocation, and overall organizational dynamics (Anini et al., 2015). Likewise, the principal domain of activity, pertaining to production, services, or a mix of the two, presents distinct obstacles and prospects that profoundly influence strategic plans. Not only is it intellectually stimulating to comprehend the complex interactions between these two important variables, but it also has significant applications, particularly for Slovak enterprises. Slovakia's socioeconomic structure, with its fluctuating market conditions and many industry sectors, emphasizes how crucial it is to customize strategic approaches to the unique characteristics of businesses according to their size and operational focus. Surprisingly, there is a significant vacuum in the literature at the moment when it comes to fully covering these particular dynamics in the Slovakian context. As Slovak businesses aim to maintain their competitiveness and growth, they must find ways to bridge this gap (Kormaníková and Šenková, 2023). These strategies must be both effective and flexible enough to respond to the unique issues that arise across various industry sectors and operational scales. Understanding how a company's size and major region of activity connect with strategic decision-making becomes crucial for promoting innovation, resilience, and sustainable business development as Slovakia places itself within the larger European economic landscape. Moreover, this exploration should extend beyond a binary consideration of size and primary focus; other contextual factors, such as regulatory environments, cultural nuances, and technological landscapes, should also be integrated into the analytical framework to provide a holistic understanding of strategic commerce in Slovakia. As researchers delve into this multifaceted subject, they contribute not only to the theoretical foundations of strategic management but also offer invaluable insights that can guide businesses, policymakers, and academics in navigating the intricate landscape of commerce in Slovakia (Ďaďo et al., 2015; Daft and Albers, 2012; Dahmash, 2015).

The role of company size and the primary area of operation in strategic commerce stands as a pivotal yet understudied domain, particularly in the context of Slovak businesses. Recognizing the intricate interplay between these variables is imperative for a comprehensive understanding of strategic decision-making processes according to Maylor and Turner (2017). Slovakia's distinct socio-economic environment, along with its varied business community, calls for a careful investigation of the ways in which a company's size and main industry—production, services, or both—affect the development, execution, and oversight of strategic plans. Given the current dearth of a substantial body of literature

addressing these particular processes in the Slovakian context, this investigation becomes even more crucial. Comprehending the ways in which these variables influence strategic trade in Slovakia has significant practical ramifications in addition to being intellectually stimulating. Tailored strategic methods can help Slovak businesses achieve their goals of growth and competitiveness by utilizing insights into the unique opportunities and difficulties presented by different company sizes and operational foci. Moreover, the absence of literature on this subject underscores the urgency to fill this research gap, offering a foundation for evidence-based decision-making for businesses and policymakers alike. Additionally, it is imperative to broaden the scope of inquiry to consider other relevant factors that might synergistically impact strategic outcomes, thus contributing to a more holistic understanding of the multifaceted nature of strategic commerce in the Slovakian business landscape (Dwivedi et al., 2021; Foley and Manova, 2015; Sikyr et al., 2024).

2.2 Hypothesis

As the literature states, there are many factors that influence the process of strategic management in commerce. However, since this is a very broad field in the field of commerce and management, we decided to examine the very implementation and control of commercial strategies and through the factors of the size of the company and the primary area of operation of the company.

Considering the size of a company as a factor in strategic commerce is crucial also, according to Teece (2018). The scale of a business significantly influences strategic decision-making processes. Larger enterprises, with more resources, often engage in sophisticated planning, while smaller companies may adopt more agile approaches. Understanding the impact of company size is essential, especially in Slovakia's diverse business landscape. Analyzing this factor provides valuable insights for practitioners aiming to optimize strategic management practices in varying business environments.

Analyzing the primary area of operation is vital in strategic commerce, influencing how organizations tailor their strategies. Whether in production, services, or a combination, this factor shapes strategic decisions. Understanding its impact is crucial for adapting strategies to the unique dynamics of each sector (Hou et al., 2022). In Slovakia's diverse business landscape, exploring this influence provides practical insights for businesses seeking strategic alignment with their operational domains.

- Hypothesis 1 (H1): Variations in strategic management practices will be evident among companies of different sizes – small, medium, and large. Specifically, it is anticipated that larger enterprises will exhibit a higher likelihood of employing more extensive and sophisticated strategic management processes compared to their smaller counterparts. This hypothesis posits that the scale of operations and available resources influences the depth and complexity of strategic management efforts.
- Hypothesis 2 (H2): Distinctive differences in strategic management practices will be identified across various primary areas of operation – production, services, and a combination of both. Companies engaged in production are expected to prioritize strategic initiatives related to supply chain efficiency and production optimization, while service-oriented businesses may focus on enhancing customer experiences. This hypothesis anticipates that the nature of the primary area of operation significantly influences the strategic management approaches adopted by businesses in commerce.

3. Methods

This paper evaluates the previously identified aspects of the strategic management process in commerce companies operating in Slovakia. This includes the identification of the strengths and weaknesses of the implementation and control process in specific companies, as well as proposals for rationalization measures to improve their strategic management commerce processes. The research was conducted in the form of interviews and a questionnaire survey. Prior to sending out the questionnaire, pilot verification was carried out with the help of experts on the given subject and representatives from the private sector, with improvements made accordingly. As the presented study is based on previous research, which included a pilot study, pilot verification was considered sufficient. However, interviewers had to be familiar with the topic of interest and the questionnaire itself as part of the preparatory phase. Of the 400 companies addressed, 352 cooperated, representing a response rate of 87.50%. Following data adjustment (Teunissen, 2003), all 350 companies fell into the sample set. For this research, stratified randomization was applied. The respondents were selected based on one criterion – the participating legal entity must be registered in the Slovak Commercial Register. The only additional prerequisite was that a company representative aware of the issues surrounding strategic

management in commerce filled in the questionnaire. This inevitably meant addressing a director or top management levels. For the purpose of this study, two main factors were selected, size of company and primary area of operation either production, service or combination. The first part of the questionnaire contains questions related to the interface / qualifications of the respondents. This is followed by a general part about strategic management and then 5 basic key areas from the mission, vision and goals, through the external environment followed by the internal environment. The penultimate part of the questionnaire contains questions focused on the selection, evaluation and implementation of strategies. The last part consists of questions aimed at checking strategies. A total of 67 questionnaire survey questions are prepared, divided into 7 sections according to the topic. Considering the focus of the publication, the last area of research focused on strategy implementation and control was selected. For each response sought, a Likert scale of 1-5 was applied: 1 – completely disagree; 3 – neutral; 5 – completely agree. To analyze the differences in the application of planning processes, the following research questions were formulated:

RQ1 - Does the implementation and control processes in the company depend on size of company?
RQ2 - Are there differences in the implementation and control processes in companies depending on the primary area of operation?

For the purpose of this study variable optimization was applied for a better understanding of the individual factors (see Table 1 below).

Table 1. Operationalisation of variables

Variable	Operationalisation	Method of measurement
Size of the company	Determinate your company size according to number of employees.	Micro enterprise; small business; medium enterprise; big business
Primary are of operation	Select the primary are of business operations	Production; services; a combination of the above
Implementation and Control questions (Implementation; Quality; Formalization; Alignment; Reserves; Growth; Motivation; Monitoring; Check; Review)	Items G1 - G10	Likert scale 1–5: 5 – completely agree; 3 – neutral; 1 – completely disagree

Source: own processing

4. Results

The first goal of the work was to make a basic overview of scopus articles using bibliographic analysis, while the articles should focus on the implementation and control of strategic commercial processes. This analysis offers a basic overview of the main relevant terms, followed by an overview of the number of words, connected to the cluster distribution of the issue using graphic maps showing the classification of clusters and the temporal development of publications. The last step enables the preview of the heat map for the deep field cluster of the graphic representation of the intensity of the relevant terms.

Table 2. Occurence score model

Term	Occurence*
Supply chain	365
Price	329
Condition	289
Production	251
Profit	245
Adoption	227
Interaction	207
Supplier	196
Manufacturer	196

*60% Rellevance score and 10x term article repetition
Source: own processing

The analysis of Scopus articles on strategic management in commerce, utilizing the Voswiever software, reveals a significant emphasis on terms that underscore the intricate dynamics of business operations. The prominence of terms such as "supply chain," "price," "condition," "production," "profit," "adoption," "interaction," "supplier," and "manufacturer" indicates a robust focus on core elements that drive strategic decision-making. The recurring mention of "supply chain" emphasizes the critical role of efficient logistical processes and interconnected networks in commerce. "Price" and "profit" signify a keen interest in financial aspects, underscoring the importance of pricing strategies and profitability in strategic management discussions. The term "condition" suggests an examination of external factors influencing business environments. The frequent occurrence of "production" aligns with a concentration on operational processes and manufacturing strategies. "Adoption" indicates a consideration of innovative practices or technology integration in commerce. The terms "interaction," "supplier," and "manufacturer" collectively highlight the significance of collaborative relationships, supply chain dynamics, and production partnerships. In summary, the prevalence of these terms reflects a comprehensive exploration of multifaceted aspects crucial to strategic management in the complex landscape of commerce.

Table 3. Relevance score model

Term	Relevance
Trading enterprise	6.53
Strategic sustainability	6.12
Post digital world	5.32
Busy executive	4.75
Latest management development	4.67
Practical thinking	4.60
Briefing	4.54
Technology roadmapping	4.20
Virtural water	3.43

Source: own processing

The highest relevance scores in the analysis, particularly for terms such as "Trading enterprise," "Strategic sustainability," "Post digital world," "Busy executive," "Latest management development," "Practical thinking," "Briefing," "Technology roadmapping," and "Virtual water," suggest a nuanced focus on contemporary and forward-looking aspects of strategic management in commerce. The term "Trading enterprise" reflects a specific attention to businesses engaged in trade, potentially indicating an emphasis on global market dynamics and international trade strategies. "Strategic sustainability" suggests a growing awareness of the importance of integrating sustainable practices into strategic management approaches, aligning with the global shift toward environmentally conscious business strategies. The mention of the "Post digital world" indicates a recognition of the evolving digital landscape and its impact on commerce, highlighting the need for adaptive and innovative strategic approaches. "Busy executive" and "Latest management development" point towards a focus on the role and skills of executives, indicating a consideration of leadership and professional development in the context of strategic management. "Practical thinking" may suggest a pragmatic orientation, emphasizing the application of strategic concepts in real-world scenarios. "Briefing" hints at a preference for concise and informative communication, potentially reflecting an awareness of the importance of effective communication in strategic decision-making. "Technology roadmapping" underscores the significance of technology planning and foresight in strategic management, aligning with the rapid advancements in technology that shape modern commerce. Lastly, the term "Virtual water" could indicate an exploration of water footprint considerations, reflecting a broader awareness of sustainability in resource management within the strategic context. Overall, the highest relevance scores for these terms suggest a comprehensive and future-oriented exploration of strategic management in commerce, encompassing technological advancements, sustainability, leadership, and practical application.

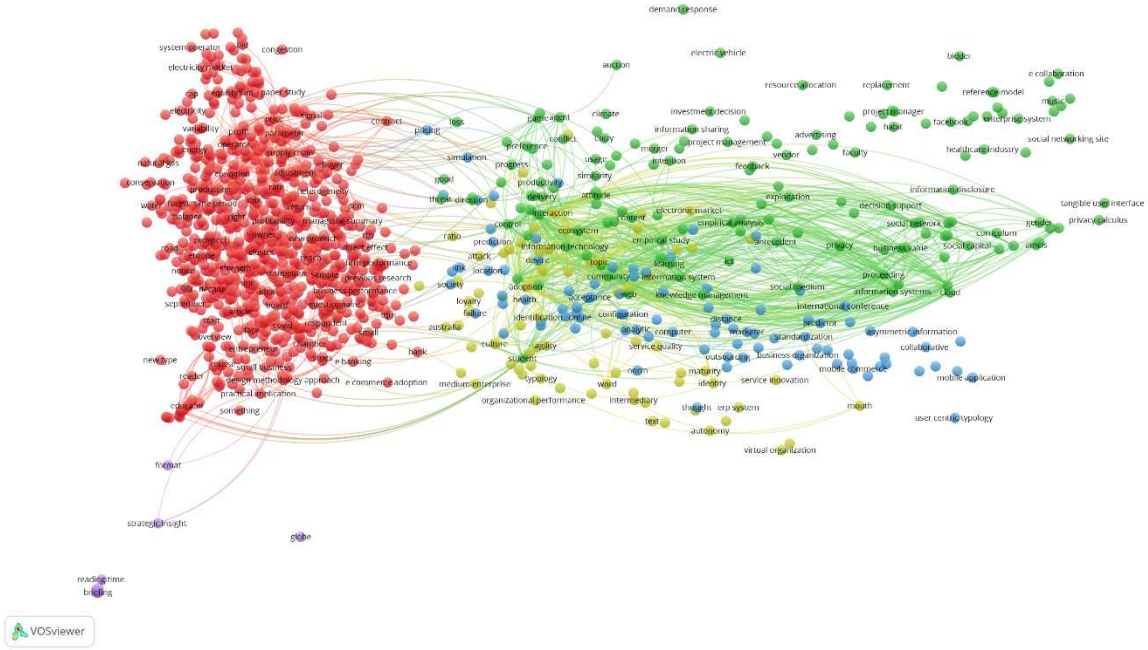

Figure 1. Graphic illustration - Network visualization
Source: own processing

For each of the 2377 terms, a relavance score was calculated. Based on this score, the most relevant terms were selected. The default choice was set for 60% most relevant terms. In total 1426 terms are presented with occurence more then 10 times per article.

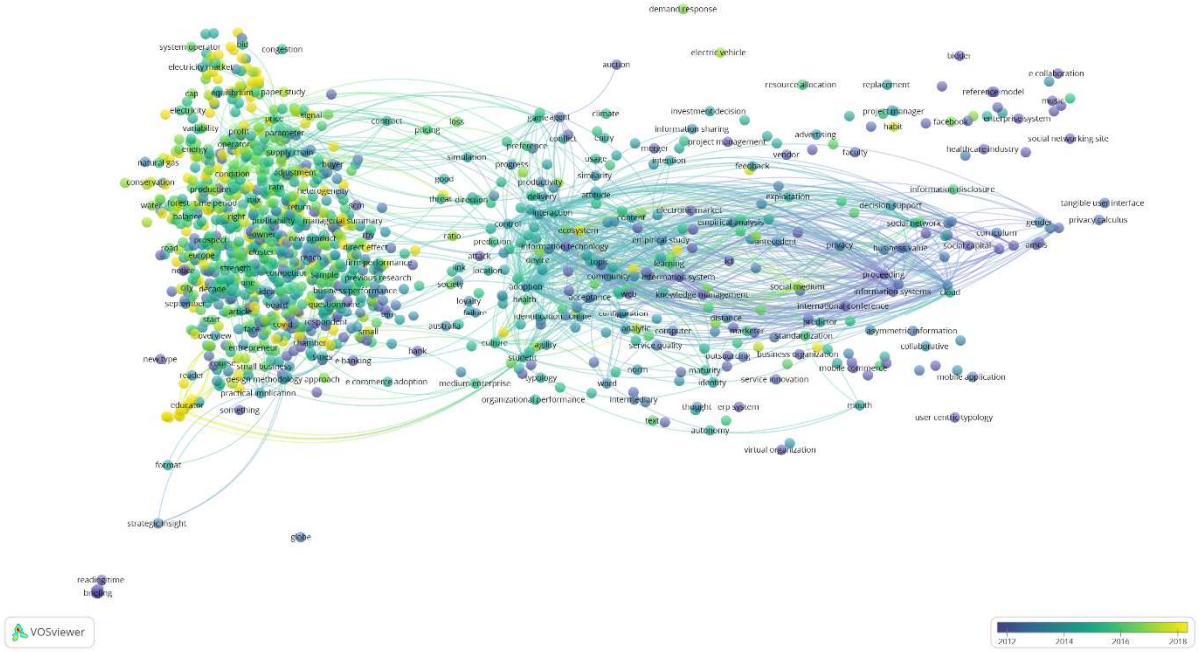

Figure 2. VOSviewer analysis - term relevance
Source: own processing

The examination of Scopus articles utilizing the Voswiever software yields insightful observations concerning the pivotal themes shaping discourse on strategic management within the commercial domain. The prevalence of terminologies such as "supply chain," "price," "condition," "production," "profit," "adoption," "interaction," "supplier," and "manufacturer" accentuates the intricate and multifaceted nature inherent in the processes of strategic decision-making. These terminologies collectively underscore the significance of factors such as logistical efficiency, financial considerations, external influences,

operational methodologies, innovation, and collaborative relationships within the commercial sphere. Transitioning to the metric of relevance scores, expressions like "Trading enterprise," "Strategic sustainability," "Post digital world," "Busy executive," "Latest management development," "Practical thinking," "Briefing," "Technology roadmapping," and "Virtual water" elucidate a prospective orientation within strategic management discourse. "Trading enterprise" implies a focus on global market dynamics, while "Strategic sustainability" signifies a dedication to incorporating sustainable practices into strategic paradigms. The reference to the "Post digital world" indicates cognizance of the transformative impact of the evolving digital landscape on commerce, necessitating adaptive strategic approaches. "Busy executive" and "Latest management development" signal an attention to executive roles and competencies, emphasizing considerations related to leadership and professional growth. The term "Practical thinking" suggests a pragmatic inclination, emphasizing the application of strategic concepts in real-world scenarios. "Briefing" underscores the importance of succinct communication in the context of strategic decision-making. "Technology roadmapping" aligns with the significance attributed to technology planning, while "Virtual water" denotes an awareness of water footprint and sustainability considerations in resource management within the strategic context. These relevance scores collectively underscore a comprehensive and forward-looking exploration of strategic management within commerce, encompassing aspects of technological advancements, sustainability practices, leadership dynamics, and practical application.

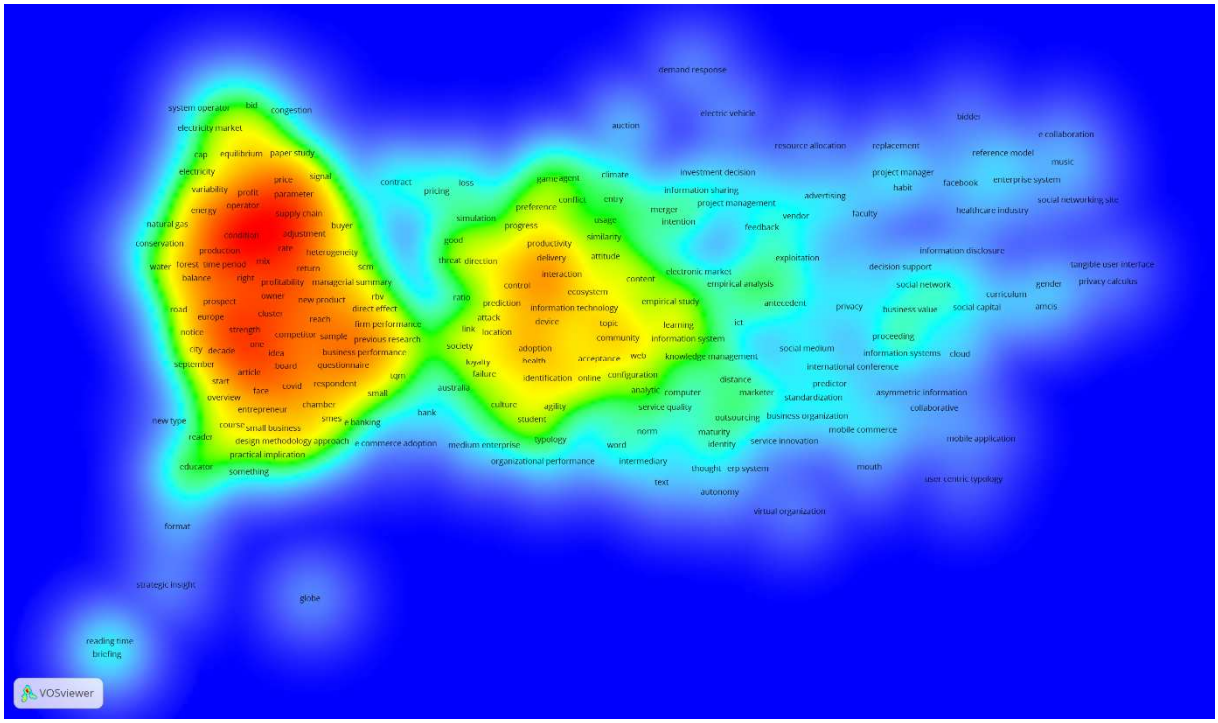

Figure 3. Visualization of density
Source: own processing

4.1 Strategic management area - implementation and control of strategy

Strategy implementation and control, often referred to as strategic management, is a critical process for organizations seeking to realize their long-term goals. From careful planning and resource allocation to monitoring and adaptation, this process involves systematic steps to ensure the effective execution of strategic initiatives. Key aspects are regular evaluations, the use of KPIs to track progress and create feedback to ensure that the strategies implemented are in line with the original objectives. In addition, it is essential to manage risks and be ready to adapt to changes in the internal and external environment. Communication and obtaining feedback from employees and stakeholders are key elements that support the success of this process. Strategy implementation and control are not static tasks, but a dynamic cycle of continuous improvement and adaptation for an organization to achieve and maintain its competitive advantage. In our research, we therefore focused on several specific points mentioned above. Questions G1 to G10 examine the given issue.

4.2 Implementation and control of the strategy according to the size of the company

The implementation and control of the strategy according to the size of the enterprise is adapted to the specific needs and characteristics of the organization. In the case of large enterprises, where there is a complex structure and multi-level management, it is crucial to create specialized teams and management layers that will be responsible for individual aspects of the strategy. The use of technological tools and software enables effective monitoring and coordination of all phases of implementation. In addition, it is essential to ensure clear communication channels between different levels of management and operatives. Conversely, SMEs may prefer a more flexible approach with less formal management. In these cases, it may be important to encourage creativity and rapid adaptation to environmental changes. Regardless of business size, it is critical to constantly monitor and evaluate strategy to adapt to dynamic business conditions and achieve long-term success. The following table shows the average values of the company size factor.

Table 4. Report

Size of the company		G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Microbusiness	Mean	3,38	3,65	3,16	3,46	3,61	3,59	3,71	3,10	3,10	3,14
Small business	Mean	3,66	3,70	3,44	3,69	3,64	3,86	3,80	3,52	3,60	3,53
Medium business	Mean	3,32	3,62	3,41	3,42	3,51	3,77	3,43	3,49	3,51	3,37
Large business	Mean	3,91	3,97	3,68	3,73	3,76	3,96	3,60	3,88	3,75	3,78
Total	Mean	3,59	3,75	3,45	3,58	3,63	3,81	3,62	3,55	3,53	3,49

Source: authors (2025)

Analysis of strategy implementation and control factors shows that large enterprises excel at implementing decisions, probably due to having enough resources for smooth and effective implementation. On the contrary, small and medium-sized enterprises placed more emphasis on the quality of strategy implementation than on its speed. From the point of view of sharing best practices, large enterprises have formal mechanisms ensuring the transfer of best practices between different areas of activity. Synchronizing strategy with organizational structure is a priority for both large and small businesses. As a result, large enterprises generally have the highest values in the area of sufficient reserve resources, signaling their ability to respond to deviations from strategy. Strategic planning shows a high impact on the growth of sales and profits in both large and small businesses. Employee motivation and remuneration are of a high standard, with the highest values for large enterprises. Monitoring and evaluation of implemented strategies is actively practiced primarily in large and small enterprises. Pre-implementation and post-implementation control is gaining importance for both small and large businesses. Overall, it can be concluded that the size of the company plays a key role in the process of strategy implementation and control, influencing the approach of organizations to various aspects of strategic management.

Table 5. Test Statistics[a,b]

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Kruskal-Wallis H	20,181	9,455	12,663	5,959	2,758	5,735	5,963	25,642	14,154	16,482
Asymp. Sig.	**,000**	**,024**	**,005**	,114	,430	,125	,113	**,000**	**,003**	**,001**
Post hoc	3-4 1-4	3-4	1-4					1-4 3-4	1-2 1-4	1-4 3-4

a. Kruskal Wallis Test
b. Grouping Variable: Approximate size of the surveyed company by employees
Source: authors (2025)

The analysis showed that there are significant differences in some aspects of strategy implementation and control between different sizes of enterprises. In the case of implementing decisions (G1) and monitoring and evaluating strategies (G8), the differences are more pronounced between medium-sized and large enterprises, as well as between micro-enterprises and large enterprises. These differences

can be explained by probable differences in available resources and complexity of business processes between different size categories. In the field of quality vs. speed of implementation (G2), the differences are most pronounced between medium and large enterprises, indicating a possible different prioritization of these factors depending on the size of the enterprise. The sharing of best practices (G3) and control before strategy implementation (G9) show differences between micro-enterprises and large enterprises, which may reflect different approaches to management practices and the needs to exchange experiences in these categories. Monitoring after strategy implementation (G10) shows differences between medium-sized and large enterprises, as well as between micro-enterprises and large enterprises, which could be related to the complexity of monitoring and evaluating strategies depending on the size of the organization. These findings could provide valuable information for managers when adapting the company's strategy in an effort to increase the efficiency and success of strategy implementation.

4.3 Implementation and control of the strategy according to the primary area of operation

The implementation and control of strategy can be influenced by the company's primary area of operation, whether it is manufacturing, service provision, or a combination of both. Each of these areas has its own characteristics and specifics that can affect the way an organization formulates, implements and monitors its strategies.

1. Production:
   - In the area of production, the key factor is the efficiency of production processes and supply chain management.
   - Strategies may include optimizing production processes, investing in technology, and securing the supply of raw materials.
   - Control includes product quality monitoring, storage management and optimization of production capacities.
2. Services:
   - In the service industry, a focus on providing high-quality and customized customer service is important.
   - Strategies may include personalized service, process innovation, and building a strong relationship with customers.
   - Control consists in measuring customer satisfaction, monitoring service performance and adapting the strategy according to the changing needs of clients.
3. Combination (Production and services):
   - For organizations combining production and services, a balanced approach to both sectors of activity is a key aspect.
   - Strategies may involve the integration of production and services, resulting in the delivery of value to customers at multiple levels.
   - Control includes monitoring performance in both sectors and ensuring synergy between them.

In any case, it is important that organizations take into account the specific needs and challenges of their primary area of operation when formulating and implementing strategy. For example, a manufacturing business will focus more on processes and inventory optimization, while a service business will emphasize customer interactions and innovative approaches. The combined company will have to manage the challenges of both industries and look for synergistic opportunities. In the following table, we will look at the average values in the case of the factor primary area of operation of the company.

Table 6. Report

Primary are of peration		G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Production	Mean	3,44	3,81	3,43	3,48	3,67	3,66	3,62	3,67	3,57	3,42
Service	Mean	3,53	3,63	3,38	3,54	3,67	3,81	3,59	3,47	3,45	3,47
Combination	Mean	3,81	3,90	3,60	3,75	3,54	3,95	3,68	3,58	3,64	3,59
Total	Mean	3,59	3,75	3,45	3,58	3,63	3,81	3,62	3,55	3,53	3,49

Source: authors (2025)

The manufacturing, service, and combination sectors differ greatly in terms of strategy implementation and control. Manufacturing businesses lead with lower ratings in the area of decision implementation, indicating greater complexity and the need to overcome technological and logistical obstacles. The ability to execute decisions quickly and efficiently, on the other hand, is a strength of the service sector and can be a hallmark of service delivery. The best values are attained by combined businesses, demonstrating their adaptability and capacity to carry out decisions in both industries. In terms of quality versus speed of implementation, manufacturing and service industries stand out with an emphasis on quality, while combined businesses show a balanced approach. Regarding the sharing of best practices, manufacturing enterprises achieve lower values, while services and combined industries show a higher importance of sharing best practices. The manufacturing sector exhibits greater difficulty in aligning strategy with organizational structure, whereas services demonstrate a superior ability to do so. The highest values are attained by combined businesses, demonstrating a balanced strategy in both industries. The services sector outperforms the industrial sector in terms of allocating appropriate reserve resources. Lower values are obtained by combined firms, which would suggest that reserve resource management requires a balanced strategy. Services outperform manufacturing in terms of how strategic planning affects sales and profit growth, whereas combined businesses have a balanced approach. Employee motivation and compensation are more important in the service industry, while combined businesses show higher value in both aspects. Monitoring and evaluation strategies show similar values for manufacturing and combined industries, with a greater need for improvement for services. A pre-strategy check shows similar values for manufacturing and combined industries with lower values for services. In the area of control after strategy implementation, manufacturing and combined enterprises achieve similar values with lower values for services. Overall, it follows that each industry has its own specific characteristics and prioritizes different aspects of strategy implementation and control.

Table 7. Test Statistics[a,b]

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10
Kruskal-Wallis H	6,977	5,734	2,920	4,752	,915	2,871	,430	2,501	2,315	1,297
Asymp. Sig.	**,031**	,057	,232	,093	,633	,238	,806	,286	,314	,523
Post hoc	2-3									

a. Kruskal Wallis Test
b. Grouping Variable: Area in which the company primarily operates
Source: authors (2025)

The difference in values between production and combination in question G1 on the implementation of decisions can be interpreted in the context of the characteristics of these industries. Manufacturing enterprises achieve lower values, which could be related to their probably higher complexity and the need to solve logistical and technological challenges in the process of implementing decisions. On the contrary, combined enterprises achieve the highest values, indicating their flexibility and ability to implement decisions in both sectors. These differences may reflect the different needs and challenges associated with strategy implementation in manufacturing and combined activities, where combined firms are likely to excel in adaptability and coordination of decisions for different parts of their business structure.

5. Discussion

The research methodology employed in this study involved a comprehensive evaluation of strategic management processes within commerce companies operating in Slovakia. The focus was on identifying strengths and weaknesses in the implementation and control processes of specific companies and proposing rationalization measures to enhance their strategic management processes. The research utilized a combination of interviews and a questionnaire survey. Prior to the questionnaire distribution, pilot verification was conducted with subject matter experts and private sector representatives to refine the instrument. With a response rate of 87.50%, 350 out of 400 companies formed the final sample after data adjustment. Stratified randomization was applied based on the criterion that participating entities must be registered in the Slovak Commercial Register, with company representatives familiar with

strategic management issues completing the questionnaire. The survey instrument consisted of 67 questions divided into seven sections, focusing on respondent qualifications, general strategic management aspects, and specific key areas ranging from mission and vision to internal and external environmental considerations. The final part of the questionnaire centered on strategy implementation and control, with Likert scale responses ranging from 1 (completely disagree) to 5 (completely agree). The subsequent analysis of Scopus articles, employing Voswiever software, provided valuable insights into the dominant themes in strategic management within commerce. Such an aprroach using Voswiever software is also recommended by Arruda et al. (2022) . The identification of terms such as "supply chain," "price," "condition," "production," "profit," "adoption," "interaction," "supplier," and "manufacturer" underscored the multifaceted dynamics influencing strategic decision-making. Simmiliar studies such as Purnomo et al. (2021) came to familiar conclusions in Indonesia. A relevance score analysis revealed contemporary and forward-looking focuses, with terms like "Trading enterprise," "Strategic sustainability," "Post digital world," and others indicating a nuanced exploration of strategic management aspects which are supported also by Rao and Shukla (2023). Further visualizations and heat maps illustrated the intensity and relevance of identified terms, offering a comprehensive overview of the research landscape. Ellegaard, O. (2018) on the other hand, he warns that bibliographic methods should be used wisely, as their misinterpretation can lead to errors.The subsequent survey results delved into the implementation and control of strategic processes, focusing on size and primary area of operation as variables. The statistical analyses, including Kruskal-Wallis tests, unveiled significant differences in various aspects of strategy implementation and control based on the size and primary area of operation of companies. Regarding company size, large enterprises demonstrated superior decision implementation and monitoring of strategies, likely due to enhanced resources, especially after Covid pandemic. This aprroach is highlighted also by Ketchen et al. (2020). Small and medium-sized enterprises emphasized the quality of strategy implementation over speed, and large enterprises exhibited formal mechanisms for sharing best practices and aligning strategy with organizational structure. For example Arora et al. (2018) points out the problematic of decline of science in corporate R&D. Strategic planning's impact on sales and profit growth, employee motivation, and strategy monitoring were actively practiced in both large and small enterprises. Bryson et al. (2018) states that strategic planning in any company is essential. Concerning the primary area of operation, manufacturing enterprises prioritized decision quality over speed, while service industries excelled in implementing decisions quickly. The need to focus in such a factors is also pointed by Jones andKierzkowski (2018). Combined enterprises exhibited a balanced approach. This aprroach is also supported by Pawlak and Kołodziejczak (2020) in agriculture sector. Significant variations were observed in sharing best practices, aligning strategy with organizational structure, and allocating sufficient reserve resources among different sectors. In conclusion, the research provides a robust methodological approach, integrating Scopus articles analysis with survey data to offer comprehensive insights into the strategic management processes of commerce companies in Slovakia. The findings shed light on the impact of company size and primary area of operation on specific aspects of strategy implementation and control, offering valuable information for managers seeking to enhance efficiency and success in strategic management. The study contributes to the broader discourse on strategic management in the complex landscape of commerce, emphasizing the need for adaptable and nuanced approaches tailored to specific organizational contexts. Such a research can contribute to better understanding of business enviroment and can be compared to other countries such as Czech Republic or Poland, where simmiliar results emerge accroding to Šebestová (2020).

Conclusion

In conclusion, this study provides a significant contribution to the understanding of strategic management within the context of commerce in Slovakia. Through meticulous research methodology and robust analysis, the study investigates the interplay between company size, primary area of operation, and the implementation and control of strategies. The findings shed light on various dimensions of strategic management, including Efficiency and Perfection, Quality and Deliberation, Formality and Collaboration, as well as Alignment and Stability. The research fills a notable gap in the literature by focusing specifically on the Slovakian business environment, emphasizing the importance and timeliness of its findings. By addressing this gap, the study not only enhances theoretical understanding but also offers practical implications for decision-making processes, resource allocation strategies, and organizational design within the commercial sector. The utilization of statistical analysis methods adds rigor to the

findings, bolstering their credibility and applicability. The comprehensive exploration of factors influencing commerce strategic management in Slovakia lays the groundwork for future research endeavors in this field, guiding further exploration and understanding of the multifaceted dynamics at play. The hypotheses formulated and tested in this study provide valuable insights into the variations in strategic management practices among companies of different sizes and primary areas of operation. Through rigorous methodology and meticulous data analysis, the study illuminates the nuanced challenges and opportunities inherent in strategic decision-making processes within the Slovakian business landscape. Looking ahead, this research sets the stage for continued exploration and refinement of strategic management practices in commerce, particularly within Slovakia's unique context. By bridging the gap in the literature and offering a nuanced understanding of the factors shaping commerce strategic management, this study facilitates evidence-based decision-making and strategic optimization in the dynamic and evolving landscape of commerce within Slovakia. On the other hand, however, we want to point out the limitations of this work in the context of the sample size, which although represents the representation of Slovak companies, but a larger number of respondents would help. We also see limitations as a result of focusing only on Slovak companies, even if the results were compared with similar works in the discussion, there is still an overview of, for example, the Central European region as a whole. Therefore, we still see possibilities for deeper research.

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Optimizing Managerial Decision-Making Processes in Complex Organizational Systems using Transformative Intelligence-Based Strategic Frameworks

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Abstract

Research background: Complex organizational systems present significant challenges for managerial decision-making, often characterized by cognitive biases, competing pressures, and multidimensional dynamics between cognitive, emotional, and social management processes.
Purpose of the article: This research examines how Transformative Intelligence (TI) theory can enhance leaders' decision-making processes and strategic action implementation within complex organizational systems, with focus on understanding relationships between cognitive flexibility, psychological adaptability, and managerial effectiveness.
Methods: A mixed-methods approach was employed including quantitative analysis of data from 60 committee chairs and 87 committee members, plus qualitative systematic content analysis of 50 committee minutes from 2019-2023. Selection and characterization committees in special education served as the case study context, representing complex managerial decision-making systems with ethical dilemmas, budget constraints, and competing organizational pressures.
Findings & Value added: Analysis revealed systematic cognitive biases operating across leadership levels: representativeness heuristics (73.2% of cases), availability heuristics (79.3%), and anchoring heuristics (81.7%). Chairpersons with high levels of transformative intelligence (17.3% of sample) showed significant improvements in decision quality metrics: bias identification and reduction (89.2% vs. 34.7% in control group), decision flexibility (78.4% vs. 23.8%), and innovative solution development (84.1% vs. 19.2%). Psychological flexibility demonstrated high correlations (r = 0.66-0.79) with all transformative intelligence components.

Keywords: Decision Making Processes Management, Transformative Intelligence, Complex Organizational Systems, Cognitive Biases, Psychological Flexibility

JEL classification: J24, J21

1. Introduction

Complex organizational systems present unprecedented challenges for managerial decision-making in contemporary business environments. These systems are characterized by multiple stakeholders, competing objectives, resource constraints, and ethical considerations that create cognitive load and decision-making complexity beyond traditional management frameworks (Fasolo et al., 2025). Research demonstrates that cognitive biases significantly impact strategic decision-making processes, with systematic biases operating similarly across individuals including overconfidence, escalation of commitment, and various heuristic-based errors that can substantially impair organizational performance (Laureiro-Martínez & Brusoni, 2018).

Research demonstrates that cognitive biases significantly impact strategic decision-making processes, with systematic biases operating similarly across individuals including overconfidence, escalation of commitment, and various heuristic-based errors that can substantially impair organizational performance (Laureiro-Martínez & Brusoni, 2018). Recent comprehensive reviews reveal that while the detrimental influence of cognitive biases on organizational performance is well-established, there remains insufficient

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attention to bias mitigation interventions that can improve organizational decisions in practice (Fasolo et al., 2025).

The emergence of cognitive flexibility as a critical factor in organizational adaptation has garnered significant attention in management research. Cognitive flexibility, defined as the ability to match the type of cognitive processing with the type of problem at hand, enables decision makers to achieve significantly higher decision-making performance when facing complex organizational challenges (Laureiro-Martínez & Brusoni, 2018). This capability proves particularly crucial in uncertain environments where traditional decision-making frameworks may prove inadequate.

Psychological flexibility has emerged as another vital component in organizational effectiveness, representing the ability to adapt to changing circumstances, manage emotions effectively, and stay aligned with personal and organizational values (Archer et al., 2024). Research indicates that psychological flexibility serves as a mediating mechanism for various organizational outcomes, including stress resilience, job performance, and adaptive capacity in complex work environments.

The intersection of cognitive biases, psychological flexibility, and organizational decision-making creates a complex landscape requiring sophisticated theoretical frameworks to understand and optimize managerial effectiveness. Current research reveals that decision-making in organizational contexts is influenced by both internal factors such as perception and external factors including digitalization and environmental complexity (Castaldi et al., 2021). However, existing frameworks often fail to integrate these multiple dimensions into coherent approaches for managerial practice.

This research addresses these gaps by examining how Transformative Intelligence theory can enhance decision-making processes in complex organizational systems. The study focuses on selection and characterization committees in special education as a representative case of complex managerial environments characterized by ethical considerations, resource constraints, and multiple stakeholder interests requiring sophisticated decision-making capabilities.

2. Methods

2.1 Research Design

This study employed a mixed-methods approach designed to examine the relationship between transformative intelligence components and decision-making effectiveness in complex organizational contexts. The research design integrated quantitative analysis of decision-making patterns and qualitative content analysis of decision processes to provide comprehensive understanding of managerial effectiveness factors.

2.2 Participants and Setting

The study examined selection and characterization committees in special education systems, representing complex organizational environments with multiple stakeholders, ethical considerations, and resource constraints. The sample included 60 committee chairs and 87 committee members across various organizational levels and functional areas.

Selection criteria required participants to have at least two years of experience in committee leadership or membership roles, involvement in decision-making processes with significant organizational impact, and willingness to participate in both quantitative assessments and qualitative interviews. The special education context was selected due to its representation of complex decision-making environments involving ethical dilemmas, budget constraints, legal requirements, and multiple stakeholder interests.

2.3 Data Collection

Quantitative data collection involved comprehensive assessment of cognitive bias patterns, psychological flexibility measures, and decision-making effectiveness indicators. Participants completed validated instruments measuring representativeness heuristics, availability heuristics, anchoring biases, and other cognitive biases documented in organizational decision-making research (Kahneman & Tversky, 1974).

Psychological flexibility was assessed using established measures examining acceptance, mindfulness, values clarification, and behavioral adaptation capabilities (Hayes et al., 2006). Decision-making effectiveness was evaluated through multiple indicators including bias recognition, decision revision capability, innovative solution generation, and stakeholder consideration in decision processes.

Qualitative data collection involved systematic content analysis of 50 committee meeting minutes from 2019-2023, providing longitudinal perspective on decision-making patterns and processes. Content analysis focused on identifying decision-making strategies, bias manifestations, flexibility demonstrations, and innovative problem-solving approaches across different organizational contexts and challenges.

2.4 Analytical Approach

Quantitative analysis employed correlation analysis, regression modeling, and group comparison techniques to examine relationships between transformative intelligence components, psychological flexibility, and decision-making effectiveness measures. Statistical analyses were conducted using established procedures for organizational research, with appropriate controls for organizational level, experience, and contextual factors.

Qualitative analysis followed systematic content analysis procedures, involving independent coding by multiple researchers, inter-rater reliability assessment, and thematic identification across decision-making episodes (Kuo et al., 2018). Integration of quantitative and qualitative findings provided comprehensive understanding of mechanisms underlying effective decision-making in complex organizational systems.

3. Results

3.1 Cognitive Bias Patterns in Organizational Decision-Making

Analysis revealed systematic patterns of cognitive biases operating across multiple levels of organizational leadership, consistent with previous research on professional decision-making (Montibeller & von Winterfeldt, 2015) and recent comprehensive reviews of bias mitigation in organizational contexts (Fasolo et al., 2025). Representativeness heuristics appeared in 73.2% of cases, typically manifesting as over-reliance on stereotypical characteristics when evaluating individuals or situations rather than considering base rate information or statistical evidence.

Availability heuristics occurred in 79.3% of cases, demonstrating tendency to overweight easily recalled information or recent events when making probability assessments or strategic evaluations. This bias proved particularly problematic in resource allocation decisions where memorable but unrepresentative cases influenced funding priorities and program development strategies.

Anchoring heuristics appeared in 81.7% of cases, showing strong tendency to rely heavily on initial information presented during decision-making processes. Committee chairs frequently anchored on first proposals or initial budget figures, with insufficient adjustment based on subsequent information or changing circumstances.

These bias patterns created systematic deviations from optimal decision-making processes, leading to suboptimal resource allocation, inadequate consideration of alternative solutions, and reduced adaptability to changing organizational requirements. The combination of multiple biases operating simultaneously created compound effects that significantly impaired decision quality across organizational levels, consistent with recent frameworks identifying the need for systematic bias mitigation interventions in organizational settings (Fasolo et al., 2025).

3.2 Transformative Intelligence Components and Decision-Making Effectiveness

Chairpersons identified as having high levels of transformative intelligence (17.3% of the sample) demonstrated significant improvements across all decision-making effectiveness metrics compared to control groups. This high-performance group showed superior bias identification and reduction capabilities (89.2% vs. 34.7% in control group), indicating enhanced metacognitive awareness of their own decision-making processes.

Decision flexibility measures revealed substantial differences between high and low transformative intelligence groups (78.4% vs. 23.8%), demonstrating enhanced ability to modify initial decisions when presented with new information or changing circumstances. This flexibility proved crucial for adaptive management in complex organizational environments requiring responsiveness to stakeholder needs and environmental changes, aligning with recent research on organizational flexibility and performance outcomes (Eng et al., 2025).

Innovative solution development showed the largest effect sizes (84.1% vs. 19.2%), indicating that transformative intelligence components particularly enhance creative problem-solving capabilities. High-

performing leaders demonstrated ability to generate novel approaches to organizational challenges while maintaining practical feasibility and stakeholder acceptance.

Perceptual flexibility emerged as a key component, representing metacognitive ability to recognize and change meaning contexts when interpreting organizational challenges and opportunities. Leaders with high perceptual flexibility showed enhanced ability to reframe problems, consider multiple perspectives, and identify underlying assumptions affecting decision-making processes.

3.3 Psychological Flexibility as Mediating Mechanism

Psychological flexibility demonstrated high correlations with all components of transformative intelligence ($r = 0.66$-0.79), suggesting integrated relationships between acceptance-based psychological processes and cognitive adaptability in organizational contexts (Archer et al., 2024). These correlations remained significant after controlling for experience, organizational level, and contextual factors.

The mediating role of psychological flexibility appeared particularly important for stress management during high-stakes decision-making episodes. Leaders with higher psychological flexibility maintained decision-making effectiveness under pressure, showed reduced emotional reactivity to criticism or setbacks, and demonstrated greater persistence in pursuing optimal solutions despite organizational obstacles.

Values-based decision-making emerged as a crucial component, with psychologically flexible leaders showing enhanced ability to maintain ethical standards and stakeholder consideration while pursuing organizational objectives. This capability proved essential for sustainable decision-making in complex environments involving competing interests and limited resources.

3.4 Organizational Meta-Capability Development

When all transformative intelligence components operated synergistically, analysis revealed emergence of organizational meta-capability enabling continuous learning, process optimization, and sustained improvements in decision-making effectiveness. This meta-capability transcended individual leader performance to create systemic improvements in organizational decision-making processes, consistent with recent frameworks for designing intelligent organizations through human-AI collaboration principles (Kolbjørnsrud, 2024).

Organizations with multiple high-transformative intelligence leaders demonstrated enhanced collective decision-making capabilities, including improved information sharing, reduced groupthink tendencies, and enhanced consideration of diverse perspectives in strategic planning processes. These organizational-level effects suggested potential for systematic cultivation of transformative intelligence across management hierarchies.

4. Discussion

4.1 Theoretical Implications for Management Science

The research reveals significant theoretical implications for understanding decision-making effectiveness in complex organizational systems. The integration of cognitive flexibility, psychological flexibility, and values-based decision-making provides a more comprehensive framework than traditional approaches focusing solely on analytical or technical competencies (Smit et al., 2025).

The finding that psychological flexibility mediates relationships between cognitive capabilities and decision-making effectiveness challenges traditional separation between cognitive and emotional factors in management research. This integration suggests that effective decision-making requires simultaneous development of analytical thinking skills and psychological adaptability, consistent with emerging research on holistic leadership approaches and recent empirical validation of psychological flexibility as a key organizational resource (Archer et al., 2024).

The emergence of organizational meta-capability when multiple leaders demonstrate transformative intelligence suggests potential for systemic interventions addressing decision-making effectiveness at organizational rather than individual levels. This finding extends current research on organizational learning and adaptation by identifying specific mechanisms through which individual capabilities aggregate to create organizational capabilities, aligning with contemporary frameworks for organizational intelligence design (Kolbjørnsrud, 2024).

4.2 Practical Applications for Organizational Development

The research provides specific guidance for developing transformative intelligence capabilities across organizational levels. Leadership development programs should integrate cognitive flexibility training with psychological flexibility interventions, moving beyond traditional focus on analytical skills to include emotional regulation, values clarification, and adaptive thinking capabilities (Kuo et al., 2018). Recent evidence demonstrates that organization-wide psychological flexibility training can significantly improve workforce resilience and performance, suggesting scalable approaches for transformative intelligence development (Archer et al., 2024).

Selection and promotion criteria should incorporate transformative intelligence assessments alongside traditional competency evaluations. The research suggests that leaders with high transformative intelligence create positive spillover effects throughout their organizational units, making these capabilities valuable for organizational performance beyond individual effectiveness. This approach aligns with contemporary research on balancing employee flexibility and organizational performance, particularly in innovation and productivity outcomes (Eng et al., 2025).

Organizational design implications include creating decision-making processes that support rather than inhibit transformative intelligence expression. This includes reducing time pressures that promote reliance on heuristics, creating diverse decision-making teams that challenge individual biases, and establishing feedback mechanisms that enable continuous improvement in decision-making processes. Contemporary frameworks for intelligent organization design provide additional guidance for implementing systematic approaches to human-cognitive capability collaboration (Kolbjørnsrud, 2024).

4.3 Integration with Existing Decision-Making Research

The findings integrate with existing research on cognitive biases in organizational settings while extending understanding of mitigation mechanisms. While previous research has documented extensive bias effects in managerial decision-making (Montibeller & von Winterfeldt, 2015), this study identifies specific capabilities that enable bias recognition and reduction in applied organizational contexts.

The role of psychological flexibility extends existing research on acceptance and commitment approaches in organizational settings by demonstrating specific mechanisms through which these capabilities improve decision-making effectiveness (Hayes et al., 2006). The research provides empirical support for integrated approaches combining cognitive and psychological interventions for managerial development.

4.4 Limitations and Future Research Directions

The study's focus on special education committees, while providing rich context for examining complex decision-making, may limit generalizability to other organizational contexts. Future research should examine transformative intelligence effects across diverse industries and organizational types to establish broader applicability of these findings.

The cross-sectional nature of quantitative assessments limits understanding of how transformative intelligence capabilities develop over time and respond to organizational interventions. Longitudinal research tracking capability development and decision-making improvements would provide valuable insights for leadership development practice, building on recent evidence for the effectiveness of systematic psychological flexibility interventions (Archer et al., 2024).

Sample size limitations, particularly for the high-transformative intelligence group (17.3% of sample), restrict statistical power for examining interaction effects and moderating variables. Larger-scale studies would enable more sophisticated analyses of factors influencing transformative intelligence effectiveness across different organizational contexts, potentially incorporating principles from contemporary organizational intelligence design frameworks (Kolbjørnsrud, 2024).

Future research should explore the integration of transformative intelligence with emerging organizational flexibility models, particularly examining how different flexibility profiles (flexible dividers, non-flexible dividers, etc.) relate to transformative intelligence capabilities and organizational outcomes (Eng et al., 2025).

Conclusions

This research demonstrates that transformative intelligence provides a valuable framework for enhancing decision-making effectiveness in complex organizational systems. The integration of cognitive

flexibility, psychological flexibility, and values-based decision-making creates capabilities that enable leaders to recognize and reduce cognitive biases, adapt to changing circumstances, and generate innovative solutions to organizational challenges.

The finding that psychological flexibility mediates relationships between cognitive capabilities and decision-making effectiveness suggests that effective leadership development requires integrated approaches addressing both analytical thinking skills and psychological adaptability. Organizations investing in transformative intelligence development can expect improvements in decision quality, adaptive capacity, and innovative problem-solving across management levels.

The emergence of organizational meta-capability when multiple leaders demonstrate transformative intelligence indicates potential for systematic transformation of organizational decision-making processes. This suggests that transformative intelligence development should be approached as an organizational rather than individual intervention, with systems-level support for capability cultivation and expression, consistent with contemporary frameworks for designing intelligent organizations (Kolbjørnsrud, 2024).

Future research should focus on developing and testing specific interventions for cultivating transformative intelligence capabilities, examining long-term effects on organizational performance, and exploring applications across diverse organizational contexts. The ultimate goal involves creating organizational conditions where transformative intelligence can flourish, enabling sustainable improvements in decision-making effectiveness and organizational adaptability in increasingly complex business environments.

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Transformative Intelligence in Decision-Making Processes and Policy Implementation Management: An Integrated Framework for Organizational Process Optimization in Complex Systems

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Abstract

Research background: Contemporary organizational environments face unprecedented complexity requiring decision-making frameworks that transcend traditional rational models. Cognitive biases systematically compromise decision quality in multidisciplinary professional contexts where technical expertise must integrate with ethical judgment.
Purpose of the article: This study explores transformative intelligence theory as a comprehensive framework for improving decision-making quality in complex systems, specifically examining Israeli special education committees as exemplars of multidisciplinary professional contexts.
Methods: A convergent parallel mixed-methods design examined 60 committee chairs and 87 multidisciplinary committee members, supplemented by systematic content analysis of 350 committee minutes from 2019-2023. Transformative intelligence was operationalized through four integrated components: perceptual flexibility, adaptive functioning, ecological engagement, and transformative creativity.
Findings & Value added: Cognitive biases manifested in 73-82% of committee decisions, with representativeness, availability, and anchoring heuristics significantly impacting decision quality. Transformative intelligence components collectively explained 67% of variance in decision-making effectiveness ($R^2 = .67$, $F(4,55) = 27.8$, $p < .001$), with psychological flexibility mediating 61% of total effects. Participants scoring high on all components (17.3% of sample) demonstrated synergistic performance improvements with exceptionally large effect sizes ($d = 3.8$-4.6).

Keywords: Transformative intelligence, Decision-making, Cognitive biases, Psychological flexibility

JEL classification: M51; O15; J24

1. Introduction

Organizational environments face unprecedented complexity due to rapid technological advances, climate change, geopolitical uncertainty, and evolving social dynamics. This complexity manifests in decision-making systems where traditional rational models, developed under conditions of relative stability, prove inadequate for addressing interconnected challenges requiring simultaneous integration of technical, ethical, budgetary, and social considerations (Kahneman, 2011). Research demonstrates that up to 70% of organizational change initiatives fail, while 60% of public policy implementations fail to achieve stated goals, often due to fundamental mismatches between complexity demands and existing cognitive capabilities (Tversky & Kahneman, 1974). Recent research has challenged the widely-cited 70% failure rate as an unsubstantiated myth lacking empirical evidence, with scholars noting this figure has no credible scientific foundation and may be useful primarily for management consultants rather than reflecting actual organizational reality (Hughes, 2024).

Contemporary research reveals a complex, multidimensional structure underlying heuristics and biases, with recent studies showing that different biases relate to each other in nuanced ways, and that cognitive structure underlying these biases can be investigated through individual differences approaches (Berthet et al., 2022; Burgoyne et al., 2023). More than 180 cognitive biases have been identified over six decades of research in cognitive science, with this list continually evolving and requiring deeper study to understand their mechanisms and dynamics in both human and AI systems (Vakali & Tantalaki, 2024). A systematic review across four occupational areas confirms that professionals use heuristics to cope with

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complex and uncertain environments, which may result in inappropriate or suboptimal decisions, though the mechanisms behind cognitive biases still require further study (Berthet, 2022).

Recent research on organization design reveals that decision-making structures can have unintended organizational-level consequences, with structures effective at information aggregation not necessarily fostering individual learning (Joseph & Sengul, 2025). Additionally, complexity theory applications in organizational and management research demonstrate that complex systems span multiple scales, from industries and markets to firms and individuals, requiring dynamic and systemic methodological approaches (Cincotti et al., 2024). Modern decision-making systems operate in three critical dimensions challenging traditional approaches. First, increasing problem complexity requires managing interdependent factors with multi-level effects and non-linear dynamics leading to uncertainty and unexpected outcomes. Second, accelerated change pace demands rapid response capability while maintaining analytical depth and quality. Third, multidisciplinary challenges require integrating knowledge and perspectives across different fields and cultural contexts (Holland, 1995).

A 2022 systematic review across four occupational areas confirms that professionals use heuristics to cope with complex and uncertain environments, which may result in inappropriate or suboptimal decisions, though the mechanisms behind cognitive biases still require further study (Berthet, 2022).

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Modern decision-making systems operate in three critical dimensions challenging traditional approaches. First, increasing problem complexity requires managing interdependent factors with multi-level effects and non-linear dynamics leading to uncertainty and unexpected outcomes. Second, accelerated change pace demands rapid response capability while maintaining analytical depth and quality. Third, multidisciplinary challenges require integrating knowledge and perspectives across different fields and cultural contexts (Holland, 1995).

The Israeli special education system provides a particularly instructive case study. Amendment 11 to the Special Education Law (2019) aimed to shift from medical to social conceptions of disability, emphasizing inclusion and equal opportunities. However, implementation led to a 35% increase in students eligible for special education services and a 68% budget increase, raising fundamental questions about decision-making quality and system efficiency. Preliminary findings indicate that 94.7% of committee chairs cope with frequent policy changes, 89.2% report gaps between formal clarity and actual complexity, and 87.3% identify significant knowledge gaps among committee members.

Classical rational approaches, based on complete information and linear logical processing, fal in systems characterized by incomplete and variable information where decision effects unfold unpredictably over time and context (Kahneman & Tversky, 2000). Research reveals systematic patterns in decision errors through three key heuristics: representativeness heuristic leading to oversimplified categorization based on superficial similarities while ignoring base rates; availability heuristic causing over-reliance on easily retrievable information; and anchoring heuristic creating fixation on initial judgments inappropriately influencing subsequent evaluation (Stanovich, 2011).

This research proposes transformative intelligence theory as an integrated framework addressing existing decision-making approach limitations. Transformative intelligence is defined as meta-systemic ability to recognize, understand, and modify dynamic interactions between reality perception and functioning, enabling adaptive and generative responses to complex changing environments. This conceptualization extends beyond traditional intelligence frameworks (Sternberg, 2019) to encompass adaptive capabilities that transcend context-specific competencies. The theoretical framework integrates four core components: perceptual flexibility representing metacognitive ability to identify, evaluate, and change meaning-making frameworks while maintaining psychological coherence; adaptive functioning encompassing response regulation across functional domains based on contextual demands; ecological engagement involving understanding, managing, and influencing complex systems while recognizing interdependencies; and transformative creativity representing the ability to develop solutions transforming existing constraints into opportunities. These components align with broader frameworks emphasizing character strengths and virtues as foundational to human excellence (Peterson & Seligman, 2004).

2. Methods

2.1 Research Design

This study employed a convergent parallel mixed-methods design (Creswell & Plano Clark, 2017) to investigate relationships between transformative intelligence components and decision-making quality in complex organizational systems. The research was anchored in a pragmatic philosophical framework emphasizing practical outcomes while applying methodological rigor to both quantitative and qualitative data collection and analysis.

2.2 Participants

The research population consisted of two primary cohorts recruited through purposive and snowball sampling strategies. The primary cohort included 60 special education eligibility and characterization committee chairs with inclusion criteria of at least three years committee leadership experience, participation in 120 hours mandatory annual training programs, and actively chairing three to five committee meetings weekly. Demographic analysis revealed 85% (n = 51) female participants, with mean age of 49.63 years (SD = 4.2), all holding master's level academic degrees with 15-20 years special education experience.

The secondary cohort included 87 multidisciplinary committee members representing five professional groups: school psychologists (n=28, 32.2%), special education consultants (n=34, 39.1%), community school consultants (n=6, 6.9%), parent organization representatives (n=13, 14.9%), and general school counselors (n=6, 6.9%). This cohort consisted of 88.5% females (n = 77) with mean age of 43.72 years (SD = 6.8).

2.3 Data Collection Instruments

Quantitative Measures

Psychological flexibility was assessed using the Acceptance and Action Questionnaire-II (AAQ-II; Bond et al., 2011), demonstrating robust psychometric properties with Cronbach's $\alpha = .91$ in the current sample. The Transformative Intelligence Component Scale was developed specifically for this study, comprising four subscales: perceptual flexibility (8 items, $\alpha = .89$), adaptive functioning (10 items, $\alpha = .92$), ecological engagement (7 items, $\alpha = .87$), and transformative creativity (9 items, $\alpha = .90$). Confirmatory factor analysis supported the hypothesized four-factor structure ($\chi^2/df = 2.14$, CFI = .94, RMSEA = .07).

The Quality of Decision-Making Index represented a composite measure integrating multiple effectiveness indicators, emphasizing functional diagnosis accuracy and cognitive bias reduction. Inter-rater reliability exceeded .85 across all dimensions.

Qualitative Data Sources

Systematic content analysis was conducted on 350 committee meeting minutes spanning 2019-2023, representing approximately 14% of all regional committee meetings. Semi-structured interviews explored participants' perceptions of committee processes, decision-making challenges, and professional development needs through carefully constructed open-ended questionnaires.

2.4 Data Analysis

Statistical analyses employed hierarchical multiple regression examining relationships between transformative intelligence components and decision-making outcomes, with systematic adjustment for demographic variables and professional experience indicators. Missing data (3.2% of total dataset) were addressed through multiple imputation using MICE algorithm. Committee meeting transcripts underwent systematic thematic analysis following Braun and Clarke's (2006) six-stage analytical framework. Inter-coder reliability achieved $\kappa = .82$ across all primary themes.

2.5 Ethical Considerations

Comprehensive ethical approval was obtained from institutional review board, supplemented by Department of Education Research Committee authorization. Informed consent was obtained from all participants with particular attention to maintaining student and family confidentiality. All data were stored in encrypted systems accessible exclusively to research team members.

3. Research Findings

3.1 Manifestation of Cognitive Biases

Qualitative analysis of 350 committee transcripts revealed pervasive cognitive bias patterns systematically influencing decision-making quality across multiple dimensions. The representativeness

heuristic was observed in 73.2% of analyzed cases (n = 256), characterized by overreliance on superficial academic performance indicators despite comprehensive multidimensional student presentations. The availability heuristic demonstrated greatest influence, occurring in 79.3% of cases where dramatic or emotionally salient past cases inappropriately influenced current decisions regardless of contextual relevance (d = 1.41, large effect). Anchoring effects were most prevalent at 81.7% frequency, indicating initial assessment information had disproportionate impact on overall deliberative processes despite conflicting evidence presentation (d = 1.52, large effect).

Table 1. Cognitive Bias Frequency and Impact on Decision Quality

Bias Type	Frequency	95% CI	Effect on Decision Quality†	Cohen's d
Representativeness	73.2%	[68.1, 78.3]	-2.14***	1.23
Availability	79.3%	[74.6, 84.0]	-2.31***	1.41
Anchoring	81.7%	[77.2, 86.2]	-2.45***	1.52

*Note: Decision quality measured on 5-point scale. ***p < .001*
Source: the researcher

Secondary analysis identified socio-psychological factors reinforcing individual cognitive limitations through group interaction processes. Contrast effects influenced 43.7% of sequential case reviews (n=153), with severity ratings systematically biased by previous case characteristics ($F(1,348) = 24.7$, $p < .001$, $\eta^2 = .07$). Groupthink phenomena occurred in 71.4% of committee meetings (n = 250), particularly when discussions exceeded planned duration ($r = .34$, $p < .001$) or dominant authority figures discouraged dissenting views ($r = .41$, $p < .001$).

3.2 Transformative Intelligence Predictive Validity

Hierarchical regression analysis revealed significant relationships between all transformative intelligence components and decision quality indicators, with the full model explaining 67% of variance in overall decision quality ($R^2 = .67$, $F(4,55) = 27.8$, $p < .001$). Each component contributed unique variance in decision outcomes, supporting conceptualization of transformative intelligence as distinct but interrelated cognitive abilities.

Table 2. Transformative Intelligence Components Predicting Decision Quality

Predictor		E			p	r^2
Perceptual Flexibility	42	08	38	.25	<.001	18
Adaptive Functioning	35	09	31	.89	<.001	14
Ecological Engagement	29	07	27	.14	<.001	12
Transformative Creativity	33	08	29	.13	<.001	13

Note: sr^2 = squared semi-partial correlation (unique variance explained)
Source: the researcher

Perceptual flexibility emerged as the strongest predictor ($\beta = 0.38$, $p < 0.001$), accounting for 18% unique variance in outcomes. This component demonstrated particular effectiveness in bias identification capabilities ($r = .72$, $p < .001$) and perspective-taking ability ($r = .68$, $p < .001$).

3.3 Psychological Flexibility Mediation

Bootstrap mediation analysis with 5,000 replicate samples examined psychological flexibility's mediating role between transformative intelligence components and decision outcomes. Results provided robust support for significant indirect effects across theoretical pathways.

Psychological flexibility mediation model:

- Overall effect (c): .62***
- Direct effect (c'): .24*
- Indirect effect (ab): .38, 95% CI [.28, .52]
- Proportion of mediated effects: 61%
- Model R^2: .73

The mediation model explained 73% of variance in decision quality, with psychological flexibility mediating 61% of total transformative intelligence effects on decision outcomes. This substantial mediation suggests transformative intelligence improves decision-making primarily through increased psychological flexibility.

3.4 Synergistic Effects Analysis

Analysis of participants scoring above 75th percentile on all four transformative intelligence components (n=11, 18.3% of sample) revealed synergistic effects exceeding additive predictions. This elite group achieved 89.2% accuracy in bias identification compared to 34.7% in low transformative intelligence groups, with opinion changes following contradictory evidence occurring 78.4% versus 23.8% respectively. Effect sizes for these comparisons ranged from $d = 3.8$ to $d = 4.6$, indicating exceptional practical significance.

4. Discussion

4.1 Transformative Intelligence as Integrated Framework

The strong predictive power of transformative intelligence components, explaining 67% of decision-making quality variance, provides empirical support for theoretical frameworks proposing that human functioning emerges through dynamic integration across multiple domains rather than isolated abilities. The synergistic effects observed when all components operate at high levels provide empirical support for the theoretical proposition that human abilities arise from multiplicative rather than additive interactions between functional domains.

4.2 Psychological Flexibility as Mediating Mechanism

The mediating role of psychological flexibility, accounting for 61% of total effects linking transformative intelligence to decision outcomes, provides critical insight into mechanisms underlying effective decision-making in complex environments. This finding extends acceptance-based therapeutic frameworks to organizational effectiveness domains while providing empirical support for psychological flexibility's transdiagnostic nature across different life contexts (Hayes et al., 2006).

Committee members exhibiting higher psychological flexibility demonstrated improved ability to recognize existing approach limitations while remaining open to innovative solutions. This finding relates to broader research on mindfulness and contemplative practices in organizations, suggesting that organizations seeking improved decision-making capabilities should incorporate contemplative approaches alongside technical training.

4.3 Practical Implications

The research findings suggest fundamental reconceptualization of educational approaches at all levels, from early childhood to continuing professional development. Traditional educational models emphasizing knowledge transmission and skill acquisition appear insufficient for developing integrated capabilities needed to meet contemporary challenges. Developing transformative intelligence requires

educational approaches cultivating metacognitive awareness, emotional regulation, social collaboration, and creative problem-solving within integrated learning experiences.

Organizations seeking enhanced decision-making effectiveness should consider implementing integrated development programs addressing all four transformative intelligence components. However, synergistic effects observed suggest these components need coordinated rather than isolated development. Organizational climate results indicate structural and cultural factors significantly influence individual capability expression.

4.4 Limitations and Future Research

Several methodological limitations warrant acknowledgment. The sample's focus on Israeli special education committees limits generalizability to other cultural and organizational contexts. The cross-sectional design precludes definitive causal inferences about transformative intelligence developmental trajectories. Self-report assessment of transformative intelligence introduces potential response bias, partially mitigated through anonymous data collection and triangulation with behavioral indicators.

Future research requires extensive cross-cultural validation and longitudinal studies examining transformative intelligence development across different career trajectories and life stages. Intervention studies testing specific training approaches should include randomized controlled trials comparing transformative intelligence-based development with traditional professional training approaches.

Conclusion

This research provides empirical validation of the transformative intelligence framework while demonstrating that systematic capability development can significantly enhance decision-making capacity and reduce cognitive bias susceptibility. The discovery of synergistic effects when all components operate at high levels suggests transformative intelligence represents an emergent capability transcending traditional conceptualizations of human intelligence and competence.

The mediating role of psychological flexibility provides critical insight into effective decision-making mechanisms, establishing links between individual psychological processes and collective effectiveness outcomes. Most importantly, research demonstrates that cognitive and emotional limitations constraining human decision-making are not fixed barriers but challenges overcome through systematic capability development in appropriate organizational and cultural contexts.

As humanity faces increasingly complex challenges requiring integration of technical expertise with wisdom, compassion, and creative innovation, developing transformative intelligence capabilities becomes essential for collective flourishing. The research provides both theoretical foundation and practical guidance for this development, recognizing the journey involves continuous learning, adaptation, and growth without fixed endpoints.

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The Effect of Self-Efficacy and Perceived Career Threats on Attitude Towards Parental Leave

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Abstract

Research background: Taking time for parental leave to fully embrace their live as a family is important for the majority of German employees. Current literature shows that the decision regarding parental leave is influenced by different factors, such as income or workplace factors, but does not consider potential interaction effects and attitude towards parental leave.
Purpose of the article: This study addresses key topics in Human Resource Management and Organizational Behavior by examining the interaction between self-efficacy and perceived career threats as predictors of participants' attitude toward parental leave, as well as family involvement and traditional gender role attitude as potential moderators.
Methods: Using a cross-sectional survey design and quantitative methods, data was analyzed through Welch´s test and moderation analysis.
Findings & Value added: Using quantitative methods, the results of a Welch-test indicate that there is a significant difference between men and women, whereas women have a more positive attitude toward parental leave. Further, by using moderation analysis, a negative relationship between perceived career threats and attitude toward parental leave was shown, moderated respectively by family involvement and traditional gender role attitude. There was a positive relationship between self-efficacy and attitude toward parental leave, moderated by traditional gender role attitude but not by family involvement. The results indicate that the difference in utilization of parental leave attitude is also reflected in different attitude toward parental leave between the genders. Further individual views and opinions about family seem to be essential in questions regarding parental leave.

Keywords: Parental leave, Self-efficacy, Career threats, Gender roles, Family involvement

JEL classification: J13, J16, M12

1. Introduction

The importance of parental leave grows rapidly in German society and also as a topic in companies. Besides of work-family compatibility, the main goal is equality between the sexes (BiB, 2022). Due to the pandemic, women often did the majority of childcare work, they reduced their working hours more than men and in general the psychological load within the family due to work-family compatibility increased (BMFSFJ, 2021). Families in Germany suffer significantly more from the increasing prices, which occur due to the war in the Ukraine and as a matter of fact, cuts in income aren't possible for many (BMFSFJ, 2023). This highlights the importance of parental leave, as covid as well as the inflation harden the situation. Understanding attitudes towards parental leave is essential for HR managers and organizational leaders aiming to design effective work-family policies and promote gender equality in the workplace.

Parental leave is considered as time off work for new parents who want to look after their children themselves and embrace their family life. Employees in Germany can request this for up to three years in total. To compensate cuts in income, parents also have the opportunity to receive parental allowance for up to twelve months and additionally for extra two months exclusively when both parents reduce their working hours (so called "Partnermonate"; BMFSFJ, 2022).

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Since 2006, fathers' utilization of parental leave in Germany has increased from 3.6 % to 42.1% in 2018. Yet the majority (75.4 %) only uses the exclusive months. On the other hand, 94 % of women in Germany use parental leave for at least 10 months (Statistisches Bundesamt, 2021; Eng.: German Federal Statistical Office). This shows a clear gap between men and women regarding parental leave in Germany. According to social role theory (Eagly, 1987), prevailing social gender stereotypes are responsible for different behaviors and attitudes of men and women through social pressure and societal expectations of individuals (Eagly & Wood, 2012).

Both men and women want to be successful in their profession while also meeting the needs of their family life (Wiese, 2005). Yet research shows, that women reduce their working hours to take care of their family more often, especially with regard to parental leave (Maume, 2006). Literature demonstrates that negative career consequences follow longer career breaks, such as wage reduction (Lequien, 2012). This indicates that parental leave is a question of career management due to its long-lasting impact on the career (Horvath et al., 2018).

Research examined factors which explain the observed gap such as income or workplace factors, to address career and equality issues and to limit the impact of longer career breaks (e.g., Berrigan, 2018). Attitude toward parental leave only has been investigated sporadically. As meta-analyses show that there is a clear relationship between attitude and actual behavior and that attitude significantly predicts behavior (e.g., Glasman & Albarracín, 2006), attitude toward parental leave and different predictors of this attitude should be considered when facing the problem of parental leave.

The career self-management model (CSM; Lent & Brown, 2013), which is based on the social cognitive career theory (Lent et al., 1994) assumes that individual and contextual factors are necessary to manage professional developmental tasks and unforeseen events (e.g., job loss). With this model, a wide array of professional events, such as parental leave, can be analysed. Self-efficacy and the expected effects of one's own behavior are the two cognitive-personal factors within this model (Lent & Brown, 2013), which can both be transferred to parental leave.

When considering CSM and social role theory, effects on attitude toward parental leave may be explained by factors of these theoretical approaches. As previous studies on parental leave didn't focus on attitude, it is still unclear, whether subjectively perceived external factors and self-efficacy play a role regarding attitude towards parental leave. Including the importance of family and gender stereotypes as moderators, in consideration of CSM and social role theory, is thus legitimate.

Therefore, we investigate the research questions in how far attitude toward parental leave is related to perceived career threats and self-efficacy, and whether gender role attitude and family involvement may have a moderating role in these relationships. Moreover, gender differences in the attitude toward parental leave will be examined. In the following section, we outline the theoretical framework for our research questions and present the generated hypotheses.

1.1 Attitude toward parental leave, Gender roles and family involvement

People's ideas and beliefs about parenthood, gender roles, and family play an essential role in relation to parental leave. A person has many different roles in their life. These different roles are directly related to each other, so that one role might be more important than another. Both, men and women rate family roles as more important than work roles. Yet, at the same time, men consider work roles as more important than women, while the latter assign higher importance to other roles (Reitzes & Mutran, 2016).

These differences might result in different behavior with regard to family and career. For example, the socially defined role of a mother is much more demanding for a woman than the role of a father for a man. A reduction of working hours caused by family demands is more likely and more frequent for women – this is also partly independent of the prevailing gender role attitude in respective families (Maume, 2006).

A representative German study showed that 12 % of men from Western-Germany can imagine taking parental leave for longer than six months, whereas 83 % of women would take parental leave for at least one year (Allmendinger et al., 2013). Various studies show that, especially for fathers, negative career expectations are a main reason against parental leave (BMFSFJ, 2018).

Based on these results presented, we hypothesize:

H1: Women have a more positive attitude toward parental leave than men.

The views on gender roles play a decisive role in the consideration of parental leave. Many studies show that a modern understanding of gender roles is positively related to an equal division of parental leave (Maume, 2008) and childcare (Bulanda, 2004). However, the operationalization was rather

heterogenous. In our study, we used operationalization from Braun (1999), who distinguishes between modern and traditional gender roles. Traditional meaning women caring for their families and men being breadwinner; modern gender roles meaning both partners care for their family.

Vogt and Pull (2010) showed that modern gender role attitude increases the probability of taking parental leave. Studies also showed such a correlation for attitude toward parental leave (e.g., Miyajima & Yamaguchi, 2017). These results are in line with social role theory, which attributes differences in behavior between men and women to gender role differences (Eagly & Wood, 2012). We anticipate a moderation effect as the relationship between different factors and attitude towards parental leave will depend on individual's views on gender roles.

Based on the findings on value differences between men and women regarding family and work roles, we assume that the importance of family for one's own life is important with regard to parental leave. We assume that family involvement plays a central role in the evaluation of potential parental leave. Following Duvander (2014), this study operationalizes the importance of one's mother/father role with the construct family involvement. Duvander (2014) demonstrated that family involvement of women is related to the length of parental leave. Analogously, Brandt (2017) showed that family involvement of men is associated with a higher probability and length of taking parental leave.

Vogt and Pull (2010) highlighted the relevance of family involvement and examined it as a moderator for the relationship between the Big Five and the use of parental leave. However, no moderating effect could be identified. Thus, the effect of family involvement isn't clear yet. Unless their results, we follow their assumption and assume a moderating effect of family involvement.

1.2 Perceived threat for the career

The already mentioned CSM is suitable to explain behavior which affects careers in a long-lasting manner. Horvath et al. (2018) already used this model regarding parental leave. The expected effects of one's own behavior are the expected obstacles to one's own career after returning to work from parental leave (Vogt & Pull, 2010) as well as expected occupational risks that may be associated with parental leave (Wiese, 2005). Studies showed that the use and duration of parental leave is highly dependent on previously anticipated career obstacles and general risks to one's career (Vogt & Pull, 2010; Wiese, 2005). A representative study was able to show that for men, negative career expectations are often an important reason against taking parental leave (BMFSFJ, 2018). In line with CSM as well as previous findings, we thus expect:

H2: There is a negative relationship between perceived career threats and attitude toward parental leave.

H2a: Family involvement moderates the relationship between perceived career threats and attitude toward parental leave. With low expressions of family involvement there is a stronger negative relationship between perceived career threats and attitude toward parental leave.

H2b: Traditional gender role attitude moderates the relationship between perceived career threats and attitude toward parental leave. With high expressions of traditional gender role attitude there is a stronger negative relationship between perceived career threats and attitude toward parental leave.

1.3 Self-efficacy

The second predictor within CSM is self-efficacy, which is the personal conviction of being able to use the own skills to show certain behavior (Lent & Brown, 2013). In their study, Horvath et al. (2018) examined self-efficacy as a possible predictor for parental leave. However, no effects of self-efficacy on planned and actual length of the parental leave were found. Instead, self-efficacy was found to affect the planned length and the return experience after parental leave. Individuals with high self-efficacy manage their return more successfully (e.g., less stress; Wiese & Heidemeier, 2012).

The relationship between self-efficacy and attitude toward parental leave hasn't been investigated properly yet. Based on the CSM, it can be expected that individuals who are convinced of themselves and their abilities are happy to take on a new "challenge" and are thus positively disposed to the possibility of parental leave. Further this relationship could be moderated by family involvement and traditional gender role attitude based on our consideration set out above.

H3: There is a positive relationship between self-efficacy and attitude toward parental leave.

H3a: Family involvement moderates the relationship between self-efficacy and attitude toward parental leave. With high expressions of family involvement there is a stronger positive relationship between self-efficacy and attitude toward parental leave.

H3b: Traditional gender role attitude moderates the relationship of self-efficacy and attitude toward parental leave. With low expressions of traditional gender role attitude there is a stronger positive relationship between self-efficacy and attitude toward parental leave.

2. Methods

2.1 Sample, procedure and study design

Before data collection, the minimum sample size was determined with the tool G-Power. Based on the planned analysis methods (Welch-test and moderation analyses) with a statistical power of .95 a sample size of 250 participants was intended.

In total, the data consists of 345 participants, yet 84 did not finish the questionnaire, so they were excluded from further analysis. The other 261 participants filled out the survey completely.

The sample consists of 102 men (39.1%) and 159 women (60.9%). The age of the participants ranged from 17 to 86 years. The mean age was 31 years (*SD* = 12.18). There were no participants without or a secondary school diploma. Twenty-five individuals (9.6%) stated that their highest level of education was “mittlere Reife” (which is similar to GCSE). The highest educational qualification of 74 individuals (28.4%) was “Abitur” (similar to A-levels). Another 61 people (23.4%) had completed vocational training, and 48 individuals (18.4%) had completed a bachelor’s degree. Forty-five individuals (17.2%) indicated a completed master’s degree and seven individuals (2.7%) a doctorate as their highest educational qualification.

The online survey was developed with LimeSurvey and it was distributed through various social media channels, such as LinkedIn or Facebook, and by email newsletters. Potential participants were provided with a link to the online questionnaire. It was possible to complete the questionnaire on smartphone or computer. No material incentives were provided for participation.

The participants were informed that by taking part in the survey they were agreeing to their anonymized data being used solely for scientific purposes. Further, they were informed that their participation was voluntary and that there was the possibility to quit the survey at any time without disadvantages for them. Participants were asked to answer the questions in an honest and spontaneous manner. After the participants gave their consent, they were redirected to the questionnaire.

2.2 Measurement instruments

Attitude toward parental leave was assessed with five items based on Miyajima and Yamaguchi (2017) on a 6-point Likert scale. All items were rephrased for gender neutrality and into German, as the original items were in English and designed to assess attitude toward parental exclusively for fathers. The items had a very good internal consistency (α = .92).

Perceived threat and risks regarding one’s own career which are connected to parental leave were assessed by two scales. Based on Vogt and Pull (2010), career threats connected to parental leave were assessed by six items which were answered on a 5-point Likert scale. As the original items were also specifically for fathers, they were rephrased to be applicable for both men and women. Possible risks were assessed based on Wiese (2005) on a 4-point Likert scale. The original items had been formulated for female managers and were also rephrased for this study. Internal consistency was good (α = .86).

To measure self-efficacy, the general self-efficacy expectancy scale of Schwarzer and Jerusalem (2003) was used. It included ten items, which were rated on a 4-point Likert scale. In this study internal consistency could be rated as acceptable (α = .76).

Family involvement was measured with a scale by Frone et al. (1992) and Frone and Rice (1987). They developed their items based on the work involvement scale of Kanungo (1982) by rephrasing it to fit a family context. The items were translated into German for this study. The four items had an acceptable internal consistency (α = .77).

Attitude regarding traditional gender roles were assessed using Braun's (1999) Gender Role Scale (ISSP 94). On a 5-point Likert scale, a total of eleven items were answered which had an acceptable internal consistency (α = .79).

3. Results

Table 1 shows an overview of the means and standard deviations of the different variables. In addition, the intercorrelations and Cronbach’s alpha values are shown.

Table 1. Means, standard deviations, correlations and internal consistencies

Variable	*M*	*SD*	1	2	3	4
1. Attitude toward parental leave	5.13	.91	*.92*			
2. Career risks and threats	2.64	.51	-.56**	*.86*		
3. Family involvement	3.01	.64	.50**	-.40**	*.77*	
4. Traditional gender role attitude	3.98	.59	-.44**	.25**	-.24**	*.74*

Notes. The arithmetic mean, the standard deviation and the intercorrelations of the variables are shown; ** $p < 0.01$ (two-sided); * $p < .05$ (two-sided); the internal consistency (Cronbach's alpha) is shown in the diagonal.
Source: author (2025)

To test Hypothesis 1, a Welch-test was conducted, as there was no homoscedasticity (tested with Levene-test; $p < .001$). Also, there was no normal distribution of the dependent variable. As the groups consisted of more than 25 individuals, the Welch-test is considered to be relatively robust against this kind of violation (Blanca et al., 2017). All the other requirements were met (outliers, scaling, independence of cases). The Welch-test showed a significant difference between men and women in their attitude toward parental leave ($t(260) = 65.45$; $p < .001$). Women ($M = 5.48$; $SD = .64$) had a significantly higher attitude toward parental leave than men ($M = 4.68$; $SD = .99$), supporting hypothesis 1. The effect size was $d = 1.13$, which is a large effect after Cohen (1988). Through the results presented, hypothesis 1 can be accepted that women have a more positive attitude toward parental leave than men. The mean value of women is higher and significantly different compared to the men within the sample.

Hypothesis 2 and 2a/b were tested with a moderation analysis using the PROCESS macro for SPSS (Model 2, 5000 bootstrap samples). The statistical requirements for regression analysis were all met after Hayes (2022; Residual independence, linearity, normal distribution of residuals, homoscedasticity). The overall model was significant ($F(5, 255) = 86.05$; $p < .001$); 53.66% of variance could be explained by this model, which is considered as a large effect by Cohen (1988).

The relationship between perceived career threats and risks and attitude toward parental leave was significant ($\beta = -.60$; $p < .001$, 95% CI [-0.77, -0.45]). Thus, hypothesis 2 could be supported. The interaction effect of the moderator family involvement was also significant ($\beta = .47$; $p < .001$, 95% CI [0.28, 0.66]; $\Delta R^2 = .03$), supporting hypothesis 2a.

The interaction effect of the moderator traditional gender role attitude was also significant ($\beta = -.33$; $p < .001$, 95% CI [-0.51, -0.17]; $\Delta R^2 = .016$). Hypothesis 2b was therefore supported.

The results indicate that perceived career threats correlate negatively with attitude toward parental leave. This is relationship is, further, moderated by both family involvement as well as traditional gender role attitude. For individuals with low expressions of family involvement or high expressions of traditional gender role attitude, there is a stronger negative relationship between perceived career threats and attitude toward parental leave. The results of the moderation analysis can be seen in table 2.

Table 2. Moderation analysis perceived career threats and attitude toward parental leave

Predictor	ΔR^2	β	*se*	*t*	*p*	BootLLCI	BootULCI
Constant		5.22	.04	120.12	.000	5.13	5.30
Career threats		-.60	.08	-7.52	.000	-0.77	-0.45
Family involvement		.34	.07	4.79	.000	0.20	0.46
Interaction_FI	.03	.55	.1	5.73	.000	0.28	0.66
Gender role attitude		-.37	.07	-5.59	.000	-0.50	-0.24
Interaction_GR	.016	.33	.09	-3.85	.000	-0.51	-0.17

Notes. Model: $F(5, 255) = 86.05$; $p < .001$; $R^2 = .5366$.
Source: author (2025)

Hypothesis 3 to 3b were tested by using moderation analyses with the PROCESS macro for SPSS (Model 2, 5000 bootstrap samples). Before the analysis, the requirements (Hayes, 2022) were tested and were all met. The results showed a significant overall model ($F(5, 255) = 35.84$; $p < .001$; $R^2 = .3987$) with a variance of 38.9% which is considered as a large effect by Cohen (1988). The relationship between

self-efficacy and attitude toward parental leave was significant (β = .32; p = .013, 95% CI [0.09, 0.57]), so that hypothesis 3 could be supported.

Family involvement was not found to be a significant moderator within the model (β = -.19; p = .429, 95% CI [-0.67, 0.21]; $\Delta R2$ = .003). Based on these results, hypothesis 3a was rejected.

The second moderator, traditional gender role attitude, was found to be significant (β = .57; p = .037, 95% CI [0.09, 1.1]; ΔR^2 = .017), supporting hypothesis 3b.

The analysis showed that Hypotheses 3 and 3b could be confirmed. This means that we were able to identify a positive correlation between self-efficacy and attitude toward parental leave. Further, traditional gender role attitude moderates this relationship by strengthening the positive relationship for individuals with low expressions of traditional gender role attitudes. Family involvement could not be confirmed as a moderator here. Results of the moderation analysis for Hypothesis 3 to 3b are shown in table 3.

Table 3. Moderation analysis self-efficacy and attitude toward parental leave

Predictor	ΔR^2	β	*se*	*t*	*p*	BootLLCI	BootULCI
Constant		5.15	.05	110.38	.000	5.06	5.24
Self-efficacy		.32	.13	2.50	.013	0.09	0.57
Family involvement		.53	.09	5.82	.000	0.35	0.68
Interaction_FI	.003	-.19	.09	-5.69	.429	-0.67	0.21
Gender role attitude		-.51	.09	-5.69	.000	-0.69	-0.35
Interaction_GR	.017	.57	.27	2.10	.037	0.09	1.10

Notes. Model: $F(5, 255) = 35.84$; $p < .001$; R^2 = .3987.
Source: author (2025)

4. Discussion

This study examined effects on attitude toward parental leave. We investigated differences between men and women as well as the relationship between attitude toward parental leave and perceived threats and self-efficacy. Further, we analyzed possible moderation effects of family involvement and gender role attitude.

Our hypothesis that women generally have a more positive attitude toward parental leave than men could be confirmed. Previous studies pointed out that there is a gap between men and women in Germany regarding parental leave. Whereas women mostly use parental leave for over a year, men tend to focus on their exclusive two months, while only a minority of men use parental leave. Our study showed that these observed behavioral differences are also seen in the attitude toward parental leave, confirming findings that behavior can be predicted by attitude (e.g., Glasman & Albarracín, 2006). This hypothesis confirms existing stereotypes regarding men and women and the division of childcare. They are in line with social role theory (Eagly, 1987), that social expectations are reflected in actions and attitudes. Although there are numerous measures for equality, men still have a more negative attitude than women. Yet it needs to be noted, that men's overall attitude is on a high level (M = 4.58). This can be explained by the different (financial) incentives here in Germany and it is also evident in the general increase in parental leave by fathers (Statistisches Bundesamt, 2021). In industries and occupational groups characterized by a high workload, parental leave is, nevertheless, not the common practice, especially for fathers and a leave for more than 2 months.

Based on CSM, perceived career threats and self-efficacy were investigated regarding their relationship toward parental leave. Parental leave is related to career management, as it can have a considerable impact on further career development (Hoff et al., 2002).

Results indicated that both, perceived career threats and self-efficacy are related to attitude toward parental leave. Individuals who perceived possible threats and risks as more likely had a significantly less positive attitude toward parental leave. Arguably, people who perceive more possible drawbacks connected to parental leave view it more negatively. Another explanation might be, that people who value their career success high, might be more likely to be aware of possible career threats connected to a longer period of work absence. As their work-life is very important to them, they don't want to risk their future career success and as a matter of fact don't take their chance of parental leave. On the other hand, when career doesn't matter much in people's lifes, they think about possible risks and even if there are

some down-sides regarding their career, they are absolutely willing to take these risks in order to take care of their children.

Further, individuals who have high self-efficacy have a more favorable attitude toward parental leave. A possible explanation for this is that these individuals perceive parental leave as another "challenge", while being convinced of their own abilities to successfully cope with it. Self-efficacy proved, thus, to be a cognitive resource in the handling of different challenging situations. Further it might be plausible that people with high self-efficacy are convinced of their own abilities and even if they can think of possible risks regarding parental leave and their career, they might believe that they can manage both and these risks don't apply to them in such a pronounced manner. Returning to their job after their leave, might also be seen as another "challenge" and they believe that they have the ability to be successful, despite their absence. In general, these results show that both individual resources (self-efficacy) as well as factors of the environment (perceived career threats) can have an influence on one's attitude toward parental leave and in the end on the decision for or against parental leave.

The moderation analysis showed that family involvement could only be partially proved as a moderator. Whereas family involvement moderates the relationship between perceived career threats and parental leave, there was no significant moderation effect for self-efficacy. This is a different result compared to the study by Vogt and Pull (2016), who were not able to find any moderation effect of family involvement at all. Our result suggests that family involvement can make a difference to some effects on parental leave, probably by changing the perception of the benefit-risk ratio associated with parental leave. As there is no moderation for self-efficacy, it can be assumed that the views regarding parental leave connected to one's ability to cope with this kind of situation are not associated with the importance of one's own family.

Traditional gender role attitude had a moderation effect regarding parental leave. Individuals with less traditional views were more likely to have less positive views on parental leave. For individuals with low traditional gender role attitude, the positive relationship between self-efficacy and attitude toward parental leave was stronger than for individuals with high traditional gender role attitude. However, the negative relationship between career obstacles and parental leave was stronger for individuals with more traditional attitude. The moderator traditional gender role attitude is therefore a promising construct to be further explored in future studies. An explanation for these results might be that views on traditions might have substantial impact on how people view certain aspects in their life's regardless of individual or contextual factors.

The present study expands the existing research on parental leave in many respects. The results of the present study support previous findings on factors related to parental leave (e.g., Berrigan, 2018; Horvath et al., 2018; Vogt & Pull, 2010). In particular, this study was able to establish the relation to perceived threats, gender role attitude, self-efficacy, and the importance attributed to family.

The finding from the study by Vogt and Pull (2010), demonstrating the relationship of perceived career threats and fathers' use of parental leave, could be supported by indicating a relationship between perceived career threats and attitude toward parental leave. Furthermore, the consideration by the authors that not only the perception of contextual and occupational factors play a role in the consideration, but also self-assessment, could be supported in the present study, since a connection between self-efficacy and parental leave could be identified, whilst Vogt and Pull (2010) were unable to verify this assumption in their study. Also, they were unable to verify the moderating effect of the subjective importance of the family. In contrast, the present study found a moderating effect of the subjective importance of the family. The different result could be explained with the scales' poor quality, whereas we operationalized all constructs with already peer-reviewed scales.

Horvath et al.'s (2018) assumption that parental leave is also a career management topic could be corroborated. Unlike in their study, a correlation between self-efficacy and parental leave was found. This may be due to different constructs. While Horvath et al. (2018) examined the actual use of parental leave, we focused on attitude toward parental leave. To better understand these different findings, future research should further investigate the relationship between self-efficacy and parental leave.

The results of this study were not representative for the total population (e.g., people in Germany), as we draw a convenience sample. Future research should draw a representative sample to demonstrate the robustness and external validity of the current findings. Additionally, no causal relationship can be deferred from these results, as this was a cross-sectional study. Future research should get closer to examining causal relationship by conducting longitudinal studies.

Another limitation of this study is that there is no normal distribution of the construct attitude toward parental leave. A possible reason for the very left-skewed distribution (ceiling effect) could be the construct attitude toward parental leave itself. More positive attitude toward parental leave can be expected because parental leave is a non-mandatory option and supposed to be a relief for parents. It can be assumed that people may be generally positive about parental leave and may generally value this opportunity for parents, even when it is not relevant for them personally.

Conclusion

This study provides important insights into the factors influencing attitudes toward parental leave, highlighting the roles of perceived career threats, self-efficacy, gender role attitudes, and family involvement, which are also highly relevant for Human Resource Management and Organizational Behaviour. The findings confirm and extend previous research, demonstrating that both individual and contextual factors shape parental leave attitudes. Although the study is limited by its non-representative sample and cross-sectional design, it lays the groundwork for future research to explore these relationships in more depth and with more robust methodologies. Overall, the results underscore the need for continued efforts to address barriers to parental leave and to promote more equitable sharing of family responsibilities.

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Tax Management and the Effectiveness of Tax Crime Detection

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Abstract

Research background: Tax crimes, including tax evasion, pose a serious threat to the financial stability of countries, undermine fair competition and reduce public revenues. In dynamically evolving tax systems, it is essential that tax administration management is able to adapt to new challenges, including the prevention and effective detection of tax crimes, with an emphasis on legislative measures and legal standards.
Purpose of the article: The aim of the study is to analyse the key performance indicators of the effectiveness of tax audits and crime detection with regard to the legal aspects regulating the tax procedure. The examination of legal frameworks and statistical relationships between efficiency indicators and legislative provisions provides suggestions for improving tax compliance in accordance with legal requirements.
Methods: The analysis uses secondary data from the summary reports of the tax offices of the Slovak Republic from 2017 to 2023, applying descriptive statistics and non-parametric tests (Friedman ANOVA) to verify statistically significant differences between the studied years in terms of selected indicators of tax audits, according to the data of the tax offices operating in the conditions of Slovakia.
Findings & Value added: The findings support the need for legislative and technological improvements and include recommendations to optimise processes, increase the efficiency of tax audits and harmonise legislation to improve tax compliance.

Keywords: Management, Tax administration, Tax crimes, Efficiency, Tax controls, Legal aspects

JEL classification: F38, G32, H2

1. Introduction

Tax administration management and the effective prevention of tax crimes are today key issues for ensuring the financial stability of the state and citizens' confidence in the tax system. In a globalised and digitalised environment, there is increasing pressure on tax administrations not only to manage tax collection efficiently, but also to detect tax evasion effectively and prevent illegal practices that can have a significant negative impact on public revenue and fair competition. These problems affect not only economic stability but also the public perception of the fairness of the tax system and thus the willingness of taxpayers to comply with their obligations. Ensuring effective management and development of the legal framework for tax administration is thus a necessity. Effective management of the tax administration involves not only the administration of taxes and the implementation of legislation, but also the prevention and detection of tax crimes that have a significant impact on the country's economy. In a context of constantly evolving tax systems and technologies, it is important that the tax administration is able to adapt to new challenges, including large-scale tax evasion and fraud. Against this background, it is clear that the issue of tax administration management is an inherent part of the modern tax system. Effective tax audit management can contribute not only to increasing public revenue but also to improving the overall credibility of the tax system. It is therefore essential to continue to explore this topic and to look for new approaches to increase the effectiveness of tax controls and prevent tax crimes.

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1.1 The importance of tax administration in the context of tax crimes

Taxes affect our daily lives and every tax is part of the tax system. This system evolves with the economic and historical development of a country, leading to a specific tax structure for each country. Responsibility for meeting tax obligations lies with the recipient of the tax, known as the taxpayer. This role is assumed either by an individual (entrepreneur/non-entrepreneur) or by a legal entity. There are cases where the tax entity may include a legal representative, a tax guarantor or even a legal successor of the natural or legal person. In the context of tax-related legal relations, these tax entities are most commonly referred to as taxpayers and taxpayers. (Schultz et al., 2011) According to Lénartová (2015) she defines a taxpayer as an anonymous consumer who pays the tax in the price of the good or service purchased because the tax is part of the consumer price. A taxpayer is a tax entity that is legally obliged to remit to the public budget the tax collected from other entities or withheld by another taxpayer on the basis of its property liability (Vančurová, Láchová 2010). Within the concept of value added tax we encounter the concept of tax payer. It is any person who independently runs a business regardless of the purpose or results of this activity.

According to Smith (2022), tax liability refers to the legal responsibility of individuals or entities to pay taxes to the government in accordance with applicable laws and regulations. It includes the payment of taxes on income, property, sales, or other transactions imposed by the government. Tax liability forms the basis of a country's tax system and is the required contribution of citizens to finance public spending and services (Gombár et al. 2022, 2023). Tax revenue optimization refers to efforts to improve the efficiency and effectiveness of tax collection by the government. This includes implementing strategies and policies aimed at reducing tax non-compliance, strengthening law enforcement, and maximizing potential tax revenues. Optimizing tax revenue is essential to support the financial sustainability of the government and to fund various public programs and services. (Herawaty, 2021)

But, as a priority, taxes play a key role in maintaining the financial stability of the state because they are the main source of revenue that finances the various financing requirements of government (Setiyaji and Amir, 2005). Taxes fulfill recurrent obligations such as paying employees and covering operational costs, they play a key role in promoting sustainable development of the state. From this perspective, taxes play a key role in achieving development goals and building the necessary infrastructure for economic progress and social welfare. (Anwar, 2022) Tax is a legal requirement imposed by the government on individuals or entities. (Waluyo, 2009 In: Paroli, 2023) Tax administration itself is more than an administrative process; it is a key pillar of the social, legal as well as economic system. Certain essential ideas, which can be termed principles, are applied in the administration of taxes and fees and are determined by the applicable legislation. For a proper understanding of the meaning of the term tax administration, here are some definitions and definitions of selected domestic and foreign authors. Kostičová (2015) describes tax administration as a system of public authorities that ensures their administration, collection as well as supervision of their correct payment and collection. It is responsible for the application of tax laws and for the resolution of tax disputes. Bird (2004 In: Široký, 2011) attributes synonyms to the term, such as the institutional framework and organisational structure through which the state implements the execution of tax policy, including tax collection, control activities and the resolution of tax offences. It encompasses all activities related to the enforcement of tax laws, including the assessment, collection and administration of tax revenues. According to a similar definition, the tax administration is a public institution whose main function is to manage and control the collection of taxes in accordance with the legislation in force. Its activities include both administrative procedures and executive measures in securing state revenues. (Pálka, 2006) The procedural view of tax administration is stated by Alma (2012), in this way the government ensures compliance with its tax laws. This includes identification of taxpayers, determination of tax liabilities and collection of taxes.

Effective tax administration is key to ensuring that tax systems function properly and that governments can finance public goods and services. The definition by Evans (2008), like previous authors, links the concepts of tax administration, process and structure and emphasizes the role of government to impose and collect taxes. Tax administration encompasses various functions such as auditing, enforcement and taxpayer services that are designed to ensure tax compliance and maximize revenue collection. Keen (2013) also lists other functions of tax administration consisting of the implementation and enforcement of tax laws by government agencies. Additional activities are taxpayer registration, tax assessment, tax collection, and dispute resolution. The author notes that the efficiency and integrity of tax administration are crucial to the success of any tax policy.

From a legislative perspective, the tax administration is obliged to act in accordance with the law, to strictly comply with national laws and regulations, and not to violate legal provisions. Zhang (2024) in his article "Research on Tax Management and Tax Risk Prevention Measures" specifically identifies the following two principles that should guide tax administration:

- **The principle of fairness.** Treat all taxpayers equally and do not favour any party.
- **Principle of efficiency.** To focus on efficiency, minimise unnecessary waste and repetitive work and increase the effectiveness of administration. The tax administration should simplify procedures and processes as much as possible, reduce unnecessary links and procedures, and make it easier for taxpayers to deal with transactions.

Kamenická (2013) discusses the importance of tax administration and attributes to it strategic importance in the functioning of public finances and economic stability of the state, effective tax collection and the fight against tax evasion, thus contributing to the financing of public goods and services. According to the authors Tanzi and Zee (2000), they identify tax administration as a crucial actor in the overall efficiency of the tax system. It is the mechanism through which the government can enforce tax laws and ensure a fair distribution of the tax burden among its citizens. A well-functioning tax administration is essential to the credibility and legitimacy of the tax system. Globally, the views of the authors cited highlight the key role of the tax administration in enforcing tax laws and ensuring that governments can raise the necessary revenue to finance public services and maintain fiscal stability. Furthermore, attention will be paid to the legal aspects or legal framework and categorization of tax crimes.

1.2 Tax administration management and its role in the detection of tax crimes

Effective tax administration management requires a comprehensive approach to the prevention and detection of tax crimes. The term tax management is often referred to as tax administration management or tax management. The success of such management depends primarily on the effective alignment of human resources, represented by tax professionals, with technological systems and processes, in particular the tax information system. This synergy between the human and technological factors is key to achieving efficient tax collection that is both beneficial to the State and least problematic and compelling for taxpayers.

The analysis of the theoretical foundations of the tax administration management issue points to the aspects that are the most frequented.

- **Organisation and management of tax administration:** the author Víghová (2011) in her paper "Organisational aspects of tax administration reform " analyses the structure of tax authorities, their competences and internal processes necessary for the effective functioning of the institution.
- **Tax inspections and audits:** the issue of inspections and audits in the tax administration is dealt with by Hamalová et al. (2015) in the publication "Theory, Management and Organization of Public Administration", where the importance of detecting irregularities and tax fraud is emphasized.
- **Tax collection:** the topic of tax collection and procedures against tax defaulters is analysed by Burák (2019), where the importance of timely and efficient tax collection is highlighted.
- **Use of technology:** the modernisation of tax processes through technology and automation in line with the rise of ICT and the phenomenon of digitalisation. Tax digitalization brings a number of benefits to tax authorities as well as taxpayers that increase the efficiency and accuracy of tax administration. (Hidayat and Defitri, 2024)
- **Taxpayer education and support:** the issue of taxpayer education and support for tax compliance. (Hamalová et al., 2015)
- **International cooperation:** the importance of international cooperation in tax administration and the fight against tax evasion is also part of the work on public administration management, especially in the area of harmonization of rules. (Chaschina, 2024)

Tax statistical analysis is an essential tool for understanding tax trends and behaviour, involving the management of the collection, organisation, analysis and reporting of tax data. However, a key tax management issue is the economic incentive for taxpayers to reduce the valuation of assets and income in

order to minimize the tax burden. This problem is caused by two main factors: the first is a perverse incentive from the tax authorities, where taxpayers benefit from lower asset valuations in self-taxation schemes. The second factor is the difficulty of measuring accurate property valuations, with the methods and quality of valuations varying considerably across jurisdictions, such as the US property tax system. Technological and methodological improvements can help address this problem, but fair property valuation remains a challenge. (Lederman, 2020)

1.3 Detection of tax crimes

López (2017) reports that tax evasion often occurs in developing countries. Therefore, it is necessary to comply with tax regulations to prevent tax evasion. Most firms avoid paying taxes by remaining smaller, but larger firms can engage in costly tax evasion. In economies where incomes are too high, there is a trade-off between overall efficiency and tax collection. Where tax evasion is high, tax collection is low. There is therefore a need to focus on more effective measures against tax evasion. Townsend (2012) explains that tax evasion is the ultimate manifestation of conventional tax-related crimes. It signifies the most serious offence that taxpayers can commit and yet, if recognized as a tax violation, it results in a fine.

According to Evertsson (2016), from a globalisation perspective, tax evasion is considered a crime with global implications. This problem is not limited to tax evasion originating solely from corporations. Corporate tax avoidance is a phenomenon that simultaneously affects different regions and different companies, resulting in global implications due to companies avoiding precisely the tax obligations within the countries in which they operate. The free market structure opens up opportunities for tax avoidance as regions and countries seek to attract international investment by adjusting their tax rules to suit corporations. Buehn and Schneider (2012) highlight the emergence of a sequence of tax avoidance events in 38 OECD countries between 1999 and 2010. These occurrences are rooted in the shadow economy and its estimation models. With the combination of indirect taxes and self-employment as drivers of tax evasion, a consistent decline in these cases can be observed across countries between 1999 and 2010. In this time frame, the average extent of tax evasion is 3.2% of official GDP for all countries. Mexico leads the averages with 6.8%, closely followed by Turkey with 6.7%. In contrast, the US and some other countries ranked at the bottom with values as low as 0.5% or 1.3%.

Slemrod (2007) argues that no government can introduce a tax system and then simply expect taxpayers to voluntarily follow it. In reality, only a minority fulfill their tax obligations to the state, while the majority look for ways to avoid paying. Over time, the pool of conscientious taxpayers is shrinking, while the ranks of non-compliant individuals are growing, thanks to the belief that the more people avoid paying taxes, the more acceptable it is. As a result, it is becoming imperative that every citizen be held legally responsible for meeting their tax obligations, while those who do not comply and do not pay are penalised. Despite the imposition of sanctions, tax evasion remains widespread. Tax evasion is now much more frequent than in the past and this pattern is likely to continue in the future.

Stankeviciute (2018) has conducted empirical research focusing specifically on the challenge faced by the European Commission in tackling tax evasion and fraud within the European Union. The aim of the research was to assess and quantify the collective financial damage caused by tax evasion on tax revenues across the EU. The study covered a sample of 28 EU Member States in 2016 (currently comprising 27 Member States) and covered a 12-year period from 2003 to 2014. The research used a methodology based on the concept of the shadow economy to examine historical trends in tax evasion. Through hypothesis testing, the research identified specific EU countries characterised by taxpayers sensitive or insensitive to EU membership, as well as their correlation with the economic conditions of these countries and the size of their national tax rates.

The empirical findings of this investigation confirmed the European Commission's concerns about the adverse impact of tax evasion on the EU economy. These findings have subsequently provided a multifaceted quantitative basis for shaping future tax policies, facilitating informed decisions aimed at mitigating tax evasion losses both within and outside the EU.

The resources, in the form of statistics and reports, providing a deeper insight into the issue of detecting tax crimes, bring to light what methods and practices are most effective in addressing this challenge. They are relevant in that context:

- The Organisation for Economic Co-operation and Development (OECD) regularly publishes studies and reports on tax trends and fraud. The report "Tax Administration 2022" offers an overview of the practices of tax administrations in OECD countries and includes data on the

number of tax audits, fraud detected and the effectiveness of various tools to detect tax crimes. (OECD, 2023)

- Europol and OLAF reports: Europol and the European Anti-Fraud Office (OLAF) publish reports on cross-border tax fraud within the EU, such as VAT carousel fraud. These reports provide statistics on identified fraud and the extent of financial losses caused by fraud. (op.europa.eu 2023)
- The international intergovernmental organisation FATF Reports: the Financial Action Task Force (FATF) publishes reports on money laundering and terrorist financing, which are often linked to tax fraud. Their reports contain case studies and recommendations for the effective detection and prevention of financial crimes. (FATF, 2023)
- National statistics: Many of the european countries publish annual reports of their financial administrations, which include data on tax crimes detected, audits carried out and the results of the recovery of tax arrears.

2. Methods

The study provides an analytical perspective on the issue of tax crimes in the context of the effectiveness of tax administration management with the ambition to contribute to the improvement of tax discipline. Accordingly, the aim of the study is to comprehensively assess a selected set of performance indicators in the field of tax administration or the values achieved by eight regional tax offices and the Office for Selected Economic Entities based in the capital of Slovakia in the field of tax audits. By examining statistically significant differences between the efficiency indicators of the regional tax offices in the performance of tax audits, the empirical study will ultimately contribute to improving the efficiency of the main processes of financial administration. To this end, secondary data from the aggregated performance evaluation reports of tax offices with jurisdiction within the Slovak Republic were analysed for the period 2017 to 2023. Data collection involved gathering quantitative records from tax office databases that contained information on cases detected, processing efficiency and resource utilisation. Means, standard deviations, medians and ranges were calculated for each category to assess the efficiency of the tax administrations. MS Excel software was used to process the data and Statistica software was used to perform the statistical analyses.

Statistical analyses have been carried out to assess the effectiveness of these practices, taking into account organisational and legislative aspects. The methodology included descriptive analysis and non-parametric statistical tests, including Friedman's ANOVA, which was used to test the hypothesis regarding the effectiveness of tax administrations. It is used to analyze differences of dependent samples when the assumptions of normality and homogeneity of variances are not met. For this test, we will consider a significance level of 0.05. If the p-value for this test is less than or equal to the significance level, we will conclude that there are statistically significant differences between at least one pair of groups considered.

Based on the main objective of the study, the following sub-objectives were identified:

- To model and compare the evolution of selected tax control indicators over time for selected tax offices in Slovakia,
- to determine the overall effectiveness of controls and the effectiveness of VAT over-deduction controls over time for selected tax offices in Slovakia,
- to identify the existence of statistically significant differences in the values of selected tax control indicators between the years under examination.

Within the analysis we will use the following indicators (variables): *total number of controls, number of controls with findings, total number of controls of VAT over-deduction, number of controls with findings of VAT over-deduction, volume of findings from tax controls in EUR, volume of withheld VAT over-deduction in EUR.*

In addition to these, we will also analyse the indicators calculated by us. These will be:

- the overall effectiveness of controls, the effectiveness of controls without VAT over-deduction, the effectiveness of controls with VAT over-deduction, (this is the ratio of the number of controls with a finding to the total number of controls),
- the effectiveness of controls with VAT over-deduction (this is the ratio of the number of controls with VAT over-deduction with a finding to the total number of controls with VAT over-deduction).

3. Results

The study focuses on analyzing differences in selected indicators of tax audits over time. The aim is to identify how the values of these indicators have varied from year to year and what factors may have influenced their variability. This analysis will provide an overview of trends and changes in the effectiveness of tax audits over the period under review. The Friedman test will be used to test the hypothesis and a significance level of 0.05 will be considered. We present the results in tabular form, where we report the value of the test statistic denoted as $\chi 2$ and the p-value. We then display the differences using box plots. We interpret the results of seven indicators of the effectiveness of tax controls and two ratio indicators of the effectiveness of tax controls.

We first perform a comparison of the indicators for **the total number of inspections** and **the number of inspections with a finding** (boxplots 1 and 2), which show similar trends in the years under study, with significant increases in 2019 and 2020. This suggests more intense activity by tax authorities in this period. For both indicators, there were statistically significant differences between years, with the highest values concentrated in 2019 and 2020, which may indicate a focus on risk areas or increased capacity for control measures. In 2017 and 2018, as well as in the period 2021 to 2023, both indicators showed similar, more stable values. This trend may indicate a period of stabilisation or standardisation of control procedures that led to less pronounced differences in these indicators. Similar values in both indicators for these years may indicate that the intensity of controls has been relatively balanced, while fluctuations in 2019 and 2020 may be exceptional and due to external factors or changes in legislation and approach to tax controls.

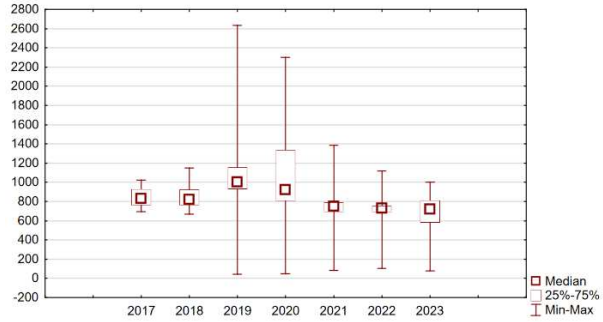

Figure 1. Total number of checks in view of the time
Source: own processing (2025)

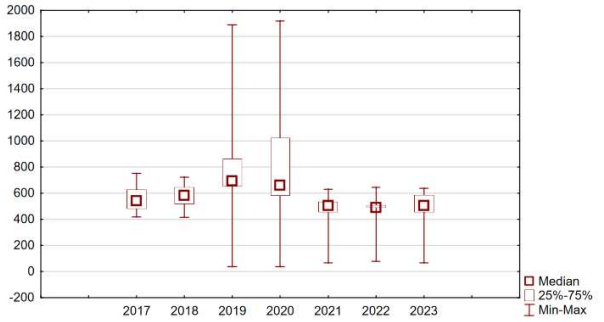

Figure 2. Number of checks with a finding
Source: own processing (2025)

The second comparison of the indicators for **the number of VAT refund inspections** and **the number of VAT refund inspections** with findings (box plots 3 and 4) reveals both similarities and differences in their development over the observed period. Both indicators show statistically significant differences across the years; however, their peak values were achieved in different years. For the number of VAT refund inspections, the highest values were recorded in 2017, indicating that tax authorities conducted more intensive inspections focused on VAT refunds during this period. In contrast, the lowest values were observed in 2022 and 2023, potentially suggesting reduced attention to this type of inspection or a strategic shift toward other areas. No significant differences were noted between 2019 and 2021, which may indicate a period of stabilization and a unified approach to these inspections. In the case of the number of VAT refund inspections with findings, the highest value occurred in 2020, possibly suggesting that inspections during this period were more targeted and effectively identified discrepancies. The lowest number of inspections with findings was in 2022, which could indicate lower inspection effectiveness or improved compliance of taxpayers with regulations. Similarly to the previous indicator, values remained stable between 2019 and 2021, supporting the notion of a consistent approach by tax authorities during this period. These differences suggest that while the overall number of VAT refund inspections was highest in 2017, the maximum effectiveness of these inspections reflected by the number of inspections with findings was achieved only in 2020. This may point to improvements in inspection methodology or targeting, which enabled a higher success rate in identifying discrepancies several years later.

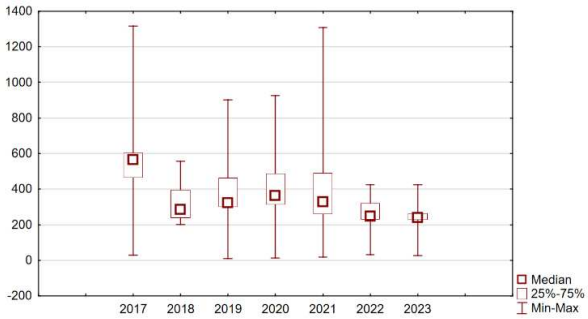

Figure 3. Number of VAT Refund Inspections
Source: own processing (2025)

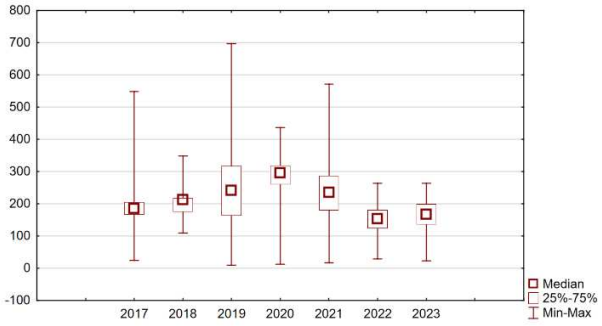

Figure 4. Number of VAT Refund Inspections with Findings
Source: own processing (2025)

The following comparison of the indicators for **the volume of findings from tax inspections** and **the volume of withheld VAT refunds** (box plots 5 and 6) reveals different trends in the development of these values over the observed years. While the volume of findings from tax inspections shows statistically significant differences between years, the volume of withheld VAT refunds remains relatively stable. For the volume of findings from tax inspections, the highest values were recorded in 2017, while the lowest were observed in 2023. This substantial decrease suggests a potential change in the approach of tax authorities to identifying discrepancies or reflects a decline in discrepancies in the observed years. Between 2018, 2020, and 2021, no significant differences were noted, which may indicate a period of relative stability in inspection procedures or less pronounced differences in the volume of findings. On the other hand, the volume of withheld VAT refunds does not exhibit significant differences between years, indicating a consistent approach by tax authorities to withholding excess VAT refunds. The stability of this indicator may signal that tax authorities maintained a similar policy for withholding VAT refunds throughout the observed period, regardless of the year. These differences suggest that while the volume of findings from tax inspections shows high variability and is sensitive to changes in approach or inspection procedures, the volume of withheld VAT refunds remains stable and less susceptible to fluctuations. This may indicate that tax authorities paid particular attention to more contentious areas with the potential for findings, while maintaining a consistent approach to withholding excess VAT refunds.

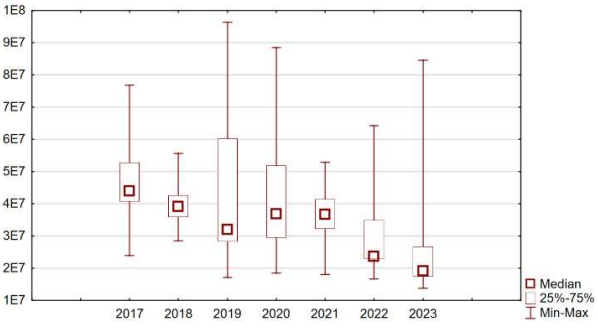

Figure 5. Volume of Findings from Tax Inspections
Source: own processing (2025)

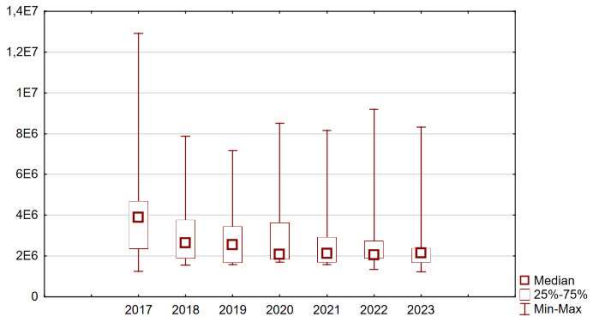

Figure 6. Volume of Withheld VAT Refunds
Source: own processing (2025)

Comparison of the indicators for **the effectiveness of inspections** and **the effectiveness of VAT refund inspections** (box plots 7 and 8) reveals differing trends in the development of these two indicators over the observed years. While inspection effectiveness shows relative stability and no statistically significant differences between years, the effectiveness of VAT refund inspections displays notable differences across periods. For inspection effectiveness, the highest performance was achieved in 2020, while the lowest was in 2018. Although no significant differences were found between years, the years 2017 and 2018 showed greater variability in inspection effectiveness, suggesting a period of adjustment or instability in inspection procedures. In later years, the inspection process stabilized, leading to reduced variation and greater consistency. In contrast, the effectiveness of VAT refund inspections showed

statistically significant differences between the observed years, with the highest effectiveness achieved in 2020, 2019, and 2018, while the lowest values were recorded in 2017 and 2021. These differences may indicate improved targeting and focus on higher-risk areas for fraud during the period from 2018 to 2020, which led to increased success in identifying discrepancies. While inspection effectiveness generally shows relative stability over time, the effectiveness of VAT refund inspections indicates a more dynamic trend, which may result from a focus on specific inspection areas and continual improvements in procedures for this type of tax obligation. This variability in the effectiveness of VAT refund inspections highlights the need for adaptability and optimization of inspection processes, which may lead to long-term improvements in the effectiveness of inspection procedures related to VAT refunds.

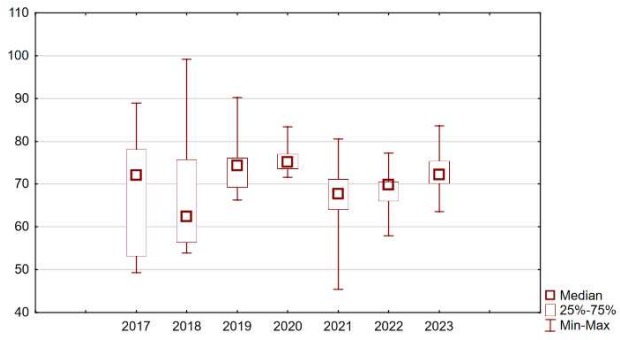

Figure 7. Overall Inspection Effectiveness
Source: own processing (2025)

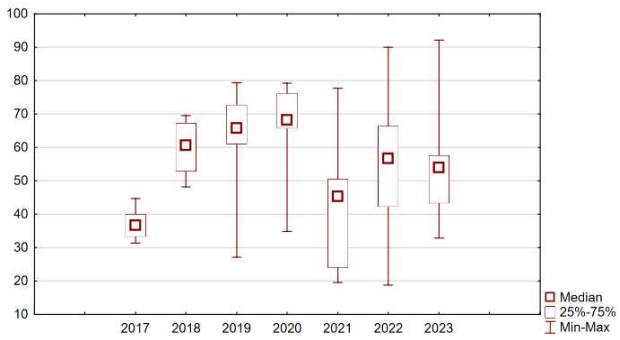

Figure 8. Effectiveness of VAT Refund Inspections
Source: own processing (2025)

Based on the provided table with chi-square (χ^2) values and p-values, the most significant statistical associations have been identified, indicating statistically significant differences between the observed indicators. The significance of the statistical association is determined by the p-value, where lower values (below the commonly used threshold of 0.05) indicate a high probability that the observed differences are statistically significant. We formulate the following hypothesis.

Research Hypothesis 1: We assume that there are statistically significant differences between the examined years regarding selected tax inspection indicators, according to data from tax authorities in Slovakia.

As shown in Table 1, the findings indicate statistically significant differences in some key indicators of tax administration, which may suggest various trends or issues in the effectiveness and focus of tax inspections over time.

Table 1. Differences Between Tax Inspection Indicators in view of the time

Indicators of Tax Inspection Efficiency	**χ^2**	**p-value**
Total Number of Inspections	19.4343	0.0035 *
Number of Inspections with Findings	22.5657	0.0010 *
Total Number of VAT Refund Inspections	17.1634	0.0087 *
Number of VAT Refund Inspections with Findings	16.8287	0.0100 *
Volume of Findings from Tax Inspections in €	21.6667	0.0014 *
Volume of Withheld VAT Refunds in €	6.8588	0.3341
Overall Inspection Efficiency	12.3810	0.0540
Efficiency of VAT Refund Inspections	19.5538	0.0033 *

Source: Gombár et al. (2025)

The results from Table 1 can be interpreted as follows. The number of inspections with findings and the volume of findings from tax inspections in € exhibit strong statistical associations, indicating that the success of inspections in identifying discrepancies and their financial volume differs significantly across periods. These differences may be due to various factors, such as an increase in inspection capacity, targeting specific sectors, or changes in inspection methodology. Such differences may suggest that

certain periods or groups of taxpayers required more intensive oversight. The efficiency of VAT refund inspections ($\chi^2 = 19.5538$, $p = 0.0033$) also shows statistical significance, indicating differences in the success of VAT refund inspections. This variability in efficiency may result from specific challenges associated with auditing refunds, which may involve case complexity or capacity constraints of tax authorities. Conversely, the volume of withheld VAT refunds in € does not show statistically significant differences ($p = 0.3341$), indicating stability in this indicator. This result may reflect a consistent approach by tax authorities to withholding excess refunds or stable volumes of such refunds over the observed period. Overall, these findings indicate dynamic trends in the effectiveness and focus of tax inspections depending on the time period and potentially on changes in legal or administrative conditions. The results suggest that improvements in specific areas could contribute to greater inspection efficiency and reduced tax evasion.

In conclusion, we state that we have achieved the objective of identifying the existence of statistically significant differences in the values of selected tax inspection indicators between the examined years. This implies that, over the observed period, the values of the indicators "*volume of withheld VAT refunds in euros*" and "*overall inspection efficiency*" do not change significantly. The research hypothesis has been confirmed.

4. Discussion

The results related to the examined tax authorities and their performance in tax inspections from 2017 to 2023 provide valuable insights into the efficiency, success rate, and focus of tax inspections. Statistical differences between the periods and indicators suggest that process improvements and optimization of inspection procedures could significantly contribute to increased efficiency and success in tax supervision. It was found that the total number of findings from VAT-focused inspections shows significant differences between the years. The highest values were achieved in 2019 and 2020, while the lowest values were observed in 2022 and 2023. This suggests that during certain periods, tax authorities focused on more efficient targeting of inspection activities or had more resources available to address VAT fraud. For practice, this means that, to maintain consistent results in VAT inspections, it would be beneficial to ensure stable resources and procedures that allow for the effective use of available capacities each year. Establishing permanent inspection standards can help avoid substantial fluctuations between years. Significant differences were also observed in the number of inspections with findings and in the volume of findings from tax inspections. Years with higher inspection volumes and success rates, such as 2017 and 2020, show that a targeted and efficient approach yields measurable results.

Based on the findings, the efficiency of tax inspections could be increased through the implementation of a risk-oriented approach, where resources are concentrated in sectors with a higher risk of tax evasion, thus maximizing the use of available resources. Utilizing advanced analytical tools, such as data analytics and machine learning algorithms, can help more accurately predict the likelihood of tax evasion and identify patterns of risky behavior. A flexible and regularly updated approach to inspection strategies will enable a quicker response to economic and legislative changes, while enhancing the expertise of tax authority staff through specialized training will improve their ability to identify risk factors and effectively use new methods of fraud detection. The effectiveness of tax inspections could also be supported by better collaboration among regional tax authorities, allowing for the exchange of information on best practices and harmonization of approaches to tax evasion detection at the national level.

We have confirmed that tax administration management plays a key role in ensuring effective tax collection and preventing tax evasion. In the context of tax crime, such as tax fraud, it is essential to introduce tools and procedures capable of responding to changes in legislation and the technological environment, contributing to more effective tax inspections. The analysis focused on the effectiveness of tax inspections with and without VAT refunds and the identification of regional differences among tax authorities in Slovakia over the period from 2017 to 2023.

Conclusion

The study provided an analytical perspective on the issue of tax crimes in the context of tax administration management efficiency. The study focused on the research objective of verifying the existence of significant differences among selected efficiency indicators of tax inspections during the monitored period within regional tax offices, based on annual reports. The existence of statistically

significant differences between the examined years for selected tax inspection indicators was verified according to data from tax authorities in Slovakia. The interpretation of the analysis results provided a foundation for formulating and proposing possible measures for tax administration management in the context of reducing tax crimes. The conducted research offered a substantial basis for further study and analysis, as it represents essential material with the potential to explore the relationship between tax administration management and the efficiency of tax inspections more deeply. The analysis of both theoretical and practical foundations confirmed the assumption that tax administration management is a key element in detecting tax crimes and ensuring fair tax collection. This research also opened up the opportunity to broaden the discussion and propose additional solutions with the potential to improve tax administration management, enhance the success rate of tax inspections, and contribute to the overall improvement of tax system functioning.

Acknowledgements

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The Fluid Reality Theory of Pygmalion Effect in Management: Integrating the Consciousness Equation and Oxytocin-Mediated Trust

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Abstract

Research Background: The Pygmalion effect demonstrates how managerial expectations can influence employee performance through self-fulfilling prophecies, yet the underlying neurobiological mechanisms remain poorly understood. Classic studies in organizational psychology show that leader expectations significantly impact subordinate performance but lack integration of neuroscientific evidence explaining how intangible expectations translate into concrete behavioral changes.
Purpose of the Article: This paper presents a unified theoretical framework integrating Fluid Reality Theory's Consciousness Equation ($\partial C/\partial t = k \cdot (I \times E - \alpha C)$) with oxytocin-mediated trust mechanisms to explain how managerial expectations shape employee performance through neurobiological and boundary dynamics. The model proposes that Connection Quality (C) represents the permeability of self-other boundaries, driven by Imagination (I) and Environment (E), with oxytocin serving as a physiological substrate mediating trust and bonding.
Methods: A theoretical synthesis approach was employed, integrating evidence from neuroscience, organizational psychology, and educational research. The analysis drew on established research on the Pygmalion effect, oxytocin's role in trust formation, and dynamic systems theory to develop the integrated framework.
Findings and Added Value: The unified model demonstrates that high managerial expectations combined with supportive environments increase Connection Quality, fostering trust, openness, and adaptive performance. Research evidence supports that oxytocin release underlies trust-building processes, with moderate challenge and social support triggering neurochemical responses that enhance focus and social connection. The framework generates testable predictions across multiple levels, from measurable brain signals to hormonal markers and improved organizational outcomes.

Keywords: Pygmalion effect, Consciousness equation, Oxytocin, Trust, Leadership expectations, Organizational neuroscience

JEL classification: E24; J50

1. Introduction

Human beings are inherently interconnected and adaptive, continuously shaped by relationships and expectations from others. Classic studies in education demonstrated the powerful Pygmalion effect: when teachers were led to hold high expectations for certain students, those students significantly improved their performance, whereas low expectations led to poorer performance (Rosenthal & Jacobson, 1968; Eden, 1990; Livingston, 1988; Eden et al., 2000). In organizational psychology, a similar phenomenon occurs—managers' beliefs about employees can become self-fulfilling prophecies that boost or hinder productivity and growth (Livingston, 2003).

Yet, the underlying mechanism by which an intangible expectation translates into concrete changes in another person's motivation, learning, or performance has remained elusive. How do a leader's or educator's mental states and assumptions come to literally change the physiological and psychological state of their followers or students? Recent advances suggest a convergence of explanations: neuroscience

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identifies neurohormonal pathways (like oxytocin) that underlie trust, social bonding, and stress responses, while systems theory and consciousness research propose that the mind is not a static entity but a dynamic process of boundary modulation between self and environment.

The Pygmalion effect has been extensively explored in organizational contexts, with numerous studies clarifying the effect and identifying mediating mechanisms of leadership and self-expectations (Siegel, 2020; Rosenthal & Jacobson, 1968; Eden, 1990; Livingston, 1988; Eden et al., 2000; McNatt, 2000). Research demonstrates that the finding that leader expectations for subordinate performance can subconsciously affect leader behavior and subordinate performance operates through two primary mediators: leadership behavior and self-expectations (Kierein & Gold, 2000; Fishbein, 2021; Good et al., 2016). However, several factors limit the application of the Pygmalion effect to workplace settings, including its subconscious nature, ethical considerations, and questions about generalizability across different populations and contexts.

Building on this foundation, we introduce the Dynamic Boundary Theory of Expectation, which integrates Fluid Reality Theory's Consciousness Equation with the biochemistry of social bonding. Research by Zak and colleagues revealed that trust is biologically mediated by oxytocin: higher interpersonal trust correlates with surges in oxytocin, which in turn enhance empathy and cooperation (Zak, 2017). In workplace experiments, simply assigning challenging-yet-achievable goals—a sign that a manager expects high performance—triggers moderate stress that releases oxytocin, sharpening employees' focus and strengthening their social bonds as they work toward the goal.

This paper develops a unified theoretical framework combining the Consciousness Equation with oxytocin-mediated expectation models to explain how managerial expectations permeate boundaries to affect employee performance. Through interdisciplinary integration spanning cognitive science, endocrinology, and organizational psychology, we aim to provide a novel, testable explanation for expectation-driven performance that spans from systems theory to the molecular biology of trust.

2. Methods

2.1 Theoretical Synthesis Approach

This study employed a theoretical synthesis methodology to develop an integrated framework combining established theories from multiple disciplines. The approach involved systematic integration of evidence from neuroscience research on oxytocin and trust, organizational psychology literature on the Pygmalion effect, and dynamic systems theory related to consciousness and boundary processes.

The synthesis process drew on peer-reviewed research from established databases to identify convergent themes and mechanisms across different theoretical domains. Particular attention was paid to empirical studies demonstrating the neurobiological basis of trust formation, the documented effects of managerial expectations on employee performance, and evidence for dynamic boundary processes in human consciousness and social interaction.

2.2 Framework Development

The theoretical framework development involved three primary components: (1) articulation of the Consciousness Equation as a mathematical model for boundary dynamics, (2) integration of oxytocin-mediated trust mechanisms as biological substrates for social bonding, and (3) synthesis of these elements into a unified model explaining expectation-performance relationships.

The framework development process emphasized testable predictions and empirical grounding, ensuring that abstract theoretical constructs could be operationalized and measured through established research methods. Each component of the integrated model was linked to specific measurable variables and behavioral outcomes.

2.3 Evidence Integration

Evidence integration focused on identifying empirical support for key components of the unified framework from existing research. This included reviewing studies on the Pygmalion effect in organizational settings, neuroscientific research on oxytocin's role in trust and social bonding, and evidence for dynamic boundary processes in consciousness research.

The analysis emphasized convergent findings across different methodological approaches and research contexts, identifying robust patterns that support the integrated theoretical framework while acknowledging limitations and areas requiring further empirical validation.

3. Results

3.1 The Consciousness Equation and Dynamic Boundary Process

The Consciousness Equation (Fuchs et al., 2025) emerged from efforts to model consciousness as a process rather than a static entity. This framework proposes that Connection Quality (C) represents the permeability or flexibility of the boundary separating an individual's inner self from the external world. When C is high, the person is open, connected, and integrative—experiencing fluid exchange with their environment. When C is low, the boundary is rigid—the person is isolated, resistant to outside input, or constrained in perspective.

The equation $\partial C/\partial t = k \cdot (I \times E - \alpha C)$ states that the rate of change in connection quality is driven by the excess of the imagination-environment interaction over the damping (boundary-closing) force. Connection Quality changes over time ($\partial C/\partial t$) depending on two driving factors: Imagination (I), encompassing internal models, expectations, and beliefs, and Environment (E), representing external reality including social input and material conditions.

The term $I \times E$ denotes the interaction between inner and outer forces (Fuchs, 2025). For example, an employee's imagination might include their self-concept and aspirations, while the environment includes the manager's behavior, organizational climate, and workplace culture. Only when these factors interact meaningfully can growth in connection occur. The equation introduces scaling constant k, reflecting how sensitively the boundary responds to the I×E interaction, and damping coefficient α, capturing the system's tendency to stabilize or close boundaries over time.

3.2 Oxytocin-Mediated Trust Mechanisms

Oxytocin, often called the "bonding hormone," is released in the brain during positive social interactions involving trust, empathy, or moderate challenge. It lowers anxiety and fosters connection or collaboration. Research demonstrates that when managers provide supportive challenge—expressing confidence while offering appropriate difficulty—employees experience manageable stress that triggers oxytocin along with other neurochemicals (Zak, 2017).

Evidence from workplace studies shows that "when a manager assigns a team a difficult but achievable job, the moderate stress of the task releases oxytocin… which intensifies people's focus and strengthens social connections" (Zak, 2017). This oxytocin surge momentarily increases Connection Quality by biochemically reducing fear (lowering α, the boundary-closing force) and enhancing the reward of social contact (effectively boosting k, the sensitivity to the I×E interaction).

The neurobiological evidence supports oxytocin's role as a key mediator in trust formation and social bonding. Studies using intranasal oxytocin administration demonstrate causal relationships between oxytocin levels and trust behaviors in economic games, with individuals showing greater trust and cooperation when oxytocin is elevated (de Visser et al., 2016). These findings extend to automated agents, suggesting that oxytocin enhances affinity for social stimuli broadly.

3.3 Integrated Expectation-Performance Model

The unified model demonstrates how managerial expectations translate into employee performance through dynamic boundary processes mediated by oxytocin. A manager's initial expectation guides their behavior toward the employee, delivering signals and trust cues that, if positive, trigger oxytocin and trust responses. Oxytocin physiologically mediates bonding, making the employee feel safe and supported.

Consequently, the employee's internal state shifts—they develop higher self-belief and lower stress, becoming more open to challenge. This enhanced internal state enables stronger performance through greater effort, creativity, and willingness to collaborate. Improved performance feeds back into the manager's perceptions, reinforcing high expectations and completing the self-fulfilling cycle.

Mathematical representation maps these dynamics onto the Consciousness Equation framework. In the employee's perspective, their rate of change in C follows $\partial C/\partial t = k \cdot (I \times E - \alpha C)$. The manager's behaviors influence E (external input), and the employee's evolving mindset represents I. High expectation and support mean E is rich, and the employee's I grows with confidence, thus I×E is large and positive, driving C upward.

The oxytocin effect temporarily increases k (making the employee more sensitive to the experience) and decreases α (reducing the tendency to close off). As a result, C rises more quickly than it otherwise would. Over time, if this state is repeated and reinforced, the employee may reach a new stable high-C state characterized by lasting trust and higher self-efficacy.

3.4 Empirical Support Across Multiple Levels

Neuroscientific evidence supports boundary flexibility as measurable in brain function. Research demonstrates that conditions raising Connection Quality correlate with increased neural synchrony across distributed networks, particularly gamma-band oscillations associated with feature integration and conscious attention. Studies on mindfulness and unity experiences show that individuals reporting boundary dissolution exhibit unusual high-frequency coherence across cortical areas.

Recent neuroimaging research using hyperscanning techniques found that brain-to-brain synchrony increased when partners established mutual trust and shared goals, compared to low-trust conditions. This provides direct neural evidence for interpersonal connection quality as a measurable phenomenon.

Organizational research confirms expectation effects in workplace settings. Meta-analyses of leadership development programs found that Pygmalion leadership training produces some of the strongest effects among various leadership interventions (Eden et al., 2000). Studies in military settings demonstrated that instructors led to believe certain trainees had exceptional leadership potential saw those trainees outperform control groups on objective measures.

However, research also identifies important limitations and boundary conditions. The Pygmalion effect shows limited generalizability to experienced employees and established work groups, raising questions about when and how expectation effects operate most effectively (Kierein & Gold, 2000). Additionally, the subconscious nature of traditional Pygmalion manipulations creates ethical concerns about deceptive practices in organizational settings.

4. Discussion

4.1 Theoretical Contributions and Integration

This research contributes several theoretical advances that broaden understanding of expectation-performance relationships while bridging gaps between neuroscience and organizational psychology. The integration of dynamic boundary theory with neurobiological mechanisms provides a mechanistic explanation for phenomena previously described only at behavioral levels.

The unified framework addresses the fragmentation in existing scholarship by demonstrating how psychological, neurobiological, and organizational factors interact synergistically to produce expectation effects. Rather than treating individual cognition, social dynamics, and biological processes as separate domains, the model shows how these operate as interconnected systems.

The framework's multi-level structure enables empirical validation across different scales of analysis. At the neural level, Connection Quality corresponds to patterns of brain network integration; at the psychological level, to measures of openness and trust; and at the organizational level, to team cohesion and performance outcomes. This multi-level operationalization means the theory can be tested using various methodological approaches.

4.2 Mechanisms and Boundary Conditions

The model highlights feedback loops inherent in expectation effects. Connection Quality feeds on itself through the damping term α—if C grows, damping grows, creating potential equilibrium unless $I \times E$ continues rising. This self-limiting mechanism may explain why even excellent coaching must be sustained or growth plateaus.

Conversely, positive feedback via manager reactions to performance can increase both I and E further. Nonlinear dynamics, such as tipping points or rapid phase shifts, may occur when slight increases in trust push the system over a threshold where $I \times E$ consistently exceeds αC, leading to transformational improvement in relationships and performance.

The framework identifies several boundary conditions affecting expectation effects. The model predicts that individuals with higher baseline sensitivity (higher k values) will be more responsive to expectation interventions. Similarly, environments with lower baseline damping (lower α) should show stronger expectation effects. These parameters likely vary based on individual differences, organizational culture, and relationship history.

4.3 Practical Implications for Leadership

The unified framework generates specific recommendations for leadership development and organizational design. Leaders should recognize that every interaction literally changes the neurochemical

states of their employees. Trust and positive expectations have material effects on brain chemistry and performance beyond psychological influences.

Practical applications include providing both Imagination and Environment supports—encouraging employees to envision high goals while offering necessary resources and psychological safety. Simple practices like setting challenging but attainable goals while explicitly expressing confidence can trigger beneficial oxytocin-mediated responses.

The model emphasizes the importance of timing and consistency in expectation setting. Since oxytocin effects are temporary (rising within minutes, decaying over hours), sustained positive interactions are necessary to establish lasting high-trust relationships. Leaders must understand that building connection quality requires ongoing attention rather than one-time interventions.

4.4 Limitations and Future Research Directions

This theoretical synthesis has several limitations requiring attention in future research. The framework relies primarily on correlational evidence and laboratory studies rather than longitudinal field experiments in organizational settings. While individual components have empirical support, the integrated model requires systematic validation.

The focus on oxytocin may oversimplify complex neurochemical processes involved in trust and performance. Other neurotransmitters and hormones (dopamine, cortisol, norepinephrine) likely interact with oxytocin in ways not fully captured by the current model. Future research should investigate these interactions and their implications for expectation effects.

Cultural and individual differences in oxytocin responsiveness may moderate the model's predictions. Research suggests significant variation in oxytocin receptor genetics and cultural norms around trust that could affect how expectation interventions operate across different populations.

The ethical implications of deliberately manipulating neurochemical responses in organizational settings require careful consideration. While the model aims to enhance rather than exploit employee potential, leaders must ensure interventions serve employee development rather than mere performance extraction.

Future research should focus on longitudinal field studies testing the integrated model's predictions in real organizational settings. Studies should simultaneously measure variables across neural, hormonal, psychological, and performance levels to validate the proposed mechanisms. Additionally, research should explore individual and contextual moderators that influence when and how expectation effects operate most effectively.

Conclusions

This research demonstrates that the Pygmalion effect can be understood through an integrated framework combining dynamic boundary theory with neurobiological mechanisms of trust formation. The unified model shows how managerial expectations translate into employee performance through measurable changes in connection quality mediated by oxytocin and other neurochemical processes.

The framework's strength lies in its ability to bridge abstract theoretical concepts with concrete biological mechanisms, providing testable predictions across multiple levels of analysis. By grounding expectation effects in neuroscience while maintaining connection to organizational outcomes, the model offers both theoretical advancement and practical guidance for leadership development.

The integration reveals that effective leadership involves consciously creating conditions that enhance connection quality between managers and employees. This requires attention to both internal factors (employee mindset and aspirations) and environmental factors (organizational support and challenge), with neurobiological processes serving as mediating mechanisms.

Future applications of this framework could transform leadership development by incorporating neuroscientific insights into management training. Rather than treating trust and expectations as soft skills, leaders could learn to understand and influence the biological processes underlying human motivation and performance.

The ultimate goal involves creating organizational conditions where all employees can access the neurobiological and psychological states necessary for optimal performance and growth. This requires sustained commitment to relationship-based approaches that combine high expectations with genuine support, guided by scientific understanding of how human consciousness and connection operate at multiple levels.

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Proactive Agility - Barriers and Capabilities of Companies: Evidence from Slovakia

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Abstract

Research background: The concept of proactive business agility, which represents its highest level, is a key aspect of sustainable competitiveness in today's volatile business environment. Identifying barriers and capabilities of companies to be agile is essential knowledge in building proactive agility.
Purpose of the article: The purpose of this article is to highlight the importance of proactive agility in companies, as well as the possible barriers and capabilities of companies in building it. The aim of the paper is to identify the factors influencing the development of the ability to be proactively agile and to analyze their presence in Slovak companies.
Methods: To achieve the set aim, secondary research was conducted to summarize knowledge and create a uniform interpretation, as well as primary research in Slovak companies using a questionnaire. The paper presents partial results of the questionnaire survey focused on identifying barriers and capabilities of companies to be agile. The results of the primary research were evaluated using selected statistical methods.
Findings & Value added: The results of the secondary research showed that opinions are not uniform in the examined issue. The results of empirical research in Slovak companies show that the main barriers to the development of agility are the complex bureaucracy and regulatory environment in Slovakia and the lack of workers with the necessary agile skills. Slovak managers consider flexible decision-making and responding to customer feedback to be the most important agile capabilities. The article provides a unified interpretation of proactive business agility, barriers and capabilities for developing agility in companies, and empirical findings about existing barriers and capabilities in Slovak companies.

Keywords: Proactive agility, Agility barriers, Agile capability, Slovak enterprises

JEL classification: L26, M10, O30

1. Introduction

In today's highly dynamic and turbulent business environment, the ability of organisations to respond quickly and effectively to change is becoming a critical factor for competitiveness and long-term sustainability. This capability is captured by the term agility, which refers to an organization's capacity to perceive changes in the external environment, make informed decisions, and subsequently adapt or transform its activities (Badakhshan et al., 2019; Omowole et al., 2024). Agility has emerged as a response to rigid and linear models of project and process management, such as the 'waterfall' approach. Instead of planning large, static phases, agile methods encourage iterative development, continuous user feedback, and rapid prototyping, ensuring that results remain relevant and adapted to changing needs (Mergel et al., 2020). These principles originally originated in software development, but have gradually spread to public administration (Mergel et al., 2020), healthcare (Obeidat et al., 2021) and SME management (Omowole et al., 2024). The Agile Manifesto (Beck et al., 2001) identifies four core values - individuals and interactions over processes and tools; functional software over extensive documentation; customer collaboration over contractual negotiations; and responsiveness to change over blind adherence to a plan. These values emphasize a proactive, human-centered philosophy. Thus, agility is not just a set of tools or practices, but a mind-set - a cultural and strategic approach focused on flexibility,

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responsiveness, and innovation (Ozkan et al., 2020). Empirical studies have shown that agile organizations exhibit greater resilience during economic shocks, better manage uncertainty, and exhibit higher levels of innovation and customer satisfaction (Omowole et al., 2024; Obeidat et al., 2021). Agility thus becomes a key enabler of organizational excellence, especially when supported by strategic capabilities such as autonomous decision making, lean management, and digital transformation (Obeidat et al., 2021; Badakhshan et al., 2019).

Within organisational development, agility can be seen as a multi-level concept, with proactive agility representing its most advanced form. In contrast to reactive agility, which focuses on responding flexibly to changes already underway, proactive agility emphasizes anticipating future challenges and managing them proactively before they occur (Werder et al., 2023). In this way, the organisation becomes not just a passive object of external influences, but an active agent that shapes its environment through the ability to anticipate, learn and adapt. Proactive agility requires strategic thinking, decentralized decision making, strong market perception and rapid deployment of innovation. This form of agility is characterized not only by flexibility, but also by intentionality and initiative, which are anchored in a culture of continuous improvement and openness to change (Sharma et al., 2017; Geyi et al., 2019). Thus, high levels of agility are not only the result of the implementation of agile processes, but also a consequence of systematically building so-called agile capabilities. These capabilities are a combination of the abilities of individuals, teams, and the entire organization to make data-driven decisions, collaborate across functions, experiment with new solutions, and respond effectively to uncertainty (Mahadevan et al., 2019). However, a significant barrier to the development of agility, and particularly its proactive form, are barriers that can be identified at the level of strategy, structure, culture and technology (Weichbroth, 2022; Lugnet et al., 2021). The most common include resistance to change, lack of trust in teams, rigid hierarchical structures, poor internal communication, or lack of leadership support and clear direction. These barriers can cause fragmented implementation of agile principles or even failure of transformation initiatives, as highlighted by well-known case studies such as the fall of Nokia due to lack of business agility (Werder et al., 2023). It is therefore essential that any successful agile transformation includes the targeted development of agile capabilities that support the spread of agility across the organisation and enable scaling (Mahadevan et al., 2019). These capabilities need to be clearly linked to the strategic priorities of the business, with a particular focus on areas such as digital proficiency, customer centricity, decision autonomy, and the ability to collaborate across departments (Geyi et al., 2019; Sharma et al., 2017). Without this foundation, agility becomes a surface-level process change, with no real impact on performance or innovation capacity.

The purpose of this article is to highlight the importance of proactive agility in companies, as well as the possible barriers and capabilities of companies in building it. The aim of the paper is to identify the factors influencing the development of the ability to be proactively agile and to analyze their presence in Slovak companies.

2. Methods

The first part of the research was a summary of scientific knowledge from secondary sources, through which the essence of proactive agility was identified and possible barriers and capabilities for the development of agility in the enterprise were identified. In this part, mainly logical methods such as: analysis synthesis, deduction, comparison, description and analogy were used.

In the second part, we focused on primary empirical research in Slovak enterprises using a questionnaire survey. The aim of the survey was to find out what attitude Slovak enterprises have towards agility, what barriers they perceive in its development and what competences are important for the development of agility. The questionnaire survey was conducted using the Google questionnaires platform in the period from January 2024 to June 2024. Our respondents were managers or owners of companies in industries and selected service sectors: accommodation, catering and transport. In total, there are 135,088 businesses in these specific industries and service sectors (Finstat 2024), from which we randomly distributed 5,327 questionnaires. The return rate of our questionnaire survey was 277 enterprises. The first part of the questionnaire focused on the identification of the research sample: enterprise size, ownership, business activity, industry and ROE indicator. The second part of the questionnaire focused on questions regarding attitudes towards agility in the enterprise: barriers and benefits of agility, factors influencing agility, and agility pins applied in enterprises. The term agility was

replaced in the questions by its description as the ability to react to unexpected changes to avoid the risk of misunderstanding the essence of the questions.

The data obtained from the questionnaire survey were evaluated using Microsoft Excel and Statistica 12. The present evaluation was preceded by the determination of the minimum size of the research sample. The following formula was used to determine it:

$$n \geq \frac{z^2 \,.\, p \,.(1-p)}{c^2} \quad (1)$$

Where "n" represents the research sample size, "z" is the critical value of the normalized normal distribution for the chosen confidence level, "p" is the estimated population size, and "c" is the margin of error (Labudova et al., 2021).

In our research, with a population size of 135,088, a minimum representative sample size of 271 respondents is required at a confidence level (z) of 90% and a margin of error (c) of 5%. Our research sample of 277 respondents is representative at the given parameters.

The evaluation of the questions of the second part of the questionnaire survey was carried out using the methods of descriptive statistics, contingency tables and testing of dependencies using the Pearson chi-square test.

3. Results

The return rate of the questionnaire was 5.22% of enterprises engaged in industries or certain service sectors. The first part was devoted to the basic identification of the research sample necessary for obtaining relevant data that allow for a more detailed analysis of the specificities of each sector. The results of the first part of the questionnaire survey are shown in Table 1.

Table 1. Basic identification of the research sample

Characteristics	**Results**			
Business activity	Manufacturing	Services		Trade
	56.03 %	43.96 %		0 %
Number of employees	0 - 9	10 - 49	50 - 249	250 +
	43.68 %	*29.96 %*	*16.25 %*	*10.11%*
Company ownership	Net domestic capital	Domestic capital prevail	Net foreign capital	Foreign capital prevail
	70.86 %	*15.47 %*	*6.47 %*	*7.19 %*

Source: authors (2024)

Table 1 shows that according to the activity, most of the respondents are engaged in manufacturing activities. According to the number of employees, small and micro enterprises are predominant, with capital tied up mainly in the domestic environment (73.64%). The identification of the research sample was complemented by an open-ended question asking in which sector the company operates. In total, there were 14 different industries: automotive; wood industry; electrical industry; chemical industry; furniture pre-industry; food industry; machinery and textile industry; transport; metallurgical industry; gastronomy: hotels, restaurants. The highest percentage share was achieved by the catering industry with 22.30%, while the lowest percentage share was achieved by the chemical industry with 2.52% and the metallurgical industry with 2.16%.

The following section will evaluate the agile advantages, barriers, capabilities and principles that influence the ability of businesses to effectively respond and anticipate change in a dynamic environment. Figure 1 presents the results of a question in which we asked respondents what advantages they see in a business's ability to respond to change and adapt in a timely manner.

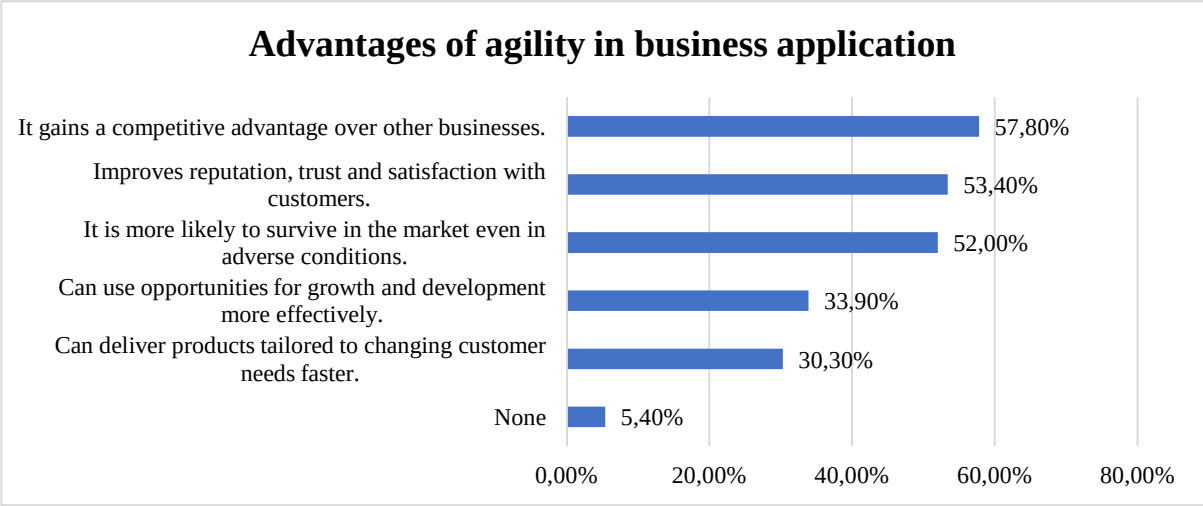

Figure 1. Advantages of agility in business application
Source: own processing (2024)

From Figure 1, we observe that the most frequently perceived benefit of applying agility in business is gaining a competitive advantage over other businesses (57.8%), followed by improved reputation, trust and customer satisfaction (53.4%) and increased ability of the business to survive in the market even in adverse conditions (52%). Fewer respondents considered the ability to more effectively exploit opportunities for growth and development (33.9%) or the ability to respond more quickly to changing customer needs (30.3%) to be an advantage. Only 5.4% of businesses did not identify any benefits associated with the application of agility.

In the next question, we asked respondents what barriers they perceived in their business' efforts to be able to react to change and adapt in a timely manner. The results are presented in Chart 2.

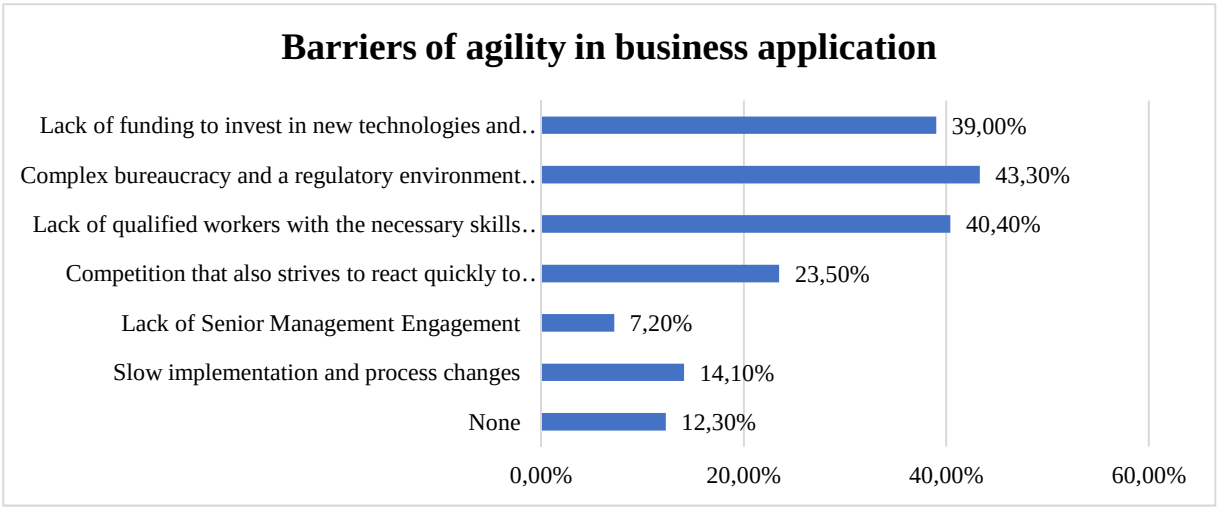

Figure 2. Barriers of agility in business application
Source: own processing (2024)

From Figure 2, we observe that the most frequently identified barrier to agility in business is complex bureaucracy and a regulatory environment that slows down decision making (43.3%). This is followed by a lack of skilled workers with the necessary skills and experience (40.4%) and a lack of funding to invest in new technologies and innovation (39.0%). Competition is also seen as a significant barrier, as it is the competition itself that reacts quickly to change (23.5%). Less common barriers are slow implementation and process changes (14.1%) and low senior management commitment (7.2%). Interestingly, 12.3% of respondents did not identify any barriers.

In the next question, we asked respondents which capabilities they consider important for the ability of the business to respond to environmental changes in a timely manner. The results are presented in Figure 3.

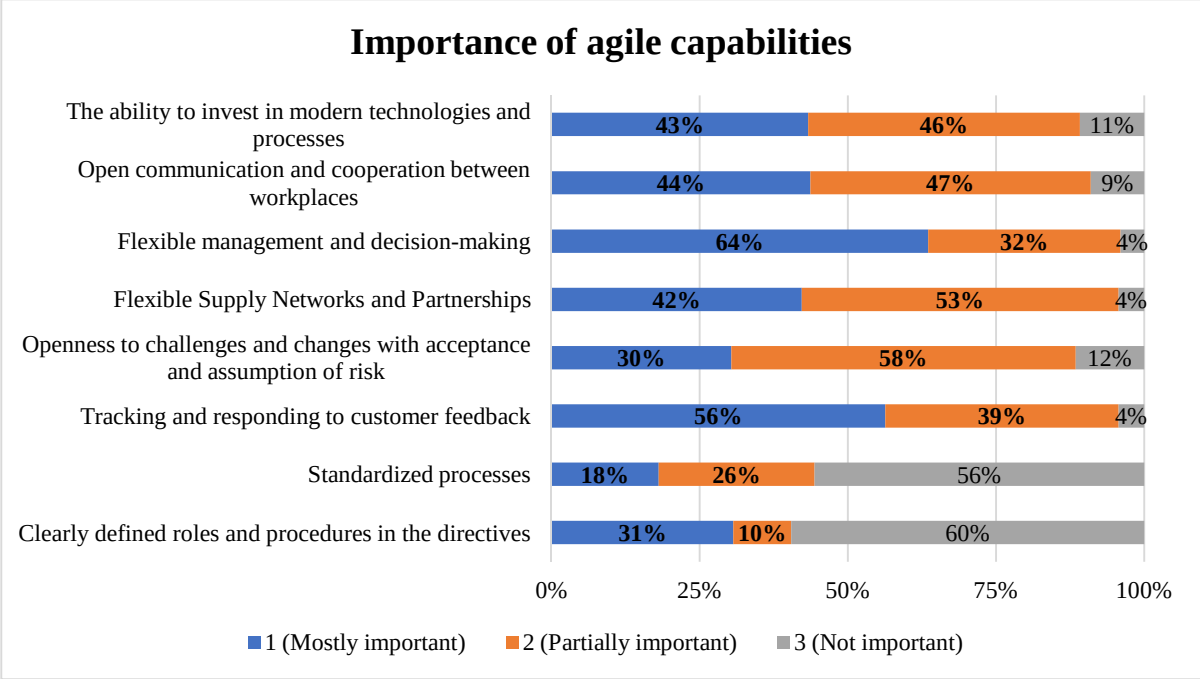

Figure 3. Importance of agile capabilities
Source: own processing (2024)

From Figure 3, we observe that respondents consider flexible management and decision making as the most important agile capability, with up to 63.54% of respondents identifying it as "very important". This is followed by the ability to monitor and respond to customer feedback (56.3%) and open communication (43.6%). Conversely, process standardization was identified as the least key capability, with only 18% of respondents considering it very important. In most cases, however, respondents combined the view of competencies as "somewhat important" and "mostly important", except for the last two options - clearly defined guidelines and procedures and standardization of processes, which are not among the agile competencies. For most of the capabilities, there is a high level of consensus on their overall importance for enterprise agility.

In the following question, we asked respondents to indicate which competencies they have in place in their company. The results of this question are presented in Figure 4.

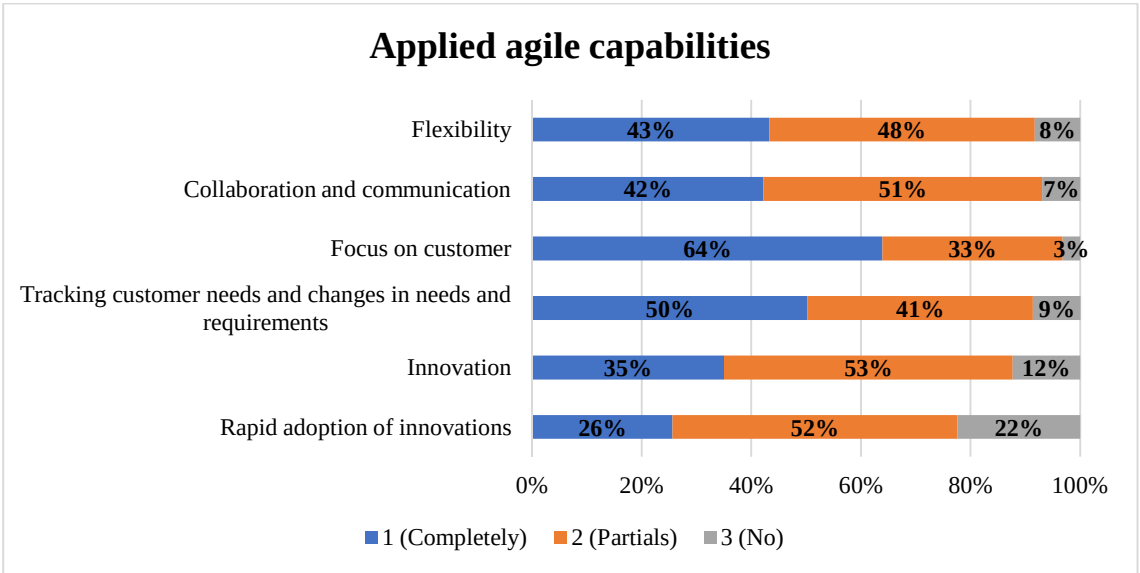

Figure 4. Applied agile capabilities
Source: own processing (2024)

From Figure 4, we observe that one of the most prevalent competencies in businesses is customer focus, which was identified as "mostly applied" by up to 63.9% of respondents. This is followed by monitoring customer needs and changes in customer requirements (50.2%) and flexibility (43.3%). A relatively high proportion of respondents also identified collaboration and communication (50.9%) and innovation (52.7%) as partially applied. Conversely, the least present capability is rapid innovation, which is mostly applied by only 25.6% of enterprises, while 22.3% said they do not have this capability at all. These results show that although basic principles such as customer orientation and flexibility are present in practice, advanced agile elements such as speed of innovation are not yet standard in the majority of Slovak enterprises.

In the last section, we compared which agile principles or capabilities the companies included in the research consider important and which are applied. The result of the findings is shown in Figure 5.

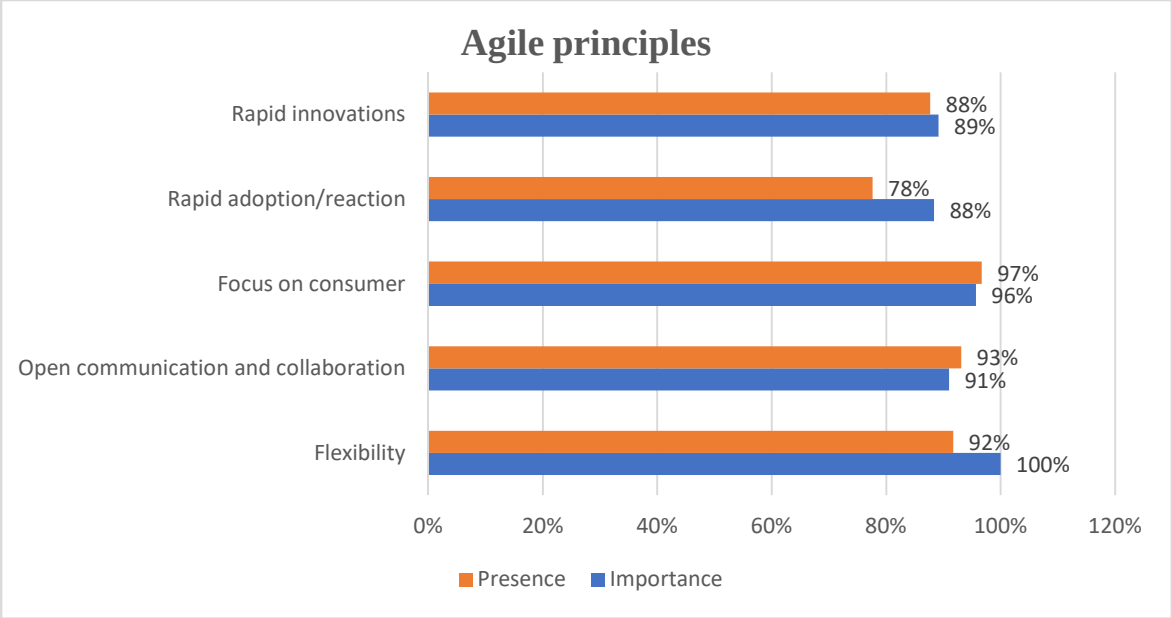

Figure 5. Agile principles – importance and application
Source: own processing (2024)

The results in Figure 5 show that the most significant difference between the perceived importance and application of agile principles is in the speed in adapting and responding to change and flexibility (8-10% difference). Given that these are the two fundamental pillars of proactive agility, there is room for improvement and focus for businesses in building agility.

4. Discussion

The results of the questionnaire survey clearly confirm that agility - especially in its proactive form - represents a key capability influencing the ability of a company to adapt to dynamic changes in the external environment. Slovak enterprises perceive agility not only as a set of tools for faster adaptation, but also as strategic thinking that can strengthen their competitiveness and long-term sustainability. The majority of respondents in our research identified gaining competitive advantage, increasing customer trust and satisfaction, and resilience in adverse market conditions as the most important benefits of an agile approach. These findings are consistent with the study of Omowole et al. (2024), which highlights agility as a key factor in the resilience of SMEs to market shocks.

In line with the findings of Geyi et al. (2019), Slovak enterprises in our survey confirm that the most important agile capabilities are flexible decision making and responsiveness to customer feedback. These capabilities enable faster organisational learning and give businesses the ability to not only embrace change but also anticipate it. This is confirmed by Werder et al. (2023), who characterize proactive agility as the highest form of agility, in which enterprises become initiators of change rather than just recipients of change. Clearly defined roles, effective internal communication or digital readiness are also important capabilities, albeit to a lesser extent.

Despite the acknowledged benefits, several barriers hinder the development of proactive agility in Slovak companies. Our data show that the most significant barriers are bureaucracy and regulatory environment and lack of skilled staff with agility knowledge. These findings are consistent with the conclusions of Weichbroth (2022) and Lugnet et al. (2021), who point out that rigid structures, lack of management support, and poor internal communication often lead to fragmented or failed agile transformation. The fact that almost a third of respondents identified the regulatory environment as a limiting factor points to the need for systemic changes, particularly in the areas of administrative simplification and innovation support.

The application of agile principles is uneven in Slovak companies. While principles such as customer orientation, flexibility and collaboration are commonly present, advanced elements - such as rapid cycles of innovation or self-organised teams - appear only rarely. This disparity suggests that even when businesses understand the importance of agility, their implementation often remains at a basic level. As Mahadevan et al. (2019) point out, true agility requires the development of capabilities at all levels of the organization - from operational processes to strategic leadership. Without this foundation, agility remains a surface change with no real impact on performance.

At the same time, our findings show that although companies declare a positive attitude towards agility, their transformation is limited by limited resources and internal resistance to change. These findings are in line with the findings of Sharma et al. (2017), who highlight that agile transformation is not only a structural change, but mainly a cultural change that requires long-term commitment, continuous learning and leadership support.

In summary, while Slovak companies understand the strategic importance of proactive agility, there is a significant implementation gap. This stems from a combination of internal (lack of skills, structural rigidity) and external (regulatory) barriers. Overcoming these requires a two-pronged approach - businesses need to develop their capabilities and internal settings in a targeted way, while policy makers should create a supportive environment for agile experimentation, innovation and talent development.

Conclusion

On the basis of the conducted research, we concluded that proactive agility plays a key role in strengthening the adaptability and competitiveness of Slovak enterprises. Although many enterprises declare a positive attitude towards agility and are aware of its strategic importance, their ability to implement proactive agility is strongly influenced by a number of internal and external barriers. Among the most significant are limited financial and human resources, rigid hierarchical structures and the complexity of the regulatory environment.

The results of the research suggest that Slovak companies most associate agility with the ability to gain a competitive advantage, increase customer satisfaction and survive even in adverse market conditions. However, advanced agile capabilities such as rapid innovation, decentralised decision-making or autonomous teams remain poorly developed in practice. This suggests that although basic agile principles are present in enterprises, their application often remains at the surface level. Another important finding is the fact that enterprises face limited external support for implementing agility and have to rely heavily on their own capabilities. This factor may contribute to slower progress in digitisation, innovation and organisational flexibility. Nevertheless, there is room for improvement, in particular through legislative changes and EU support, which can create more favourable conditions for developing agile principles and linking them to strategic business management.

A limitation of this research is the dynamic nature of the external environment, where constantly changing economic and legislative conditions can affect the ability of firms to adapt and implement effective strategies towards greater agility.

Future research should focus on the long-term impact of agility on the performance and innovation capability of Slovak enterprises, as well as on the identification of mechanisms that will enable them to overcome obstacles in the process of agile transformation. At the same time, it is recommended to focus research attention on specific forms of agile management in different sectors and size categories.

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Generational Perspectives on Employee Well-being

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Abstract

Research background: In the face of rapid technological change, shifting societal structures, and evolving demands on the workforce, employee well-being has become a critical focus in contemporary human resource management. Well-being, which encompasses physical, mental and social dimensions, significantly influences both individual performance and organisational outcomes. As workplaces become increasingly multigenerational, understanding how well-being is perceived and prioritised across different age cohorts is essential for effective HR strategy development.
Purpose of the article: The primary aim of this study is to analyse differences in the perception of well-being among Generations X, Y, and Z, and to identify the factors that most significantly shape their subjective experiences of well-being. The study seeks to generate strategic insights to help organisations align HR practices with the diverse and evolving needs of employees across generational cohorts.
Methods: The research employs a mixed-methods design, with a predominant focus on quantitative analysis. Data were collected through a structured survey targeting employees of Generations X, Y, and Z. The survey assessed how participants perceive and value various aspects of well-being, including work-life balance, technological engagement, and organisational support.
Findings & Value added: The study reveals significant generational differences in expectations and experiences related to well-being. Generation Z emphasises flexibility and purpose-driven work, while Generation X favours stability and structured work environments. These findings underline the importance of generationally responsive HR policies. The paper offers practical recommendations for implementing inclusive, flexible, and development-oriented HR strategies that enhance long-term satisfaction, engagement, and motivation across the workforce.

Keywords: Employee well-being, Generational differences, Human resource management, Work-life balance, Organisational strategy

JEL classification: J24, M54, I 31

1. Introduction

In today's world, where rapid technological change, increasing demands on workers, and shifting social structures shape daily life, the topic of well-being is becoming ever more significant. Well-being, understood as a state of physical, mental, and social health, is a crucial factor that influences not only the quality of personal life but also the performance of an individual on the job.

The traditional concept of striving for a balance between work and personal life is increasingly being replaced by a contemporary approach focused on fostering well-being. This modern perspective stems from the understanding that work and family life are not separate spheres, but interconnected dimensions that together form the fabric of daily life. The key lies in creating conditions that allow for individually optimal arrangements - ones that reflect the needs, circumstances, and values of each person (Kelliher et al., 2018; Homfray et al., 2022).

In recent decades, the concept of well-being has emerged as a central theme in public health, social policy, and sustainable development. Well-being, as an overall state of contentment and fulfilment, marks a shift away from purely economic indicators such as GDP, towards a more holistic understanding of human development. The World Health Organisation (WHO) regards well-being as a key indicator of

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both quality of life and social sustainability. Its importance was underscored by the COVID-19 pandemic, which exposed the fragility of healthcare systems and the consequences of social inequalities (World Health Statistics, 2024).

Although the harmonisation of work and private life has traditionally been viewed as a personal concern, it is increasingly being integrated into human resource management as a vital element in the modernisation of workplace environments and the promotion of employee well-being (Homfray et al., 2022).

Studies using cross-sectional and longitudinal surveys in various regions indicate that perceptions of well-being vary significantly among Generations X (1965–1980), Y (1981-1999) and Z (2000–2013). Organisational well-being demonstrates a generational gradient, generally declining from Baby Boomers to Generation Z. Each generational cohort exhibits distinct patterns in terms of engagement, types of commitment, and the factors that drive workplace satisfaction (Smaliukienė and Bekešienė, 2020; Kalpesh and Nayak, 2024).

The primary aim of this study is to analyse differences in the perception of well-being among Generations X, Y, and Z, and to identify the factors that most significantly shape their subjective experiences of well-being. The study seeks to generate strategic insights to help organisations align HR practices with the diverse and evolving needs of employees across generational cohorts.

1.1 Theoretical Background

The World Health Organisation (WHO, 2021) defines well-being as a dynamic state in which both individuals and societies achieve a balance between the physical, mental, and social dimensions of life. Simons and Baldwin (2021) describe well-being as a state of positive feelings and the realisation of a person's full potential within the world. It can be assessed both subjectively and objectively through a health promotion-oriented approach.

Understandings of well-being vary significantly across cultures and contexts. While Western frameworks often emphasise individual satisfaction and subjective happiness, other traditions, such as the Latin American concept of Buen Vivir, place collective well-being and harmony with nature at the forefront (Artaraz et al., 2021). Within the scope of sustainable development, well-being is increasingly viewed as the intersection of health, social justice, and environmental sustainability, forming a foundation for new strategies in policy making and organisational governance (WHO, 2021).).

At the same time, it is becoming evident that achieving this balance is not a universal process but rather an individual journey influenced by a range of internal and external factors. These factors include not only an individual's biological and psychological predispositions, but also the social environment, available resources, and the extent to which organisations or societies create conditions conducive to supporting this balance (Lee et al., 2021).

Organisations capable of recognising and accommodating these differences, such as offering flexible working arrangements tailored to the abilities and availability of employees, hold the potential to attract a broader spectrum of talent. In doing so, they not only expand their human resource base, but also enhance the quality and diversity of skills within their teams. The outcome is a synergistic effect, whereby collaboration between employers, employees, and the wider society generates value that extends beyond conventional expectations (Homfray et al., 2022; Howard et al., 2017).

1.2 Objective and Subjective Well-being

Objective well-being focusses on measurable factors that influence quality of life, such as life expectancy, access to healthcare, education, or economic stability (World Health Statistics, 2024). Data from HR analytics and productivity metrics are also used in this context (De Neve and Ward, 2023). These indicators offer valuable information on the overall condition of society and help identify areas that require targeted improvement.

Subjective well-being, on the other hand, reflects how individuals perceive their own life circumstances, encompassing aspects such as happiness, overall life satisfaction, and emotional stability. This approach highlights the importance of social relationships, work conditions, and the ability to manage stress effectively. Research shows that higher levels of subjective well-being improve the resilience of individuals and their ability to cope with demanding challenges (World Health Statistics, 2024). Subjective well-being is typically measured using surveys and questionnaires designed to capture personal experiences and perceptions (Diener et al., 2018).

However, subjective well-being is also shaped by broader contextual factors, such as the quality of political systems. Studies by Orviska et al. (2012) show that the well-being of individuals is positively influenced by political systems that offer a high degree of democratic freedoms, effective governance, and low levels of corruption. Countries where people have better access to public services and can actively participate in decision-making processes tend to exhibit higher levels of life satisfaction.

1.3 Pillars of Well-being

O'Reilly (2013) classified the following pillars of well-being within the context of social work:

- Building meaningful relationships with partners, family, friends, colleagues, and the wider community is vital, particularly in times of stress.
- Being mentally and physically active and having a sense of purpose - through work, caregiving or personal interests - provide the direction and fulfilment of life.
- Continual learning and the commitment to human values help people, including social workers, find meaning and improve their practice.
- Giving to others through compassion, empathy, and support, whether in the form of time, care, or material resources, strengthens individuals and contributes to the well-being of society.
- Practice of mindfulness and presence supports the development of authentic relationships, effective communication, and reflective listening, all of which are foundational to the values and principles of social work.

Another multidimensional approach is represented by the PERMA model (Positive emotion, Engagement, positive Relationships, Meaning, and Accomplishment) developed by Seligman (2017). Drawing on further literature (Kalpesh and Nayak, 2024; O'Leary and Tsui, 2023; Pietruszyńska, 2023) and insights from experts at the Gallup Institute, well-being can also be understood through five core pillars that reflect key domains of human life: meaning, relationships, health, finances, and community. Based on data collected from individuals in more than 150 countries, it has been concluded that these five factors are decisive in determining whether a person is truly thriving or merely surviving. This concept formed the basis for the survey conducted in this study (Brixová, 2019), who defines these factors:

- Meaning – Focusses on a sense of purpose and fulfilment in life. Individuals who experience meaning in their activities and life goals tend to report greater happiness and greater resilience to stress.
- Relationships – Encompass the quality of interpersonal connections. People with strong and supportive relationships manage stress more effectively and generally report greater life satisfaction.
- Finances – Reflect perceptions of economic stability. Financial insecurity is a major stressor that can significantly affect quality of life.
- Health – Includes both the care of physical health and illness prevention. Sufficient physical activity, a nutritious diet, and restorative sleep are key to achieving long-term health and well-being.
- Community – Relates to one's connection with the surrounding environment and involvement in community life. Those who actively contribute to the improvement of their local context tend to experience a greater sense of fulfilment and satisfaction.

2. Methods

For this investigation, a quantitative data collection method was selected in the form of a survey. The aim of data collection was to analyse generational differences in perception of well-being and to identify the factors that influence these differences. The study focused on measuring respondents' subjective levels of well-being using standardised scales, as well as identifying relationships between generation, employment status, lifestyle, and other socio-economic factors.

The questionnaire was designed to include general demographic questions and specific items aimed at assessing various dimensions of well-being. To evaluate well-being, the questionnaire was based on the Gallup methodology as adapted by Brixová (2019). The full questionnaire is provided in Appendix 1.

The first part of the questionnaire included questions that allowed the categorisation of the respondents into their respective generational groups (Generation X, Y, or Z), as well as the collection of basic socioeconomic data such as gender, level of education, and occupational status. The second part comprised a total of 22 scaled questions divided into five main domains: physical health, mental health, social well-being, spiritual well-being, and financial well-being. Each of these areas was represented by several items intended to assess subjective perceptions of well-being within the respective domain.

The survey used closed-ended questions with a five-point Likert scale, allowing quantification of responses and subsequent statistical analysis. The Likert scale served as the primary instrument for measuring well-being, allowing respondents to express the degree to which they agreed with specific statements. The scale ranged from 1 (strongly disagree) to 5 (strongly agree), ensuring consistent evaluation in the various aspects of well-being.

The research sample consisted of 260 respondents in total. In constructing the sample, efforts were made to ensure balanced representation of the three generational cohorts (X, Y, and Z), as well as gender, in order to produce relevant and generalisable results for analysing intergenerational differences in the perception of well-being. Data collection was carried out using an online questionnaire, which enabled access to a broad spectrum of participants with diverse socioeconomic backgrounds.

The questionnaire was created using Google Forms and was distributed primarily through social media platforms and personal networks. Data collection took place in January 2025.

In line with the research objective, the following research questions were formulated:

1. Are there statistically significant differences in the perception of well-being between generations?
2. Which factors most significantly influence the level of well-being within each generational group?
3. Can a generation be identified that exhibits the highest or lowest levels of well-being?

To test for statistically significant differences in the perception of individual dimensions of subjective well-being across Generations X, Y, and Z, a one-way analysis of variance (ANOVA) was performed. This method was chosen because of its effectiveness in identifying differences in mean values among more than two groups across various quantitative variables. ANOVA was performed separately for each of the five dimensions of well-being: physical, mental, social, spiritual, and financial health.

3. Results

For analysis purposes, 7 responses were excluded from the total sample of 260 respondents, as they did not meet the criteria of the selected research sample. Consequently, 253 valid responses were analysed.

The structure of the sample in terms of gender and generational distribution is presented in Table 1.

Table 1. Sample Structure by Gender and Generation

Gender	**Men**		**Women**	
Generation	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Z (2000–2013)	42	44.21 %	71	44.94 %
Y (1981-1999)	24	25.26 %	51	32.28 %
X (1965-1980)	29	30.53 %	36	22.78 %
Total	**95**	**37.55 %**	**158**	**62.45 %**

Source: own elaboration

To support the objectives of this article, only summary results are presented for the entire questionnaire - in the five well-being categories.

Each dimension of subjective well-being was quantified as the arithmetic mean of responses to a set of relevant items, all measured using a five-point Likert scale. The average score for each dimension was calculated as the mean of all subitems within the given category. These results are displayed in Table 2.

Table 2. Mean Scores for Well-being Dimensions by Generation

Generation	Physical Health	Mental Health	Social Well-Being	Spiritual Well-Being	Financial Well-Being
Z (2000–2013)	3.25	3.31	3.56	3.70	3.26
Y (1981-1999)	3.54	3.69	3.77	3.95	3.44
X (1965-1980)	3.46	3.89	3.78	3.96	3.34

Source: own elaboration

3.1 ANOVA Test Procedure

The independent variable under observation was generational affiliation, categorised into three levels: Generation X, Generation Y, and Generation Z. For each dimension of subjective well-being, a test was conducted to determine whether the mean scores differed statistically significantly across these generational groups.

Within the one-way analysis of variance (ANOVA), both between-group variance (variability between generations) and within-group variance (variability within each generational cohort) were calculated. The resulting F-test was used to assess whether the ratio of these variances was sufficiently large to reject the null hypothesis of equal means.

The level of statistical significance was set at $\alpha = 0.05$. Where the analysis yielded statistically significant results, Tukey's HSD post-hoc tests were applied to compare all possible pairs of groups and to identify specific intergenerational differences.

The results of the ANOVA and post-hoc analyses are summarised in Table 3.

Table 3. Summary of ANOVA Results and η^2

Dimension of Well-being	**F (2, 250)**	**p-value**	**η^2**	**Effect Size Interpretation**
Physical health	2.30	0.103	0.018	Small to medium
Psychological health	5.29	0.006	0.041	Small to medium
Social health	0.77	0.464	0.006	Negligible
Spiritual health	10.11	< 0.001	0.075	Medium or greater
Financial health	10.90	< 0.001	0.080	Medium or greater

Source: own elaboration

The one-way analysis of variance (ANOVA) indicated statistically significant generational differences in three dimensions: psychological, spiritual, and financial well-being. The corresponding effect sizes suggest a medium magnitude, highlighting the substantive relevance of generational membership in the perception of these well-being aspects.

Although the difference in physical health among groups did not reach statistical significance, the size of the effect size ($\eta^2 = 0.018$) suggests a weak effect, which could reflect a trend in generational differences in perceived physical well-being. In contrast, social health exhibited neither statistically nor practically significant differences, indicating a relatively homogeneous perception of social relationships across the generations under study.

Based on the statistically significant findings from the one-way ANOVA, post-hoc comparisons using Tukey's HSD test were conducted for the dimensions where significant generational differences were identified (psychological, spiritual, and financial health). This procedure enabled the identification of specific generational pairings with the most pronounced differences, while also controlling for multiple comparisons and thereby reducing the risk of Type I error.

Post-hoc results revealed a statistically significant difference in psychological health between Generation X and Generation Z, with a mean difference of -0.4061 ($p = 0.0086$), indicating that Generation Z reports lower levels of psychological well-being compared to Generation X. A detailed summary of these findings is presented in Table 4.

Table 4. Post-hoc Test – Psychological Health

Generation (1)	Generation (2)	Mean Difference	p-value	Statistically Significant
X	Y	-0.1036	0.7636	No
X	Z	-0.4061	0.0086	Yes
Y	Z	-0.3025	0.054	No

Source: own elaboration

In the domain of spiritual health, statistically significant differences were observed between Generation X and Generation Z (mean difference = -0.6162; p = 0.0002), as well as between Generation Y and Generation Z (mean difference = -0.4806; p = 0.0030). These findings are summarised in Table 5.

Table 5. Post-hoc Test – Spiritual Health

Generation (1)	Generation (2)	Mean Difference	p-value	Statistically Significant
X	Y	-0.1356	0.6889	No
X	Z	-0.6162	0.0002	Yes
Y	Z	-0.4806	0.0030	Yes

Source: own elaboration

In the financial health dimension, statistically significant differences were found between Generation X and Generation Z (mean difference = -0.5714; p = 0.0007), as well as between Generation Y and Generation Z (mean difference = -0.5937; p = 0.0002). These data confirm that perceived financial well-being is markedly lower among younger respondents. The corresponding results are presented in Table 6.

Table 6. Post-hoc Test – Financial Health

Generation (1)	Generation (2)	Mean Difference	p-value	Statistically Significant
X	Y	0.0223	0.9903	No
X	Z	-0.5714	0.0007	Yes
Y	Z	-0.5937	0.0002	Yes

Source: own elaboration

3.2 Responses to the Research Questions

Based on the analysis of data obtained through the quantitative survey, it was confirmed that subjective well-being perception differs statistically significantly among Generations X, Y, and Z. ***This finding clearly addresses the first research question*** (Are there statistically significant differences in the perception of well-being between generations?) significant differences were identified primarily in the dimensions of psychological, spiritual, and financial health, where Generation Z consistently reported lower levels of subjective well-being compared to older generations. These differences were substantiated through the results of the one-way ANOVA and subsequent post-hoc tests, which demonstrated that Generation Z tends to evaluate aspects such as life stability, financial security, and existential meaning significantly more negatively.

In relation to the second research question (Which factors most strongly influence the level of well-being within each generational group?) the data revealed key determinants of well-being unique to each generation. For Generation Z, the most influential factors include financial insecurity, difficulties managing stress, and weaker anchoring in a stable value system. Members of this cohort also face increased instability in both the educational and occupational spheres. For Generation Y, the level of subjective well-being is most affected by the ability to balance work and personal life, opportunities for self-fulfilment, and access to career advancement. In the case of Generation X, decisive factors include a stable working environment, health-related security, and a long-term sense of purpose in one's professional life, all of which contribute positively to their overall perception of well-being.

Addressing the third research question (Can a generation be identified that exhibits the highest or lowest level of well-being?) the analysis of mean scores across the individual well-being dimensions indicates that Generation X demonstrates the highest level of subjective well-being, particularly in the domains of

psychological and spiritual health. On the contrary, Generation Z consistently shows the lowest levels of subjective well-being in the observed areas, with the most pronounced deficits found in emotional balance, existential grounding, and perceptions of economic self-sufficiency. Generation Y generally falls between these two groups, characterised by a relatively balanced but more variable perception of life satisfaction.

4. Discussion

Generational differences in work-related attitudes are reflected in distinct patterns of organisational well-being. Research in various sectors indicates that Baby Boomers consistently report higher levels of work engagement, job satisfaction, and affective organisational commitment, in addition to lower levels of overcommitment and occupational stress (Stevanin et al., 2018).). Generation X employees typically exhibit intermediate levels of well-being, while Millennials (Generation Y) tend to report reduced engagement and elevated levels of burnout. Their organisational commitment is often more normative than affective in nature. In the limited number of studies that include Generation Z, this cohort consistently demonstrates the lowest levels of organisational engagement, with social relationships emerging as the principal determinant of their workplace well-being (Smaliukienė & Bekėsienė, 2020).

The findings of Kalpesh and Nayak (2024), based on a sample of more than 12,000 participants and using various measurement tools, support a consistent trend: while job satisfaction remains a shared concern across generations, the balance between external conditions and social influences on well-being varies significantly by generational group.

Although the current survey was conducted exclusively among Czech employees and included only three generational cohorts, the results align with the findings reported by researchers in other international contexts. Therefore, these generational differences must be carefully considered in the development of organisational and human resource strategies, particularly in areas such as staff participation, retention, and well-being support.

Conclusion

In light of current challenges in human resource management, the concept of well-being is emerging as a key strategic tool for improving working conditions, productivity, and overall employee satisfaction. This paper has presented the concept of well-being and its core pillars. With three generations currently co-existing in the labour market, creating policies that accommodate the needs and expectations of all age groups represents a significant challenge for managers.

The primary aim of this study was to analyse generational differences in the perception of well-being among Generations X, Y, and Z, and to identify the key factors that most strongly shape their subjective experiences of well-being. The research sought to provide strategic insights to support organisations in aligning their HR practices with the evolving and diverse needs of employees across generational cohorts.

Statistical analyses confirmed the presence of significant generational differences in perception of well-being, particularly in the dimensions of psychological, spiritual, and financial health. The findings indicate that Generation X reports the highest and most stable levels of subjective well-being, while Generation Z consistently displays the lowest levels. This corresponds to data indicating lower scores among Generation Z in areas such as financial security, existential grounding, and the ability to manage psychological stress. Generation Y occupies an intermediate position, characterised by a relatively balanced, yet more variable, perception of individual well-being components.

The results underscore that perceptions of well-being are not uniform across generations but are shaped by a complex interplay of biological, social, economic, and value-based factors, reflecting both the current stage of life and the broader cultural and societal context. Accordingly, it is essential that human resource management strategies account for the specific needs of each generation, offering tools that are adapted to their distinct values and life circumstances.

The findings presented in this study provide a robust empirical foundation for the design and implementation of age-sensitive HR strategies, enabling organisations to respond effectively to the needs of a heterogeneous workforce. The practical implications are particularly relevant in the areas of age management, employee well-being support, career development, and prevention of psychological burnout.

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Appendix 1

1. What is your gender?
Female
Male

2. What year were you born in?
1965-1980
1981-1999
2000-2013
Other:

3. What is your level of education?
Primary education
Secondary school with a diploma
Secondary school with a high school diploma
Higher education

4. What is your role within your current job?
Manager
Ordinary employee
Self-employed
Unemployed
Other

Rate the statement, with ***1 being not at all agree***, ***5 being fully agree***

Physical health

	1	2	3	4	5
I feel physically fit					
I think I move often enough to benefit my					
Most nights I sleep long enough to feel rested					
I eat a balanced diet					
I engage in activities that help me feel physically well					

Mental health

	1	2	3	4	5
Most of the time I feel mentally at ease					
I can cope with stress and challenging situations					
I have a positive attitude to life					
I have plenty of time to myself					

Social health

	1	2	3	4	5
I have people around me that I can rely on in challenging situations					

I feel I have enough time for activities that bring me joy and relaxation					
I feel that I maintain a balanced relationship between my work responsibilities and my personal life					
I feel that I am part of a community or group where I feel accepted					
I spend enough time building and maintaining relationships with close people					

Spiritual Health

	1	2	3	4	5
I feel like my life has meaning					
I feel grateful for what I have					
I feel that my job matches my skills and interests					
My work motivates me to grow as a person					

Financial health

	1	2	3	4	5
I am worried about my future from a financial point of view					
I feel confident in my ability to effectively manage my financial resources					
I have a sufficient financial reserve for unexpected expenses					
I feel that my current financial situation allows me to fulfill my needs and goals					

Management of Intangible Assets: Aspects of Evaluation and Identification of Digital Assets of an Enterprise

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Abstract

Research background. Intangible resources, including information and intellectual components, are becoming increasingly important in digitalizing business activity. Improving the methodologies for assessing these resources is important for effective management decision-making. However, identifying and assessing intangible resources, especially digital assets, requires further improvement. Currently, no generally accepted methodologies for assessing resources that are not recognized as assets and are absent from financial statements, such as information resources, internally created business reputation, and employee training

Purpose of the articleis to develop and improve existing approaches to the assessment and identification of intangible resources in general, and digital assets in particular, as well as to develop accounting and analytical support for the use of information and intellectual resources in the business processes of the enterprise.

Methods: The study employs conceptual and system analysis, monographic and comparative analysis, statistical methods, and visualization tools. Based on publicly available statistical reporting data on the activities of Ukrainian enterprises for the period 2018-2024, correlation and regression modeling of the dependence of the enterprise's residual income indicator on the structure of capital investments was carried out.

Findings & Value added: The developed approach to the assessment and identification of intangible resources contributes to the enhancement of both the processes of managing the information and intellectual component of capital and the formation of accounting and analytical support for assessing the market value of an enterprise as a business unit.

Keywords: Recognized intangibles, Unrecognized intangibles, Digital assets, Smart contracts, Cryptocurrencies

JEL classification: C51, D 80, M21, M40, O30, O32

1. Introduction

The accelerated development of information technologies, the rapid digitalization of business processes, and the introduction of artificial intelligence into the activities of economic entities are driving

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the transition of the economic systems of leading countries from Industry 4.0 to the fifth and sixth technological paradigms.

Intangible resources encompass research and development (R&D), intellectual property, brands, software, databases, structural organizational capabilities, business experience, and the professional skills of personnel. These resources are crucial for modern business units seeking to maintain competitiveness and drive innovation in an increasingly dynamic and knowledge-based economy to remain competitive and innovative.

According to a study by Brand Finance, in 2023, the global intangible value increased by 8% compared to 2022, amounting to $ 61.9 trillion, which is nearly three times higher than the US GDP (Brand Finance, 2024). During the same period, the value of global tangible net assets remains stable (62.7 trillion US dollars in 2023 compared to 62.9 trillion US dollars in 2022). In 2024, the global value of intangible assets reached USD 79.4 trillion. During the same period, the value of global tangible net assets also increased, amounting to USD 68.8 trillion. The constant increase in the value of intangible assets, as illustrated in Fig. 1 and, Fig. 2, which has been observed since 2000, reflects their growing impact on the global economy.

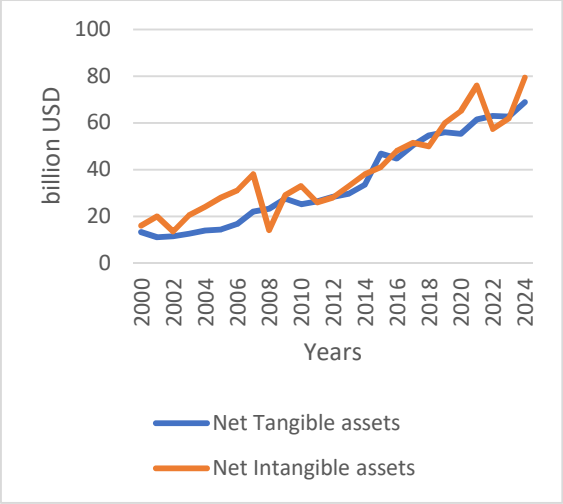

Figure 1. Dynamics of global asset value by years

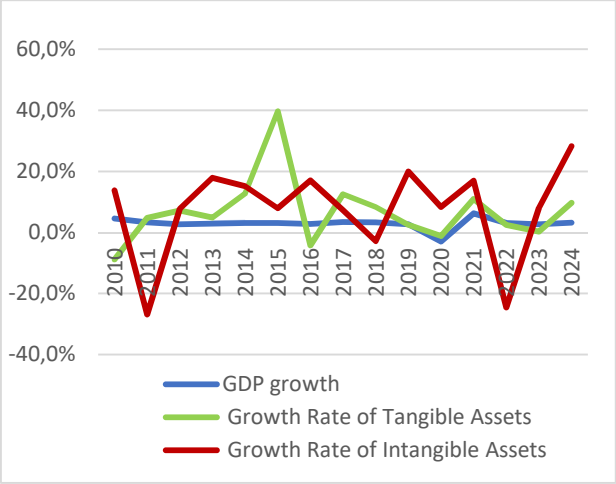

Figure 2. Dynamics of growth of global GDP and assets, %

Source: own processing (2025) *based on Brand Finance, 2024, and MacroTrends (2024)*

According to experts from Brand Finance and WIPO (Brown, A. et al., 2025), the global value of companies' intangible assets demonstrated an increase by 28% in 2024 compared to 2023, reaching its highest level since the beginning of observation. It is worth noting that countries It is worth noting characterized by a high technological structure have a high level of use of intangible assets in business processes.

The financial reports of the largest US corporations for 2024 show that, as in 2023, the predominant share of total business unit value is attributable to intangible assets (77%), compared to an average of 54% among the world's largest corporations. In contrast to the US, the Chinese economy remains largely tangible, and only 16% of the total valuation of business sector assets is valued as intangible. (Brandirectory, 2024)

A comprehensive analysis of the structure of intangible assets of the world's 500 largest corporations, conducted using data from Brand Finance, 2024, reveals a noticeable transformation in the composition of disclosed intangible value. In particular, there has been a discernible shift away from the generic category of goodwill towards more clearly defined intangible assets, such as corporate brands, proprietary software, and advanced technological solutions (Brown, A. et al., 2025). The same opinion is shared by Hayashishita, & Oda (2025), who emphasize that to respond effectively to dynamic market conditions, companies must develop the capabilities necessary to generate new knowledge. In this context, the knowledge acquisition process is closely related to investments in intellectual and information resources that form the enterprise's general intellectual property.

The results of research by Lin & Ye (2024), Glova et al. (2018) and Kiseľáková et al. (2024) demonstrate the significant impact of investments in R&D on the overall financial results of activities both at the level of individual business entities and at the level of industries, as well as on GDP growth at the level of national economic systems.

1.1 Issues in identifying and valuing intangible resources for effective management

Based on the commonly accepted understanding, intangible resources encompass both "disclosed" (i.e., reflected in the accounting and financial statements of enterprises) and "undisclosed" assets. In a general sense, "undisclosed assets" cannot be recognized as assets in accounting because they do not meet the characteristics of assets under IFRS. According to experts from Brand Finance and WIPO, such resources can be categorized into three main components: rights, relationships, and intellectual property (Brown et al., 2025).

By the recommendations of the International Accounting Standards Board, a resource is recognized as an enterprise asset if it provides future economic benefits, can be identified, is reliably measured, and is separated from the owner (enterprise). Thus, many objects of managerial influence that form the intellectual property of the enterprise remain beyond the attention of managers. At the same time, the intellectual property of the enterprise, including production experience, professional skills, business knowledge, marketing strategies, and others, often forms the enterprise's competitive advantages. Research by Stavytskyy et al.(2019), Kiseláková et al. (2024), and Gumbau-Albert &Maudos (2022) revealed a general positive impact of intangible asset growth on enterprise development. Intangible resources are generally defined as drivers of economic development for business units, industries, and national economies (Andersson et al., 2023; Sveikauskas, 2024; Labunska et al., 2024).

It should be noted that for companies, some of the intangible resources that cannot be identified as assets, primarily information and intellectual resources that generate novel knowledge, are often more valuable than identifiable intangible assets. These resources directly contribute to the formation of internally generated goodwill, which reflects the difference between the fair market value of the enterprise and the value of its identifiable tangible and intangible assets (Corrado et al., 2022; Labunska et al., 2024; Kostarakos et al., 2024).

According to the current International Financial Reporting Standards (IFRS) (IFRS Foundation, 2024), internally generated intangible resources- including information and intellectual resources- are generally not to be recognized on a company's balance sheet. According to IAS 38 Intangible Assets, certain intangible resources should be recognized as assets only if they have been acquired, or there is certainty that they will acquire, a marketable form. While research activities often do not yield direct financial benefits, they contribute significantly to the formation of internally generated goodwill within the enterprise, which arises from the acquisition of new information, knowledge, and experience during the research process (Lin & Ye, 2024). Thus, the majority of R&D expenditures are not capitalized and are considered expenses of the enterprise in the period of their incurrence. Thus, such an approach not only distorts the financial reporting of the current period and leads to incorrect assessments and misinterpretations of financial indicators, as well as the adoption of management decisions based on them, but also ignores the internally generated goodwill of the business unit.

Inaccurate assessment of intangible resources as objects of managerial influence within an economic system at any level can lead to several adverse consequences, such as underestimation of innovative potential and innovation capacity, irrational allocation of resources in business processes, and a decrease in the competitiveness and market value of the entities.

Therefore, a well-founded accounting and analytical support for the management of intangible resources, both in capitalized and non-capitalized form, plays a pivotal role in identifying drivers of economic growth at enterprises, industries, and national economic systems in general. This contributes to the development of an effective strategy and an adequate policy for managing enterprise development.

Despite their critical role in fostering innovation and enhancing competitiveness, the understanding of the composition of intangible assets remains limited.

1.2 Digital assets as objects of managerial influence

Revolutionary advancements in the implementation of modern technologies and the acceleration of business digitalization across all sectors of the economy, especially through the use of artificial intelligence and blockchain technologies in the management process, have led to a significant increase in

such assets as digital assets of business units (European Commission & High Representative, 2025). Such assets do not have a physical form and exist exclusively in digital form. Among the most widespread of these are smart contracts and cryptocurrency, which are based on the use of blockchain, as this ensures transparency, security, and efficiency of financial transactions. At present, their use is actively being implemented worldwide in various industries, such as finance, logistics, and trade. A more precise and comprehensive definition was provided by the European Financial A crypto-asset is defined as “a digital representation of value or contractual rights created, transferred and stored on some type of distributed ledger technology (DLT) network (e.g., Blockchain) and authenticated through cryptography” (European Financial Reporting Advisory Group (EFRAG), 2020).

The assessment and identification of digital assets have been the subject of studies by specialists from leading global consulting firms, commonly referred to as the "Big Four": PwC (2023), Deloitte (2021), Ernst & Young (2024), and KPMG (2023). According to their recommendations, the inclusion of cryptocurrency and other digital assets in the composition of intangible assets is the most conceptually justified approach.

Despite the substantial body of research on the assessment and identification of digital assets, in particular Peters et al. (2020), Miroshnichenko & Birch (2024), Yang et al. (2024), as well as in recommendations provided in IFRS-IAS 38, there remains a lack of consensus among researchers and practitioners regarding the classification of digital assets as intangible assets.

First and foremost, it should be noted that, in the author's opinion, digital assets can be qualified as "disclosed" assets (i.e., they can be reflected on a company’s balance sheet), since they have all the criteria of assets according to IFRS: identifiability, measurability, and directed to generate economic benefits by the owner. Secondly, the majority of digital assets meet the criteria of intangibility as defined in IFRS (IAS) 38(IFRS Foundation, 2024). However, the European Financial Reporting Advisory Group EFRAG (2020) recommendations indicate that digital assets that are the objects of purchase and sale transactions can be classified as inventories under IAS 2, (IFRS Foundation, 2024). Likewise, digital assets are not identified as a separate group in Brand Finance reports (Brand Finance, 2024). Meanwhile, considering the specific features of the recognition value of digital assets and their disclosure in financial statements is crucial for accurately understanding the potential value of an enterprise's intellectual capital and ensuring effective management of such assets.

Thus, the purpose of this study is to conceptualize and improve existing approaches to identifying and valuing intangible resources, with a particular emphasis on digital assets, as well as to develop accounting and analytical support to ensure the effective use of information and intellectual resources in the enterprise's business processes.

2. Methods

To substantiate the significance, needs, and requirements for developing an accounting and analytical framework to support the processes of forming and effectively managing intangible resources, the following research hypothesis was proposed.

Hypothesis: There is a statistically significant relationship between the set of indicators reflecting the dynamics of innovation activity in the industry $\{x_i\}$, (in particular, the growth rate of innovation expenditures, the volume of capital investments in intangible assets, the number of innovatively active enterprises), and a set of indicators characterizing changes in the efficiency of doing business in the industry $\{y_i\}$,(namely, the growth rate of total income, the share of profitable enterprises, and the profitability of operating activitiesof the sector).

To construct the canonical correlation models, data from official statistics of Ukraine for 2018-2020 (State Statistics Service of Ukraine, 2025) were used. Data for 2022 are not representative, as they reflect the impact of the war on business development.

The uniqueness of the canonical correlation method lies in the fact that it allows you to find the strongest possible correlation between two systems of indicators. No other method can determine the correlation between two systems of indicators in such a comprehensive way.

The problem of identifying the maximum possible correlations between the two sets of indicators is solved by introducing new variables - canonical functions, which are defined as linear combinations of the initial features. At the preliminary stage, the entire set of indicators was divided into two groups: explanatory features and outcome variables, which accumulate the effects of the former. For this purpose, the authors calculated the rates of change of the following indicators: costs for innovation activity in the

industry(x_1), the volume of capital investments in intangible assets (x_2), as well as the number of innovatively active enterprises in the industry (x_3)) in 2020 compared to 2018. In addition, the growth rates of the indicators of the effective plane were determined: total income (y_1), the share of profitable enterprises (y_2), and the profitability of operating activities of enterprises in the industry(y_3), (Appendix A, Table A1).

The study also applied the regression analysis method to determine the most significant factors from the set of explanatory variables ($x_{1,}, x_2$, x_3) that influence the integral indicator of the rate of change in industry income (y_1).

To develop the author's approaches to the identification and assessment of intangible assets in the enterprise management system and represent them in financial reporting, a comparative analysis of existing approaches presented in scientific sources and practical recommendations was conducted.

3. Results

To substantiate the significance and confirm the impact of capital investments on the formation of intangible assets characterizing the innovation activity of business units and their effect on business performance, canonical correlation models were constructed in the study. In particular, to derive two canonical functions, i.e., two new variables, uniquely defined by a given set of attribute values, two sets of variables were used - result indicators {y_i} and explanatory indicators {x_i}, which affect the results. The system of effective indicators is formed by the variables growth rate of income (y_1), growth rate of the share of profitable enterprises (y_2), and operating profitability growth rate (y_3). The attribute system contains such indicators as growth rate of capital investment in intangible assets (x_1), growth rate of innovation expenditure (x_2), and share of innovative enterprises' growth rate (x_3). Canonical variables can always be interpreted as complex indicators of the quality of two groups of features; therefore, they require the most careful study. The Statgraphics Centurion19 software environment was used for statistical data processing.

Therefore, the model of the relationship between two systems of indicators that describe the dependence of the change in the efficiency of doing business in the industry {Vi} on the innovation activity in the industry {Ui}, aimed at the formation of an intangible (informational and intellectual) resource, is represented of three ranked systems, Table 1.

Table 1. Results of Canonical Correlations

NN models	Description of Canonical Function Systems	Eigenvalue	Canonical Correlation	Wilks Lambda	Chi-Square	D.F.	P-Value
1	$U_1 = 0{,}688x_1 + + 0{,}524x_2 - 0{,}022x_3$ $V_1 = 0{,}962y_1 + 0{,}186y_2 + 0{,}531y_3.$	0,498974	0,706381	0,335102	71,6126	9	0,0000
2	$U_2 = -0{,}815x_1 + 0{,}915x_2 + 0{,}099x_3$ $V_2 = 0{,}506y_1 + 0{,}891y_2 - 0{,}308y_3$	0,245008	0,494983	0,66883	26,3457	4	0,0000
3	$U_3 = 0{,}085x_1 - 0{,}251x_2 + 1{,}01x_3,$ $V_3 = -0{,}152y_1 + 0{,}716y_2 + 0{,}883y_3$	0,114123	0,337821	0,885877	7,93709	1	0,0048

Source: own processing (2025)

The obtained results allow us to conclude that the first model of the system of two canonical functions most successfully describes the relationship between the set of explanatory and outcome variables. These two canonical variables (Ui and V_i) demonstrate a close relationship, as evidenced by the canonical correlation coefficient$r_{U_1V_1} = 0{,}706$. This relationship is formed by the indicators x_1, y_1, x_2, y_3.

A visualization of the relationship between canonical variables is provided in Fig. 2.

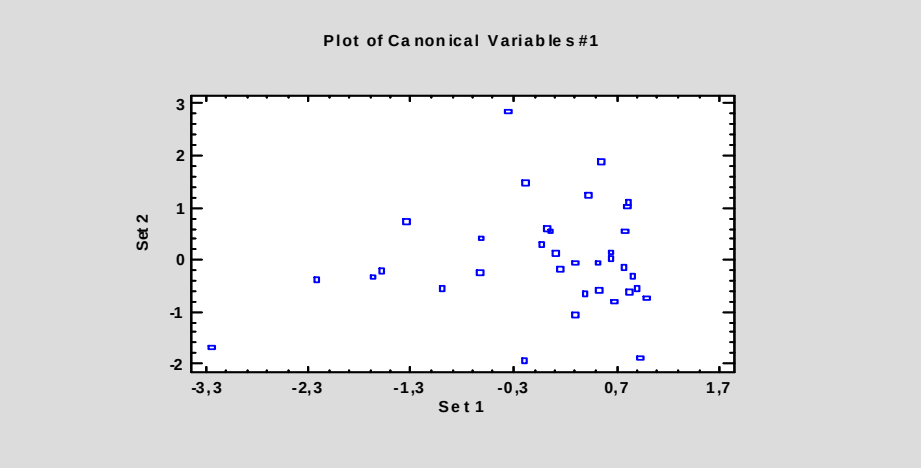

Figure 2. Results of the evaluation of the relationship between the resulting and characteristic canonical variables

Source: own processing(2025), based on the use of the software product Statgraphics Centurion 19

According to the second and third systems, the identified canonical variables exhibit a weaker relationship, as evidenced by the canonical correlation cofficients $r_{U_2V_2} = 0{,}495$ та $r_{U_3V_3} = 0{,}338$, respectively. It should be noted that although the correlation coefficients are lower, they are still significant according to Pearson's criterion. The relationship is formed in the second system by the indicators x_2, y_2, x_1, y_1, and in the third -x_3, y_3, y_2.

Thus, the conducted study confirms the presence of a statistically significant influence of indicators reflecting the dynamics of innovative activity in the industry$\{x_i,\}$, due to the use and further formation of intangible assets in the general area set of indicators by which the effectiveness of business processes of structural units (in our case, the sectors of the economy) is determined.

To determine the influence of three factors: growth rate of capital investment in intangible assets (x_1), growth rate of innovation expenditure (x_2), and the share of innovative enterprises' growth rate (x_3), on the performance indicator growth rate of income (y_1) , a multifactor regression model was calculated, which has the formula1:

$$y_1 = 2{,}031E6 + 372{,}51x_1 + 104{,}741x_2 \quad (1)$$

The results of the multiple regression analysis are presented in Table 2.

Table 2. Multiple Regression - Analysis of Variance

		Standard	*T*		
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*	
CONSTANT	2,03076E6	2,24356E7	0,0905148	0,9281	
X1	372,51	114,922	3,24142	0,0019	
X2	104,741	25,705	4,07474	0,0001	
Source		*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model		2	3,72141E17	20,92	0,0000
Residual		67	1,779E16		
Total (Corr.)		69			

Source: own processing(2025), based on the use of the software product Statgraphics Centurion 19

The third factor in the model was found to be insignificant according to the Student's criterion; therefore, it is excluded from the model. The coefficient of determination is sufficient $R^2 = 38{,}44$. Thus, the variability of the factors retained in the model explains 38.44% of the variability of the dependent indicator. This confirms the hypothesis of a rather high impact of these indicators on the overall growth rate of business efficiency in the economic sector.

Blockchain occupies a prominent position among digital assets, as its implementation has significantly influenced the financial processes of business entities and the organization of enterprise activities in general. According to Precedence Research (2024), the global blockchain technology market

was valued at USD 26.91 billion in 2024 and is projected to reach approximately USD 1,879.30 billion by 2034.

Modern business structures are actively exploring the possibilities of using blockchain technologies to create and effectively manage digital assets, such as smart contracts and digital currencies.

Blockchain technology in smart contracts is used to monitor logistics processes, verify data, preserve evidentiary information, and implement contractual automation. This contributes to market expansion and addresses the growing demand for secure transaction operations without the participation of intermediaries. According to the analytical report on the smart contracts market (Market.us, 2024), the global smart contracts market was valued at USD 1.9 billion in 2024. It is expected that by 2033, the demand for smart contracts will reach USD 14.9 billion. The forecast trend line of the smart contracts market, Fig. 3 (left-hand), demonstrates the accelerated growth of the market volume by 2033.

Similar trends are inherent in the global cryptocurrency market (Grand View Research, 2025), but the projected growth trend demonstrates a more restrained pace due to regulatory restrictions on the use of cryptocurrency, which are currently imposed in the majority of countries of the world (Fig. 3, right-hand).

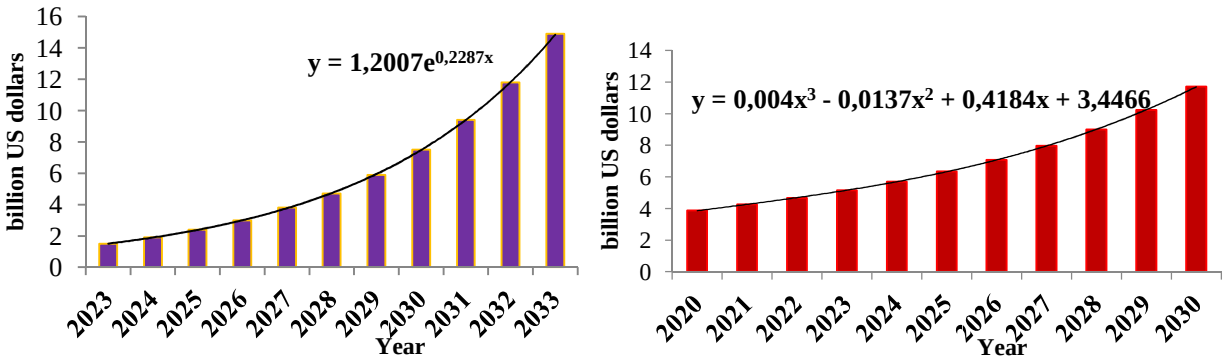

Figure 3. Actual volume (2023-2024) and forecast of the global smart contracts and cryptocurrency market

Source: own processing (2025) *based on Market.us, 2024, and Grand View Research, 2025*

Thus, the development of digital technologies, their integration into business processes not only transform traditional approaches to conducting business activities but also create new challenges and opportunities for enhancing business efficiency. In this context, the problem of developing approaches to identifying and reliably assessing digital assets, such as smart contracts and cryptocurrencies, in enterprise management and accounting systems is of particular significance.

According to the authors, a smart contract, as an intangible asset, should be recognized in the enterprise's accounting system and considered an object of managerial influence within the enterprise's management system. In this case, its cost should be determined by capitalizing the full development costs (TC), supplemented by the costs associated with setting up the management system for information and functional development support (RdC) and the performance of obligations by the parties to the smart contract (RoC)This approach differs significantly from IAS 38 (IFRS Foundation, 2024), which states that the value of an intangible asset is estimated based solely on the development or acquisition costs incurred. This concept does not recognize as capitalized the costs associated with hedging risks arising in the process of creating and using the asset. The structure of the proposed valuation model is presented in formula 2.

$$FC = TC + RdC + RoC \tag{2}$$

Where FC- the full capitalized cost of the smart contract

The composition of costs to be included in the assessment of an intangible resource in the form of a smart contract, to clarify its value as a management object within the enterprise management system, is presented in Table 3.

Table 3. Additional cost structure for joining the smart contract evaluation in the business unit management system

NN	Cost Category	Functional Purpose
Costs related to informational and functional support of smart contract ***development*** ***(R_DC)***		
1	Collection and preparation of information for preliminary description	Establishing a base for technical, legal, and analytical modeling of the contract
2	Adaptation of existing software	Integration of the smart contract with ERP systems (accounting, document management)
3	Legal support for development	Ensuring the contract's compliance with applicable legislation
4	Personnel training	Enhancing employees' qualifications for smart contract management
5	Formulation of technical requirements for developers	Defining smart contract requirements according to the legal framework and business goals
Costs related to informational and functional support of smart contract ***execution*** ***(RoC)***		
6	Accounting and analytical support	Ensuring the organizational, accounting, and analytical operations of the contract
7	Legal support during contract execution	Supporting contract execution and dispute resolution

Source: own processing (2025)

It should be noted that the costs listed in positions 2-4 of the table above are not capitalized in financial statements according to IA S38 (IFRS Foundation,2024). However, in the author's opinion, these costs constitute the additional value of intangible resources created in the process of activity, which reflects the formation of internally generated goodwill as a result of the implementation of innovations.

In the process of implementing and operating a smart contract within the management system, it is necessary to take into account the costs of risk management that are not subject to capitalization and are recognized as expenses of the period in which they are incurred. A clear classification of capitalized and non-capitalized costs provides a relevant information basis for making management decisions and assessing the effectiveness of using this intangible asset.

Blockchain is a digital asset that belongs to intangible assets, whose value is subject to reassessment during the period of its operation. At the same time, this asset is characterized by a relatively short period of use, typically no more than three years, and most often about one year from the moment of its implementation in business processes. Accordingly, the authors consider it is advisable to use an approach in which 50% of the cost of the blockchain is attributed to operating expenses immediately after creation (or acquisition), and the balance is amortized throughout use using the straight-line depreciation method.

Another digital asset used by modern enterprises using blockchain technologies is cryptocurrencies. As of March 2025, according to CoinMarketCap (2025), there are more than 10,000 types of cryptocurrencies circulating on the market. They are designed to replace Bitcoin or at least improve some of its parameters (for example, mining algorithm, coin distribution method, transaction speed). The most common of them are Ethereum, Tether, XRP, Figure 4, left-hand.

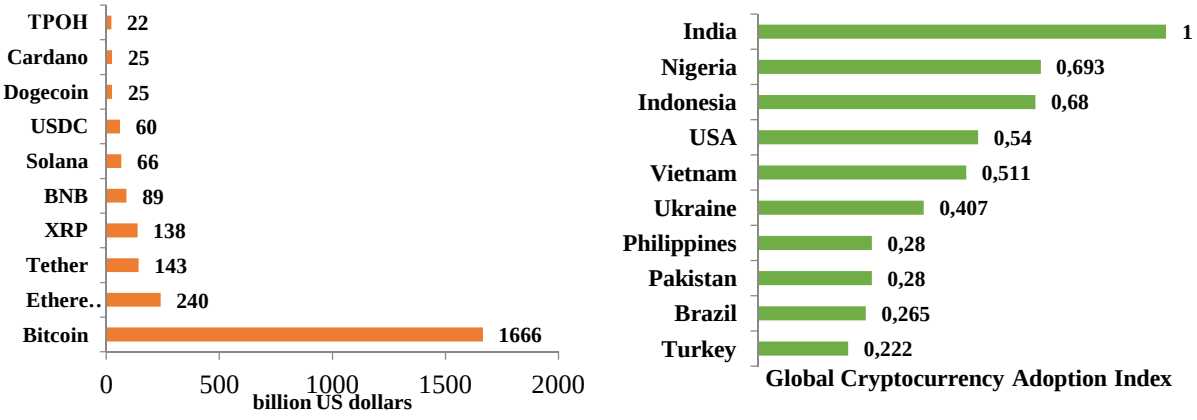

Figure 4. Overview of the Current Global Cryptocurrency Market
Source: own processing (2025) *based on CoinMarketCap (2025)*

The legal status of cryptocurrencies varies significantly in different countries and continues to evolve in many of them. In most countries, cryptocurrencies are not recognized as legal tender, but can be used as a commodity or a store of value. Such countries include, in particular, the United States, Canada, Great Britain, Japan, Australia, Spain, Germany, Ukraine, Mexico, and Argentina, among others. The use of cryptocurrency, specifically Bitcoin, as a means of payment is legally permitted by the two countries: El Salvador and the Central African Republic. Despite the global spread of cryptocurrency, there are still countries where its use is entirely prohibited by law, including Bolivia, Algeria, and Pakistan (Cryptomus, 2024).

In the current context of increased volatility of major global currencies, cryptocurrency is increasingly being used by business entities in different countries as a tool for minimizing financial risks. At the same time, the current regulatory framework still lacks both national and international standards that regulate the accounting procedure for cryptocurrencies. This situation necessitates the assessment of the compliance of such digital assets with the recognition criteria established in IAS 38 Intangible Assets or IAS 2 Inventories (IFRS Foundation, 2024).

Given the significant volatility in cryptocurrency market prices, their valuation in monetary terms is accompanied by a number of methodological challenges. If their initial measurement, according to many scholars (Jackson, A. B., & Luu, S. (2023), Peters et al. (2015), Crumbley et al. (2024), should be carried out using the methodology of full costs of its acquisition (or mining), their subsequent revaluation presents many difficulties.

A common method of hedging the risks associated with storing assets in cryptocurrency is the use of stablecoins. Stablecoins are programmable digital currencies that are typically pegged at a 1:1 ratio to fiat currencies. Issued primarily on blockchain networks such as Ethereum and Tron, stablecoins combine the power of blockchain technology with the financial stability required for practical use of cryptocurrencies, making their use increasingly widespread. The most widely used stablecoins currently include USDT and USDC (Cointelegraph,2025).

Having analyzed existing approaches, the authors tend to support the first of the outlined methodologies, but propose the use of revaluation of the value of the cryptocurrency on the date of reporting or at the date of its disposal based on the binding of its value to fiat currencies such as the US dollar or the Euro.

4. Discussion

The results of the conducted canonical analysis of the influence exerted by the system of indicators characterizing the innovative activity of a business unit in the process of creating and utilizing intangible assets on the system of business efficiency indicators demonstrate the need to expand and refine the set of descriptive indicators. In particular, the list of such indicators should include not only the volume of investments in intangible assets recognized in financial statements, but also the total volume of investments in intangible resources, which may not always meet the criteria for recognition as assets. However, the lack of statistical data on evaluating business processes at the industry level makes it impossible to implement such an approach in practice. This, in turn, justifies the need to calculate internally generated goodwill as an integral indicator that reflects the presence of a formed but unidentified information resource of the enterprise.

Studies examining the impact of intangible assets on income and return on capital indicators are presented in the works of Méndez Morales et al. (2024), Jancenelle (2021), and Bagna et al. (2024), all of which, through the use of alternative mathematical tools, confirmed the existence of a positive impact. The uniqueness of the methodology proposed by the authors lies in the assessment of the overall influence exerted by a system of descriptive indicators that characterize the formation and use of intangible resources in the process of innovation activity, on the system of resulting indicators (in particular, changes in the growth rates of industry income, overall profitability and the share of profitable enterprises). This made it possible to identify the most significant characteristic indicators from the point of view of impact, as well as to select the resulting indicators that are most affected by them.

It is also worth acknowledging the viewpoint of Milenović, Teofilović, and Lukić (2024), Semenova et al. (2025) regarding the significance of effectively utilizing total intellectual capital, which encompasses both the identified part of disclosed assets in financial statements and the unidentified part of intangible resources, in achieving the target profitability of companies.

In the study Dragomir (2024), particular attention is drawn to the existing significant impact of asset structure (the share of intangible assets in the total volume) on the enterprise`s ROI. Dragomir (2024) highlights a reverse relationship between profitability and investment in intangible assets, which is deemed illogical and is directly attributed to deficiencies in cost accounting and the financial reporting practice of recognizing only intangible assets, while omitting the broader scope of intangible resources. This once again underscores the need to improve the assessment of digital assets, both disclosed (capitalized) and their non-disclosed part, Azimov et al.(2024). In particular, the author's approach to the valuation of such a digital asset as smart contracts is based on this approach.

From the perspective of evaluating cryptocurrencies as part of an intangible resource, considered as of management influence, their value during the period of use may be assessed according to various models. The first approach involves the valuation at historical cost less any accumulated impairment losses. However, according to many scholars, including Alsalmi et al. (2023), Huang et al. (2023), and Parrondo (2023), the relevance and practical utility of this model for assessing cryptocurrencies are questionable, particularly when the primary purpose of holding cryptocurrency is capital appreciation due to price fluctuations. In such cases, accounting data fails to reflect the true market value of these assets. An alternative accounting policy, consistent with IAS 38 and IAS 13 (IFRS Foundation, 2024), is the revaluation model, which is considered more acceptable by many scholars (Elsayed, R. A. (2025); Lazea et al., 2023). According to this model, a cryptocurrency should be measured at its fair value at the revaluation date, less any subsequent accumulated impairment losses.

The authors adhere to the latter approach, but propose to determine the value of the acquired cryptocurrency by converting it into the value of major world currencies, with subsequent revaluation using the approaches applied to “monetary” assets. At the same time, since cryptocurrency is not recognized as legal tender, it does not meet the criteria for monetarism, and therefore, such a classification is conceptually contradictory. These include income, overall profitability, and the share of profitable enterprises within a sector.

Conclusion

The study analyzed the global dynamics of corporate asset growth, divided into tangible and intangible components. It was found that intangible assets demonstrate outpacing growth both in value terms and in their share within the overall structure of companies' assets compared to tangible ones.

Based on the application of canonical analysis methods, the hypothesis of a significant impact of the system of indicators characterizing the formation of intangible assets in the context of innovative activity of business entities (across specific sectors of the economy) on the system of resulting indicators of business processes has been confirmed. This is confirmed by the canonical correlation coefficient $r_{U_1V_1} = 0{,}706$, which was formed by the influence of the indicators of the growth rate of capital investment in intangible assets, growth rate of innovation expenditure on growth rate of income, and operating profitability growth rate.

The results of multiple regression analysis demonstrate a significant influence, at the level of 38%, of the indicators of investment in intangible resources and innovative activity of enterprises in the industry on total industry income. These findings underscore the need for further improvement of approaches to the identification and assessment of intangible assets, such as digital assets/

The conducted analysis, based on publicly available statistical sources, has presented stable trends in the increasing use of digital assets, particularly blockchain, smart contracts, and cryptocurrencies, in the economic activities of business entities worldwide.The research findings propose approaches to improving the methods for evaluating smart contracts as objects of managerial influence used for decision-making within a management system. Particular emphasis is placed on incorporating previously unaccounted information regarding the informational and intellectual resources generated during the development and implementation of smart contracts within an enterprise, to ensure a more accurate assessment of their value.

The global cryptocurrency market is rapidly evolving, transforming traditional ideas about financial instruments. Ukraine ranks among the leading countries in terms of cryptocurrency adoption, which indicates a high potential for the development of financial innovations. To enable a reliable assessment of cryptocurrencies as a means of minimizing enterprise financial risks, recommendations have been developed regarding the accounting treatment of their value at the stages of acquisition (mining), revaluation, and disposal.

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Appendix A

Table A1 Systems of factor (X_i) and effective (Y_j) indicators used to model the relationship using the canonical correlation method

Industry	**Growth Rate of Capital Investment in Intangible Assets (X1)**	**Growth Rate of Innovation Expenditure (X2)**	**Share of Innovative Enterprises Growth Rate (X3)**	**Growth Rate of Income (Y1)**	**Growth Rate of the Share of Profitable Enterprises (Y2)**	**Operating Profitability Growth Rate (Y3)**
Extraction of crude petroleum and natural gas	39,4	196,2	80	65,1	66,7	40,3
Mining of metal ores	216,7	97,9	50,5	107,3	65,0	143,1
Other mining and quarrying	128,1	32,6	43,1	106,2	92,5	95,9
Manufacture of food products	71,7	225,1	39,6	104,8	98,6	102,1
Manufacture of beverages	77,3	355,7	41,9	110,2	96,7	142,2
Textile manufacturing	119	50,7	41,1	95,5	96,6	105,8
Manufacture of wearing apparel	31,7	435,2	27	94,3	98,9	92,8
Manufacture of leather and related products	143,7	19,5	23,5	88,3	86,6	-19,5

Manufacture of wood and cork products, except furniture; manufacture of straw and plaiting materials	187,2	98,5	30,3	92,2	96,3	92,0
Manufacture of paper and paper products	100,3	161,1	42,2	59,8	99,0	114,8
Printing and reproduction of recorded media	64,5	18,4	14,2	89,3	94,5	63,7
Manufacture of chemicals and chemical products	185,1	198,4	51,4	99,8	99,0	-349,6
Manufacture of basic pharmaceutical products and pharmaceutical preparations	95,9	309,4	67,1	109,2	104,1	136,0
Manufacture of rubber and plastic products	1260,5	87,6	32,2	95,7	98,5	-27,1
Manufacture of other non-metallic mineral products	175,1	36,1	44	125,3	95,5	154,0
Metallurgical production	27,7	49,3	42,9	70,6	93,1	105,3
Manufacture of fabricated metal products, except machinery and equipment	163,6	41,1	38,8	96,1	95,3	84,9
Manufacture of computers, electronic and optical products	78,4	72,5	67,5	77,5	93,4	78,8
Manufacture of electrical equipment	64,8	91,6	52,4	77,9	91,8	32,0
Manufacture of machinery and equipment	278,9	101,8	44,6	95,2	98,4	84,8
Manufacture of motor vehicles, trailers and semi-trailers	38,3	147,9	52,5	96,2	96,7	81,4
Manufacture of other transport equipment	87	40,8	50,7	95,6	94,4	56,9
Manufacture of furniture	59,3	40,8	42,1	118,1	98,1	153,9
Manufacture of other products	298,4	57,7	41,4	101,6	94,7	133,1
Repair and installation of machinery and equipment	94,8	266,5	26,7	98,6	96,4	-16,0
Electricity, gas, steam and air conditioning supply	155,4	59,2	57,6	120,5	89,9	-457,5
Water collection, treatment and supply	135,3	29	73,6	109	94,2	79,0
Waste collection, treatment and disposal activities; materials recovery	145,3	120,7	38,9	82,1	102,1	-26,8
Land and pipeline transport	43,6	36	22,3	93,5	97,5	-52,2
Warehousing and support activities for transportation	76	75,8	24,4	96,7	96,2	47,0
Publishing activities	56,8	96,7	17,1	90	100,5	252,5
Computer programming, consultancy, and related activities	56,5	171,6	23,8	133,7	102,0	107,4
Information service activities	56,9	29,1	15,8	123,2	102,0	181,7
Architectural and engineering activities; technical testing and analysis	86,4	102,5	26,7	112,7	96,4	81,4
Advertising and market research	79,4	555,1	13	114,4	96,8	51,8

Source: Labunska, Yermachenko, and Sidak (2025), based on the database of the State Statistics Service of Ukraine (2025)

Level of Digitalization of Communication Media with the Public in Selected Cities

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Abstract

Research background: The main objective of the contribution is to define the concept of digitalization of society, to point out the needs and reasons for its emergence, as a response to the acute solution of the problems of citizens living in these cities and towns. Intelligent, i.e. smart technologies create possibilities for solving the changes that municipalities and cities face as a result of urbanization and population growth. However, this solution is only possible in cooperation with legislation that will respond quickly and professionally to the ongoing changes.
Purpose of the article: The next part of the article is devoted to the growing communication problems that smart municipalities and cities can solve by implementing innovative solutions in individual areas of the city economy and is the output. The article therefore focuses on the analysis of the basis for the use of innovative solutions in the field of digitalization of communication media by local government entities using the example of the Slovak Republic. Based on the current legal regulation, it defines the essence of local government, analyzes the possibilities, means and procedure of municipalities and cities in implementing smart solutions.
Methods: The research part of the paper will draw on the results of an international research project in which four cities in the Prešov and Košice regions were evaluated. 12 criteria were evaluated in each city. This paper will be based on the evaluation of one of these criteria, namely: "Level of digitalization of communication media with the public" in each evaluated city.
Findings & Value added: Based on the analysis of the results obtained, the authors proposed procedures for individual cities on how the level in this area could be improved.

Keywords: Innovation, Modernization, Local Government, Environment, Smart City

JEL: K23, O10, O30, Q56

1. Introduction

In the introduction, we will present the conditions of the concept of digitalization of society, point out the needs and reasons for their emergence, as a response to the acute problems of citizens living in these cities and municipalities. In smart cities, sustainable urban development is achieved through "new, efficient and user-friendly technologies and services, in particular in the areas of energy, transport and ICT" (European Court of Auditors, ECA Special Report, 2023). In addition to using technologies to save resources and reduce pollution, a smart city also aims to make city services more responsive and accessible, to make public spaces safer and to improve transport, water and waste management, street lighting and building heating. (Ministry of Education, Research, Development and Youth of the Slovak Republic, 2014) “The ability to adapt to and use digital technologies will be a key factor for success in an increasingly digital business environment.” (Ivanová, Kordoš et al., 2024)

In the article, we present a view of the Smart City and its impact on the quality of life of citizens, as well as legislative regulation in terms of the possibilities of intelligent local government in the Slovak

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Republic, or smart cities, which is related to the use of information and communication technologies. (Machyniak, Mikuš, Dzureková, 2023)

One of the evaluation criteria: " The level of digitalization of communication media with the public " in the project "Socio-economic strategy for the development of climate-neutral and smart cities and its importance for the private and public sector", in two regions: the Prešov region and the Košice region, based on the available information, it gives us a picture of the current state of development of digitalization of selected 8 cities from the above-mentioned 2 regions of Slovakia.

2. Methods

Research file selection

For a more detailed analysis, 4 cities from the Prešov region (Levoča, Prešov, Sabinov, Vysoké Tatry) and 4 cities from the Košice region (Spišská Nová Ves, Trebišov, Michalovce, Sobrance) were selected.

Evaluation criteria

The research focuses on multiple criteria of smart cities, with this paper specializing in the level of digitalization of communication media with the public.

Other criteria include: Smart city strategy/vision, feasibility study, information about the smart city vision in other documents, city services for residents available in the form of applications, digitalization of administrative service support for the population, level of use of digitalization in environmental protection, smart technology in energy, population safety, public lighting, smart technology in transport and digitalization of city fees and taxes.

Data collection and analysis

The data was obtained from public city websites and published documents.

The evaluation was carried out on a point scale, with weights assigned by 3 independent evaluators, including a city representative.

This approach increases the validity and reliability of the research.

2.1 The concept of smart cities in the Slovak Republic

The term Smart City is not completely unknown. To clarify it, we can characterize this term as the management of a city in its various areas through information and communication means. Its implementation is oriented towards the various urban areas for which the city is responsible.

Cities on the path to Smart must define a strategy, define goals and start implementing specific projects. Subsequently, the deployment of technologies creates space for local governments to obtain large amounts of data that can be used for management. For what management? The obtained data can be further analyzed and evaluated. Based on them, it is possible to adjust parking policies, adjust the number of garbage cans in cities, create low-emission zones, etc. The team of authors (Štofejová, Kráľ, Fedorko, Bačík et al., 2023) point out that environmental awareness among consumers is increasing, as they begin to prefer sustainable products and services. "It can be assumed that the competitiveness of companies in the future will depend greatly on how companies are able to implement the principles of the circular economy." (Levický, Fiľa et al., 2022)

However, city managers must understand the importance of data for the development of individual cities. If they have data but cannot use it to their advantage, they will never move the city closer to sustainability. That is why management is an important part of every city. However, it is primarily associated with the management skills of representatives.

In the Slovak Republic (hereinafter referred to as “SR”), the topic of smart cities and regions has been gaining increasing attention in recent years, both from the cities themselves and higher territorial units (hereinafter referred to as “HTU”), as well as from independent experts, innovative companies and the state. Cities and regions are gradually experimenting with sharing open data, introducing modern technologies, building professional and analytical capacities directly at the offices and involving the professional and general public in decision-making. At the same time, an important mushroom of independent experts, interest groups and innovative startups focused on developing new and improving existing tools in public administration is emerging in the country.

In Slovakia, the topic of smart cities and regions has been gaining increasing attention in recent years, both from the cities and higher education institutions themselves, as well as from independent experts, innovative companies and the state. Cities and regions are gradually experimenting with sharing

open data, introducing modern technologies, building professional and analytical capacities directly at the offices and involving the professional and general public in decision-making. At the same time, an important mushroom of independent experts, interest groups and innovative startups focused on developing new and improving existing tools in public administration is emerging in the country.

In previous years, the state has made several efforts to support the topic of smart cities and regions, mainly through financial contributions from the European Union (hereinafter referred to as the "EU"), for example in the form of projects to support the professional capacities of local government, the development of digital and data services of public administration, the support of innovative solutions for small and medium-sized enterprises (hereinafter referred to as the "SMEs") in local governments, or projects focused on green renewal and adaptation to the climate crisis and mitigating its consequences. At the system level, the legislative and methodological framework is formed by Act No. 539/2008 Coll. on the support of regional development, as amended (Act No. 539/2008 Coll. on the support of regional development) (hereinafter referred to as the "Regional Development Act") and the Methodology for the creation and implementation of economic development and social development programs for the programming period after 2020, which is available in the updated version from February 2022. This methodological document contains a special Annex No. 6 entitled Smart sustainable development as a target quality of development strategies, which emphasizes the connection between the conceptual and implementation dimensions of the smart development strategy.

An important step was the transformation of the Office of the Deputy Prime Minister of the Slovak Republic for Investments and Informatization (hereinafter referred to as “ÚPVII”) into the Ministry of Investments, Regional Development and Informatization of the Slovak Republic (hereinafter referred to as “MIRRI SR”) covering the agenda of regional development, coordination of the use of financial resources from EU funds and digitalization of public administration. The connection of these three extensive agendas is key for an effective policy of supporting smart cities and regions as self-governments using information and communication technologies (hereinafter referred to as “ICT”) and access to EU resources for the creation of integrated solutions contributing to sustainable regional development. In this context, MIRRI SR therefore has a unique opportunity to become the national coordinator of the smart cities and regions agenda in the Slovak Republic, ensuring the consistency and compatibility of policy at the national level with the development needs, interests and requirements of self-governments, while the first steps towards this position are already in the process of implementation. Thanks to a national project supported by the Operational Programme Effective Public Administration (hereinafter referred to as "OP EVS"), a special methodological and evaluation unit was established to support the development of smart cities and regions. The agenda of smart cities and regions is brought together in one place within MIRRI SR, i.e. in the section of innovations, strategic investments and analyses (HUB). The Programme Slovakia 2021 - 2027 (hereinafter referred to as "P SK") also includes the smart development of cities and regions across all policy objectives and allocates an amount exclusively to support this issue (Ministry of Investments, Regional Development and Informatization of the Slovak Republic, Action Plan of Smart Cities and Regions for 2023 - 2026, 2022).

Another document that is of fundamental importance for the practical implementation of Smart City is "Support for Innovative Solutions in Slovak Cities", which was prepared and published by the Ministry of Economy of the Slovak Republic (hereinafter referred to as the "ME SR").

The concept of Smart City has become a trend that the Slovak Republic is currently facing. In Slovakia, the city of Kežmarok recently presented its own Smart City concept, the city of Poprad initiated the creation of the Slovak Smart City Cluster, and the city of Nitra presented a proposal for the implementation of the Smart City concept. According to information from the Ministry of Economy of the Slovak Republic, 10 Slovak cities are preparing to develop similar plans in the coming months (Ministry of Economy of the Slovak Republic, Support for Innovative Solutions in Slovak Cities, 2017).

2.2 The use of mass media in the development of the Smart City concept

Smart City concept represents a modern approach to urban management and development that uses digital technologies, data analytics and intelligent solutions to improve the quality of life of residents, increase the efficiency of urban services and promote sustainability. In this process, mass media play an important role as a mediator of information, a facilitator of public debate and a tool for supporting civic participation. Mass media have several possibilities of use in the development of the Smart City concept:

Informing and educating the public - Mass media (television, radio, press, internet portals, social networks) are the basic channel for disseminating information about prepared and implemented smart projects. Through news, programs, documents or reports, city residents can gain an overview of new technological solutions that can make their everyday lives easier - e.g. smart lighting, digital parking, air quality monitoring or smart waste management. At the same time, the media fulfill an educational function - they increase digital literacy and prepare residents to adapt to new technologies. This is especially crucial for older generations or socially vulnerable groups who may feel threatened by technological changes.

Support for citizen participation - Smart City is not only about technology, but especially about people. A successful smart city actively involves its citizens in decision-making processes. The media can significantly contribute to informing citizens about the possibilities for participation - whether it is public discussions, voting, sharing ideas through participatory platforms, or evaluating the functionality of smart solutions. Interactive media formats, such as online broadcasts of discussions, podcasts, comments on social networks or specialized mobile applications, allow citizens to express their opinions and directly influence the direction of the city.

Transparency and trust - Cities that communicate their actions transparently through mass media build the trust of citizens. Regular publication of data on the budget, public procurement, project results or feedback from citizens supports open self-government. Transparency is a key principle of smart cities - the public has access to open data, follows the development of projects in real time and knows how public funds have been used. The media thus also acts as a control mechanism and guardian of the public interest.

Crisis and operational communication - In the event of a crisis (natural disasters, pandemics, service outages), mass media are essential for rapid and effective communication between the municipality and the public. The city can quickly warn residents, coordinate evacuations, provide updates or guidance through television, radio, social networks or push notifications in city applications. Smart cities integrate media into their crisis plans as an active tool for early warning and management of emergency responses.

Promoting smart solutions and building a city's image - Mass media also serves as a marketing tool for promoting an innovative and technologically advanced image of the city. By presenting smart projects, cities can attract investors, startups, experts and tourists. At the same time, they inspire other cities to similar initiatives. The media can highlight successful examples - e.g. reducing CO_2 emissions through electromobility, better traffic management using smart traffic lights, or increasing safety through an intelligent camera system. Mass media are an integral part of the development of the Smart City concept. Their proper use can significantly contribute to the awareness, engagement and satisfaction of residents. Thanks to them, a smart city can become not only technologically advanced, but also an inclusive, transparent and participatory space for living.

In the development of the Smart City concept, it is possible to use print, electronic and new media at the national, multi-regional, regional and local levels. Among the most popular mass media today are social media. A team of experts (Supeková, Keklak, Masarová, Jakešová, 2023) emphasize that social media and networks have become not only a digital phenomenon of recent decades but also represent a digital space of unexpected future possibilities. "They are becoming an inimitable tool and medium for marketing companies, especially means of their promotion and advertising. At the same time, however, they are also important in many other areas, not only as sources of information, but also as means of contemporary interpersonal communication." As stated by the authors Igarová, Kádeková, Košičiarová (2023, p. 166), today almost every company has a profile on social networks such as Instagram, Facebook and YouTube. Companies can use elements of influencer marketing, which is considered a modern phenomenon, within social networks.

3. Results

The most important criteria included: smart city strategy/vision, feasibility study, level of digitalization of communication media with the public, city services for residents available in the form of applications, level of use of digitalization in environmental protection, level of use of smart technology in energy, and level of use of digitalization of city fees and taxes.

We will take a closer look at the level of use of digitalization of media communication with the public in the Prešov Region and the Košice Region, which we will present more specifically in this article.

3.1 Evaluation in the Prešov Region

In the regional assessment of the level of use of digitalization of communication media with the public according to the table below, the best ranked city was Vysoké Tatry with 0.28 points, followed by Levoča with 0.25 points, the city of Prešov with 0.2 points and the city of Sabinov with a total of 0.18 points. Given the fact that the environment covers a wide range of possibilities for its protection, the individual approaches of the cities are also different.

In the City of Vysoké Tatry, in the area of the level of use of digitalization of communication media with the public, they have published the Tatra biweekly on the website.

Levoča has a Facebook profile, LIMKA - interviews and Levočský TV weekly on its website.

The city management of Prešov tries to communicate with the public through regular mass media outputs (social networks, city periodicals, etc.). Part of the higher level of communication with the public are also either ongoing or prepared participatory processes, when the city wants to hear about the problems of residents, or about their needs. Citizens can obtain information from the city website, social networks _FB, Instagram, Prešovský magazín (it is distributed to households and published on the city website), sms applications info. At the same time, the city provides online live broadcasts of the meetings of the Prešov City Council.

In Sabinov, they have set up a profile on the social network Facebook and an official board on their website for the purpose of communicating with residents.

Table 1. Rating in the Prešov Region

Evaluation area – criteria	**Weight**	**Total evaluation criteria evaluation commissions**			
	0.01 – 1.00	**SABINOV**	**VYSOKÉ TATRY**	**LEVOČA**	**PREŠOV**
	Representative the city which rated:	**Mr. Bass Player**	**Mr. Ganzarčík**	**Mr. Novotná Tea**	**Mr. Dubecká**
Level of use of digitalization of communication media with the public	0.03	0.18	0.28	0.25	0.2
Order		4.	1.	2.	3.

Source: Own development of smart city assessment.

3.2 Evaluation in the Košice region

In the regional assessment of the level of use of digitalization of communication media with the public according to the table below, the best ranked city was Spišská Nová Ves with 0.26 points, followed by the city of Sobrance with 0.21 points, the city of Trebišov with 0.17 points and the city of Michalovce with a total of 0.09 points.

In the area of the level of use of digitalization of communication media with the public, the City of Spišská Nová Ves has its own television - TV Reduta, a city website, a Facebook profile and a YouTube profile.

The city of Sobrance has a Facebook profile, a city website, a city newspaper - Sobrančan, and a city TV - Sobranská televízia.

The city of Trebišov communicates with the public through its website in the official bulletin board, city newsletter, and questions and answers sections.

The city of Michalovce has published - City in your pocket, eDoc, communication via the city website, social networks.

Within the two evaluated regions, the best position was achieved by the City of Vysoké Tatry, which we expect will be an inspiration for other cities in the application possibilities of the level of use of digitalization of communication media with the public.

Table 2. Evaluation in the Košice region

Evaluation area – criteria	**Weight**	**Total evaluation criteria evaluation commissions**			
	0.01 – 1.00	**Michalovce**	**Sobrance**	**Spišská Nová Ves**	**Trebišov**
	Representative the city which rated:	**Mrs. Machová ***	**Mrs. Iškyová**	**Mr. Pohly**	**Mr. Dembická**
Level of use of digitalization of communication media with the public	0.03	0.09	0.21	0.26	0.17
Order		4.	2.	1.	3.

Source: Own development of smart city assessment.

4. Discussion

The concept of digitalization within Smart City projects is significantly affected by the lack of qualified employees. This situation affects not only the planning and implementation of digital solutions, but also their long-term sustainability, management and development. Several authors point out the lack of Slovak employees: (Karácsony, Czókolyová, Mura et. al. 2024, Kömüves et al., 2024).

Digitalization in urban environments requires experts from various fields – IT specialists, data analysts, project managers, cybersecurity experts, infrastructure management. The lack of qualified workers leads to delays in the deployment of smart technologies such as sensors for traffic monitoring, smart lighting or real-time data collection systems.

Without adequate staffing, digital solutions are often implemented without thorough planning, testing, and monitoring. This can lead to lower quality of service, higher system failure rates, and reduced citizen satisfaction. Furthermore, if a team is not in place to continuously manage, update, and evaluate solutions, their long-term sustainability is reduced.

The lack of employees is not just a personnel problem but fundamentally affects the success and quality of the digitalization of cities. The solution can be systematic internal capacity building, close cooperation with universities, support for education in digital skills, flexible working models and sharing of know-how between cities. However, without sufficient personnel security, the vision of a truly smart city is difficult to implement.

Conclusion

The results of the evaluation of the project criteria are intended to serve to better orient cities in the field of smart cities, to ensure their development in this area, which will make life easier for residents and support communication between the city and its residents in the area of many monitored services.

The cities evaluated have published the following in terms of the level of use of digitalization

of communication media: online city periodical, city television, online interviews and broadcasts of city council meetings on the website, as well as an official bulletin board, city newsletter, questions and answers, social networks: Facebook, Instagram and YouTube profile.

The above methods of communication are easily applicable to other cities.

The first results of the research show that the level of digitalization of district towns is at different levels and some towns will need help in this regard. The results of this research represent an important step towards understanding and improving the use of digitalization in the area of the level of digitalization of communication media with the public in Slovak towns and are an inspiration in the area of improving the digitalization of all district towns.

After the evaluation phases of individual cities are completed, it will be possible to define proposals for improving individual levels of smart cities and propose basic criteria for the creation of smart cities, whether in Slovakia, Ukraine or internationally. Thus, increasing the standard of living of residents of municipalities and cities.

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Transformative Intelligence as a Core Competency for Educational System Management: Integrating Organizational, Technological, and Human Dimensions in 21st Century Leadership

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Abstract

Research background: Contemporary educational systems face unprecedented challenges requiring fundamental transformations in leadership approaches within increasingly complex digital, social, and global environments.
Purpose of the article: This study presents Transformative Intelligence (TI) as a meta-systemic competency essential for educational leaders navigating the convergence of pedagogical innovation, organizational complexity, technological integration, and human development needs.
Methods: The research employs a systematic integrative literature review methodology across PsycINFO, ERIC, Web of Science, and Google Scholar databases (2000-2024), coupled with case study analysis of educational transformation. A three-level thematic analysis identified patterns across research domains while maintaining sensitivity to disciplinary differences.
Findings & Value added: Through systematic integration of psychological flexibility principles, artificial intelligence capabilities, and humanistic educational approaches, this research develops a comprehensive theoretical framework demonstrating how educational leaders can effectively implement technological innovations while preserving human-centered approaches. Empirical validation through case study analysis reveals transformative intelligence as a foundational meta-competency enabling leaders to maintain effectiveness during technological implementation, crisis management, and stakeholder relationship preservation. The research advances educational leadership theory by bridging psychological adaptability, technological innovation, organizational learning, and contemplative pedagogy while providing practical guidance for institutions seeking sustainable excellence in complex 21st-century environments.

Keywords: Transformative intelligence, Educational leadership, Psychological flexibility, AI integration, Contemplative pedagogy, Organizational transformation

JEL classification: J53, M12

1. Introduction

Educational institutions worldwide operate within unprecedented complexity (Fuchs, 2024), characterized by technological disruption, global crises, demographic transformation, and evolving societal expectations that demand enhanced leadership capabilities transcending traditional management paradigms (Avolio et al., 2009). The convergence of artificial intelligence capabilities, psychological adaptability requirements, and crisis management necessities has created complex dynamics across educational sectors, requiring leadership frameworks that integrate human-centered approaches with technological innovation while maintaining educational effectiveness during uncertainty and rapid change.

Contemporary educational leaders must simultaneously manage technological integration without compromising educational values, coordinate diverse stakeholder communities with varying expectations, develop organizational resilience capable of adapting to multiple simultaneous crises, and ensure

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equitable access while optimizing resource allocation through innovative approaches (Bass & Riggio, 2006). The complexity of modern educational leadership extends beyond traditional instructional or administrative domains to encompass crisis management, technological stewardship, multicultural community building, and psychological support for entire educational ecosystems experiencing unprecedented stress and uncertainty.

This transformation necessitates what emerging scholarship identifies as transformative intelligence, defined as the meta-systemic capacity to identify, understand, and modify dynamic interactions between perception of reality and functioning within it, enabling adaptive and generative responses to complex changing environments (Hayes et al., 2006). Unlike traditional intelligence paradigms that conceptualize capabilities as fixed traits, transformative intelligence operates as a dynamic process integrating perceptual flexibility, adaptive functional capability, ecological engagement, and transformative creativity within unified theoretical frameworks.

The urgency of developing comprehensive leadership frameworks becomes evident when examining contemporary educational challenges. Educational leaders face organizational and financial collapse, characterized by unprofessional governance, toxic organizational culture, severe budget deficits, and neglected physical and educational infrastructure. These challenges demonstrate the practical applicability of transformative intelligence frameworks while highlighting the essential integration of technological innovation with human-centered approaches.

However, significant gaps exist in both theoretical understanding and practical frameworks for preparing and supporting educational leaders in navigating this complexity. Existing leadership theories often treat psychological adaptability, technological competence, and organizational transformation as separate domains requiring distinct approaches and fail to address their synergistic interactions in real-world leadership contexts (Judge & Piccolo, 2004). Traditional educational leadership preparation programs, developed for more stable and predictable environments, often lack systematic attention to crisis management, psychological resilience, and technological integration as core competencies rather than supplementary skills.

2. Methods

2.1 Research Design

This study employs a systematic integrative literature review methodology designed to synthesize theoretical frameworks across multiple domains and identify convergent patterns supporting the development of Transformative Intelligence theory. The research follows a mixed-methods approach combining theoretical synthesis with empirical case study analysis.

2.2 Search Strategy and Data Sources

A comprehensive search strategy was implemented across four major databases: PsycINFO, ERIC, Web of Science, and Google Scholar. The search parameters included peer-reviewed articles published between 2000-2024 in English and Hebrew languages. Key search terms encompassed: "educational leadership," "psychological flexibility," "AI education," "contemplative pedagogy," "transformational leadership," and "organizational transformation."

2.3 Inclusion and Exclusion Criteria

Inclusion criteria: Peer-reviewed articles focusing on theoretical frameworks, empirical studies, and case analyses related to educational leadership, psychological flexibility, artificial intelligence in education, and contemplative pedagogy. Studies were required to demonstrate academic rigor, theoretical contribution, and empirical support.

Exclusion criteria: Non-peer-reviewed sources, publications before 2000, opinion pieces without empirical foundation, technical manuals, and preliminary studies with limited validation.

2.4 Data Analysis

The theoretical synthesis employed a three-level thematic analysis designed to identify patterns across research domains while maintaining sensitivity to disciplinary differences:

Level 1 (Foundational): Analysis of intelligence definitions, leadership theories, and technology roles
Level 2 (Integrative): Examination of cross-domain relationships and synergistic effects
Level 3 (Meta-theoretical): Investigation of paradigmatic shifts and future directions

2.5 Case Study Methodology

The research includes analysis of an educational transformation case study demonstrating practical application of transformative intelligence principles. The case study follows established qualitative research protocols for organizational transformation analysis.

2.6 Quality Assessment

All included sources underwent quality assessment based on academic rigor, theoretical contribution, and empirical support. Priority was given to high-impact journals and established researchers in the field.

3. Results

3.1 Evolution of Educational Leadership Theory

Educational leadership theory has undergone profound transformation over the past century, evolving from rudimentary hierarchical models to adaptive frameworks reflecting the multifaceted nature of modern educational institutions. This evolution represents a fundamental paradigm shift driven by changing societal expectations, technological advances, and deeper understanding of organizational dynamics and human behavior in educational settings (Burns, 1978).

The transformation reflects growing recognition that educational institutions operate as complex adaptive systems, where leadership effectiveness depends not solely on formal authority but on the capacity to facilitate learning, innovation, and positive change across multiple organizational levels and stakeholder communities during both stable and crisis periods (Spillane, 2006).

Contemporary educational leadership theory encompasses integrated models that synthesize elements of instructional, distributed, and transformational leadership approaches, reflecting how contemporary school leaders utilize different leadership types in varying situations while coordinating with teachers to influence instruction and learning outcomes (Leithwood & Jantzi, 2000).

3.2 Psychological Flexibility and Educational Leadership

Psychological flexibility theory, developed within Acceptance and Commitment Therapy frameworks, offers comprehensive understanding of maintaining effectiveness during challenging circumstances through six core processes that operate synergistically to create effective and values-based behavioral patterns (Hayes et al., 2006). Recent research demonstrates that psychological flexibility serves as a crucial meta-competency for contemporary organizational leaders, with particularly strong correlations between flexibility components and leadership effectiveness during change management and crisis contexts.

Cross-cultural empirical research involving diverse adult and adolescent populations consistently demonstrates that psychological flexibility predicts enhanced life satisfaction, reduced symptoms of depression and anxiety, and improved physical health outcomes across various contexts (Bond et al., 2013). Research among educational professionals reveals that psychological flexibility significantly moderates stress effects, demonstrating protective capabilities in adversity that parallel challenges faced by educational leaders in diverse school communities.

3.3 Artificial Intelligence Integration in Educational Management

Artificial intelligence applications in educational management represent fundamental shifts from simple automation toward complex systems that analyze patterns, make predictions, and adapt based on experience while maintaining human oversight and ethical standards (Holmes et al., 2019). Contemporary AI applications encompass predictive analytics that identify at-risk students through multiple data streams, intelligent communication systems providing continuous stakeholder support, smart resource management optimizing facility utilization and scheduling, and data-driven decision support aggregating information for strategic planning.

The integration of AI-enhanced assessment with psychological flexibility development represents a paradigm shift toward data-driven yet human-centered approaches to leadership development, enabling precise identification of development needs while maintaining focus on authentic relationship-building and values-based decision-making essential for educational leadership effectiveness.

3.4 Transformative Intelligence Theoretical Framework

Transformative Intelligence represents a meta-systemic capacity integrating four core components functioning through recursive feedback loops (Fuchs & Fuchs, 2025). Perceptual flexibility encompasses

meta-cognitive awareness, enabling perspective shifts across meaning-making systems, challenging individuals to recognize the constructed nature of experiential reality while maintaining sufficient psychological coherence to function effectively across diverse contexts.

Adaptive functional capability represents the capacity to modulate responses across six functional domains, including physical-sensory-motor integration, emotional-behavioral regulation, social-communicative effectiveness, academic-cognitive agility, psychological flexibility processes, and development of 21st-century skills in response to contextual demands while maintaining goal-directed action and value coherence.

Ecological engagement encompasses the capacity to understand complex system dynamics across multiple scales and participate effectively in collective action, supporting both individual flourishing and systemic health. Transformative creativity represents the capacity to generate novel solutions that transform existing constraints into opportunities while implementing innovations effectively in real-world contexts.

3.5 Case Study Validation

The transformation of an educational institution provides compelling empirical validation for transformative intelligence frameworks in educational leadership contexts. Upon assuming leadership responsibilities, the institution exhibited characteristics of organizational collapse, including unprofessional governance, toxic organizational culture, poor budgetary oversight, and corrupt practices.

The systematic application of transformative intelligence principles enabled complete organizational transformation within a three-year timeframe, achieving financial recovery from severe deficit to operational surplus, developing inclusive multicultural community structures replacing tribal governance patterns, implementing innovative pedagogical approaches improving academic outcomes, establishing full enrollment with waiting lists, and creating a thriving community center extending institutional influence beyond traditional educational boundaries.

4. Discussion

4.1 Theoretical Contributions

The research presents several significant theoretical contributions to educational leadership scholarship. First, the integration of psychological flexibility, technological innovation, and contemplative pedagogy within a unified framework addresses gaps in existing literature that typically treats these domains separately. Second, the conceptualization of transformative intelligence as a meta-systemic capacity provides a novel approach to understanding leadership effectiveness in complex environments.

The case study validation demonstrates practical applicability of integrated leadership frameworks in complex educational transformation contexts. The systematic application of transformative intelligence principles enabled simultaneous intervention across multiple organizational levels while maintaining coherent institutional vision and community relationships. This success contrasts sharply with traditional leadership frameworks that focus on isolated domains without addressing their dynamic interactions.

4.2 Integration of Human and Technological Dimensions

The research demonstrates successful integration of technological innovation with human-centered educational approaches, challenging traditional assumptions about competition between efficiency and relationship focus. The implementation of digital systems was successful because it was guided by clear educational principles and implemented through approaches that maintained focus on human relationships and educational quality.

This integration aligns with theoretical frameworks suggesting that artificial intelligence can enhance, rather than replace, human capabilities when implemented through human-centered design principles and comprehensive change management approaches (Bass & Riggio, 2006). The transformation demonstrates how strategic AI integration emphasizes predictive analytics supporting early intervention strategies while maintaining human judgment about individual student needs.

4.3 Implications for Educational Leadership Preparation

The research findings have profound implications for educational leadership preparation programs requiring fundamental reconceptualization of leadership development approaches. Traditional programs, which primarily focus on instructional improvement and organizational management, prove inadequate

for addressing contemporary challenges requiring crisis management capabilities, technological integration competence, multicultural community leadership, sustainable resource management, and psychological resilience during prolonged uncertainty.

Future educational leadership preparation must incorporate integrated competency development, combining theoretical understanding, practical skill development, psychological resilience building, and technological literacy within experiential learning contexts that simulate contemporary leadership challenges while providing mentorship and support for professional growth.

4.4 Limitations and Future Research

Several limitations require acknowledgment in interpreting research findings. The case study, while providing compelling evidence for transformative intelligence applications, represents a single institutional context that may not generalize across different cultural, economic, or organizational environments. The integration of multiple theoretical frameworks, while enabling comprehensive understanding, creates complexity in isolating specific causal mechanisms and identifying optimal intervention approaches.

Future research should include randomized controlled trials providing evidence for the effectiveness of transformative intelligence-based interventions while establishing causal relationships between participation in development programs and enhanced functioning across multiple domains. Multi-site implementation across diverse institutional contexts would provide evidence for generalizability and scalability while identifying contextual factors influencing implementation success.

Conclusion

This research presents transformative intelligence as a comprehensive framework that systematically integrates psychological flexibility, technological innovation, and contemplative pedagogy to address unprecedented challenges facing educational leadership in the 21st century. The theoretical framework demonstrates how meta-systemic capabilities enable educational leaders to navigate complex technological, social, and cultural transformations while preserving human-centered educational values and authentic community relationships.

The empirical validation through case study analysis provides compelling evidence for the practical applicability of transformative intelligence frameworks in complex organizational transformation contexts. The research advances educational leadership theory by bridging previously separate domains within a unified theoretical framework while providing both conceptual understanding and practical guidance for contemporary educational practitioners.

The implications extend beyond individual leadership development to encompass possibilities for systematic transformation of educational institutions and preparation programs capable of addressing global challenges while preserving local educational values and community relationships. Future educational leaders must embrace transformative intelligence as a foundational meta-competency, enabling navigation of technological acceleration, cultural diversity, environmental challenges, and social complexity characterizing contemporary educational environments.

The ultimate significance of transformative intelligence lies not merely in its contribution to educational effectiveness but in its potential to foster human flourishing in all dimensions, including individual well-being, collective wisdom, cultural creativity, and ecological sustainability. As educational leaders develop transformative intelligence capabilities, they contribute to the evolution of educational consciousness itself, participating in the ongoing project of realizing human potential in service of all life.

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Workforce Stability in Healthcare: Key Predictors of Hospital Nurse Retention

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Abstract

Research background: Securing an appropriately sized and qualified nursing workforce is a critical function of healthcare human resource management. The shortage of nurses poses a significant risk to the continuity of healthcare delivery; therefore, identifying the factors that influence nurses' decisions to remain in their current positions is essential for developing sustainable staffing strategies in hospitals.
Purpose of the article: The main goal of the study is to identify factors that exert a statistically significant influence on nurses' decisions to remain in or leave their current employment.
Methods: Binary logistic regression analysis was employed to examine the extent to which selected factors namely engagement, burnout, workload, specialization, hospital ownership, and professional experience serve as statistically significant predictors of nurses' intentions to remain in (coded as 1) or leave (coded as 2) their current employment. The analysis was based on primary data obtained through a structured questionnaire administered to a sample of 500 hospital nurses.
Findings & Value added: The binary logistic regression analysis identified four variables as statistically significant predictors of nurses' intent to remain in or leave their current employment, specifically engagement ($B = -0.382$; $p = 0.016$), higher burnout propensity ($B = 0.368$; $p = 0.027$), greater workload ($B = 0.328$; $p = 0.026$), and shorter duration of professional experience ($B = -0.476$; $p = 0.004$). In contrast, neither specialization nor hospital ownership status were identified as significant independent predictors. The overall model demonstrated statistical significance ($\chi^2 = 56.043$; $p < 0.001$) and explained between 50.6% and 55.5% of the variance in the decision to remain.
The findings underscore the importance of developing and implementing targeted management strategies that promote employee engagement, mitigate burnout, optimize workload distribution, and value professional experience. Such measures are essential for strengthening workforce stability within healthcare institutions.

Keywords: Job Demands – Resources, Staff sustainability, Burnout, Work-Related Health Problems, Hospital nurses

JEL classification: I0, J6, M5, Y9

1. Introduction

The work of hospital nurses is one of the most demanding professions, requiring not only a high level of expertise but also mental and physical resilience. The healthcare sector of today is facing new challenges and changes. Retaining nurses is crucial in stabilizing and ensuring the necessary healthcare workforce in hospitals.

Shortage of nurses, turnover or intention to leave have negative effect on organizational performance, resulting in financial and human resource losses (Neves et al., 2022). Nurses' intention to leave their job is a worldwide concern. Internal and external brain drain factors are the main reason for nurses' intention to leave their job (Ayalew et al., 2021).

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1.1 Literature Review

The work environment and life satisfaction have an essential relationship in wellbeing and a determining influence on mental health and quality of life. The relevance of this connection is particularly evident in daily interactions and people's functionality in their work activities (Morales-García et al., 2024). The healthcare profession has been identified as one of the highest-risk occupations in terms of the likelihood and prevalence of negative psychological outcomes due to its challenging nature characterised by high levels of human contact, emotional demands and workload (Mazzetti et al., 2024).

Nurses in health-care environments, in daily contact with suffering patients, terminal situations, and impacting treatments, are one of the categories most exposed to the risk of work stress, turnover, dissatisfaction, and burnout (Ramaci et al., 2024). A positive work environment can enhance nursing safety and patient satisfaction while alleviating nurse stress. Conversely, a poor work environment can harm nurses' physical and mental health and compromise the quality of care (Gou et al., 2024). In addition, the job demands–resources (JD–R) theory discusses "work engagement in addition to burnout and considered burnout and work engagement to be mediators of the relation between job demands and negative outcomes (health problems), and job resources and turnover intention, respectively" (Zeng et al., 2022). In general, healthcare organizations struggle to deal with individual and working environment conditions related to moderate to high levels of employee stress, high-employee turnover rates, and an ageing workforce (Midje et al., 2024). The nurse staff is considered an integral part of the healthcare workforce and makes up approximately 60% worldwide. Optimal nurse staffing in hospital departments is a priority for most head nurses around the world. Adequate staffing levels in departments are essential for patient safety and the provision of high-quality healthcare (Yu et al., 2024). Sub-optimal nurse staffing characteristics can be observed during nursing shortages, such as inadequate staffing levels, longer working hours with overtime, and high turnover. Bae (2024) considers mandatory overtime to be a significant factor contributing to intent to leave (Bae, 2024). Employee retention is conceptually the opposite of turnover. It can be defined as the ability to retain workers within the organization where they are employed for prolonged time, typically one year or more. The key question for healthcare managers and policymakers is understanding which factors affect, directly or indirectly, the retention of healthcare workers, and how to better exploit such factors to maximize employee retention (Moscelli et al., 2025). Sustainability occurs when resources are used as efficiently as possible, without compromising the quality of care for patients (Hossny, 2022). Neves et al. (2022) maintain that the factors affecting nurses' intention to leave include work environment, emotional exhaustion, practice safety, and shortage of staff. Inadequate staffing, including an increased workload in work environments unfavourable to nursing practices, usually motivates professionals to leave. Burmeister et al. (2019) state that nurses' intention to leave is significantly influenced by the increased perception of inadequate staffing in the department and lower job satisfaction. Alenazy et al. (2023) concluded that the turnover rate of nurses can be lowered by job satisfaction of other members of the nursing team, their productivity, and career intentions.

1.2 The scientific concept of Job Demands - Resources theory

Fundamental to the JD-R model, is the proposition that any occupation has contextual risk and protective factors that can be classified as job demands or resources. Job demands, defined as the physical and psychological stressors inherent in a work role, can trigger a process where employees experience sustained psychological and physiological drain, explicitly linked to the health impairment process (Parkinson-Zarb et al., 2025). Job resources and demands have a multiplicative impact on emotional exhaustion and job satisfaction (Awwad et al., 2022). The Job Demands–Resources (JD-R) theory is grounded in the conceptualization of burnout syndrome, characterized by two core components: (1) excessive job demands that contribute to employee exhaustion, and (2) a lack of adequate job resources that leads to diminished work engagement (Della Bella et al., 2022; Paterson et al., 2024). In the JD-R theory, the authors define job demands as physical, psychological, social, or organizational aspects of the job that require sustained physical or psychological (cognitive and emotional) effort or skills and are therefore associated with certain physiological or psychological costs (Vachhrajani et al., 2022; Meng et al., 2023; Marzocchi et al., 2023; Xie et al., 2024). Job demands are defined as organizational requirements that require physical and psychological efforts for fulfilment. If individuals perceive job demands outweighing job resources, they will experience physical and cognitive costs in form of JS, exhaustion, and burnout (Sousan et al., 2022). According to Udushirinwa et al. (2022), the risk of high stress and imbalance between high job demands and low job resources exists in almost every workplace. Moreover, they state that

healthcare workers are exposed to significant deficits in job resources (Udushirinwa et al., 2022). The phenomenon is made up of two components: a problem (e.g. resource/time scarcity) and a process (clinical decision-making to prioritize care) (Stemmer et al., 2022). Burnout consists of two components, named exhaustion and disengagement from work. The exhaustion dimension refers to feelings of physical fatigue and overload with relation to work, while the dimension of disengagement refers to the distance from work and negative attitudes toward their own work (Wójcik et al., 2022).

1.3 Burnout and Work-Related Health Problems

The World Health Organization (WHO) recognizes occupational burnout as a result of chronic stress experienced in the workplace consisting of three dimensions: the feeling of loss, negative feelings concerning work and the mental distance toward it, as well as reduced professional effectiveness (Wójcik et al., 2022). Job burnout is seen as the antithesis of work engagement, a state characterized by vigour, dedication, and absorption (Urban et al., 2024). Burnout is one of the most studied psychosocial syndromes in the workplace in recent years, typically shouldered by service professionals (Nonnis et al., 2024). In Europe, every forth worker experience that their health is at risk due to conditions of working life. Burnout is defined as a persistent, negative, work-related state of mind in 'normal' individuals that is primarily characterized by exhaustion. The state of mind is accompanied by distress, a sense of reduced effectiveness, decreased motivation, and the development of dysfunctional attitudes and behaviours at work (Frögéli et al., 2022). Depersonalization is reflected in treating patients as objects rather than human beings, leading to a callous attitude towards patients (Wei et al., 2024). Work-related health challenges and adverse health outcomes, such as musculoskeletal disorders, stress, and burnout, are increasing within occupational health worldwide (Thapa et al., 2022).

Research gap: *Based on a literature review, to identify the factors that, within the context of the JD-R theory, predict retention or turnover, and to assess their strength among hospital nurses.*

2. Methods

The primary goal of the study is to use binary logistic regression to determine which variables have a statistically significant impact on nurses' decisions to stay in their current employment or to leave.

Partial goals:

Step 1: Review of scientific literature – the literature analysis is based on sources from the Web of Science database, with articles published in journals indexed in the SSCI.

Step 2: Operationalization of variables and determination of measurement methods – this step involves selecting variables identified through the literature review. The chosen variables are measured using a Likert scale. Responses reflect the degree of agreement with specific statements on a 1–5 scale. The variables of satisfaction and sustainability are measured and recoded as follows: strongly disagree – 1; disagree – 2; neutral – 3; agree – 4; strongly agree – 5. The variable of engagement is assessed and recoded using the following scale: never – 1; rarely – 2; don't know – 3; often – 4; always – 5.

Step 3: Model testing through binary logistic regression – In this phase, binary logistic regression analysis is used to examine which independent variables have a significant impact on the defined dependent variable.

Step 4: Interpretation of binary logistic regression results – verification of hypotheses and assumptions based on the results of variable measurement.

Step 5: Developing recommendations for healthcare institutions in Slovakia – these recommendations will be based on the findings from the model that identifies predictors of the intention to leave.

Application of the statistical method:

Binary logistic regression is a technique employed to examine the relationship between a binary dependent variable and one or more independent variables, which may be either categorical or continuous. This method utilizes the logistic (sigmoid) function to estimate the probability that the dependent variable falls into one of two categories, typically represented as 0 or 1.

Hypotheses:

H1: There is a statistically significant relationship between engagement and the intention to leave.

H2: There is a statistically significant relationship between burnout propensity and the intention to leave.

H3: There is a statistically significant relationship between perceived workload and the intention to leave.
H4: There is a statistically significant relationship between the nurses' attained specialized education and the intention to leave.
H5: There is a statistically significant relationship between the hospital ownership status and the intention to leave.
H6: There is a statistically significant relationship between the number of years worked and the intention to leave.

3. Results

The purpose of the binary logistic regression was to determine which variables have a statistically significant effect on nurses' decisions to stay in their positions or to leave. The dependent variable was binary, coded as 1 for remaining in their current employment and 2 for intending to leave. The model incorporated six predictors: engagement, burnout propensity, workload, specialized education, hospital ownership status, and the length of nursing experience.

Table 1. Block 0: Initial block of the regression model

Classification Table[a,b]							
	Observation		Prediction				
			Sustainability		Percentage Correct		
			1	2			
Step 0	Sustainability	1	367	0	100		
		2	133	0	0		
	Overall percentage				73.4		
Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.015	0.101	100.575	1	0.000	.362
Variables not in the Equation							
Step 0	**Variable**			**Score**	**df**	**Sig. (p-hod.)**	
	Engagement			14.270	1	0.000	
	Burnout Propensity			24.308	1	0.000	
	Workload			20.104	1	0.000	
	Specialized Education			9.816	1	0.002	
	Hospital Ownership Status			0.962	1	0.327	
	Nursing Experience			19.964	1	0.000	
	Overall Statistics			**54.176**	**6**	**0.000**	

Source: Authors' elaboration, 2025

Baseline model (step 0)

In the baseline model (no predictors), the constant is B = -1.015 ($p < 0.001$), which indicates that, in the absence of independent variables, the likelihood of nurses remaining employed is significantly higher than that of leaving. The exponential coefficient (Exp(B) = 0.362) implies that the odds of a nurse leaving are 0.362 times the odds of remaining in her current position. The overall classification accuracy of the null model is 73.4%, with all cases predicted as remaining, resulting in 100% accuracy for the remain category and 0% for the leave category.

The Variables not in the Equation table revealed that multiple variables demonstrated statistical significance in univariate analyses, including engagement ($p < 0.001$), burnout propensity ($p < 0.001$), workload ($p < 0.001$), nursing experience ($p < 0.001$), and specialized education ($p = 0.002$). Conversely, hospital ownership status and gender were not found to be significant predictors.

Table 2. Block 1: Method – Entry

Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 1	Step	56.043	6	0.000
	Block	56.043	6	0.000
	Model	56.043	6	0.000

Summary Model			
	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Step 1	523.197	0.506	0.555

Hosmer and Lemeshow Test			
	Chi-square	df	Sig.
Step 1	4.001	8	0.857

Classification table *a					
			Predicted		
			Sustainability		Percentage Correct
	Predicted		1	2	
Step 0	Sustainability	1	354	13	96.5
		2	107	26	19.5
	Overall Percentage				76.0

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	**Variable**						
	Engagement	-0.382	0.159	5.790	1	0.016	0.683
	Burnout Propensity	0.368	0.166	4.880	1	0.027	1.444
	Workload	0.328	0.148	4.945	1	0.026	1.389
	Specialized Education	0.284	0.268	1.121	1	0.290	1.328
	Hospital Ownership Status	0.246	0.244	1.019	1	0.313	1.279
	Nursing Experience	-0.476	0.165	8.308	1	0.004	0.621
	Constant	-1.173	1.202	0.953	1	0.329	0.309

Source: Authors' elaboration, 2025

Resulting Model (step 1)

After incorporating all variables into the regression model, there was a statistically significant increase in its predictive accuracy (Omnibus test: $\chi^2 = 56.043$; df = 6; $p < 0.001$), demonstrating that the model is appropriate for predicting nurses' decisions. The model also exhibited improved pseudo-R^2 values (Cox & Snell $R^2 = 0.506$; Nagelkerke $R^2 = 0.555$), explaining between 50.6% and 55.5% of the variance in the decision to remain in current employment. Additionally, the Hosmer-Lemeshow test value was non-significant ($p = 0.857$), indicating a good fit between the model and the actual data.

The model's classification accuracy increased to 76.0%. It correctly classified 96.5% of respondents who indicated they would remain and 19.5% of those who expressed their intention to leave. Although the sensitivity for the leaving category remains relatively low, this marks a notable improvement compared to the null model.

Binary logistic regression takes the form:

$$P(leaving\ the\ current\ employment) = 1 / (1 + e\hat{}(-z))$$

$$where:$$

$$z = -1.173 - 0.382 \cdot engagement + 0.368 \cdot burnout + 0.328 \cdot workload$$

$$+ 0.284 \cdot specialization + 0.246 \cdot hospital\ ownership\ status - 0.476 \cdot experience$$

Table 3. Interpretation Table

Variable	B	Sig.	Exp (B)	Interpretation
Engagement	-0.382	0.016	0.683	Higher engagement **reduces the likelihood of leaving** (by appr. 31.7%).
Burnout Propensity	0.368	0.027	1.444	Higher burnout propensity **increases the likelihood of leaving** (by appr. 44.4%).
Workload	0.328	0.026	1.389	Higher perceived workload **increases the likelihood of leaving** (by appr. 38.9%).
Specialized Education	0.284	0.29	1.328	Not significant – does not have a statistically significant effect ($p > 0.05$).
Ownership Status	0.246	0.313	1.279	Not significant – hospital ownership does not influence turnover.
Nursing Experience	-0.476	0.004	0.621	Longer work experience **reduces the likelihood of leaving** (by appr. 37.9%).

Source: Authors' elaboration, 2025

Interpretation of regression coefficients:

The table shows that four out of six predictors were of statistical significance ($p < 0.05$): Engagement had a negative regression coefficient ($B = -0.382$; $p = 0.016$; $Exp(B) = 0.683$), which means that with each one-unit increase in engagement, the likelihood of leaving decreases by approximately 31.7%. This result supports the hypothesis that higher job engagement has a protective effect against turnover intentions. The burnout propensity had a positive and statistically significant effect ($B = 0.368$; $p = 0.027$; $Exp(B) = 1.444$). This indicates that with a one-unit increase in burnout score, the likelihood of leaving increases by 44.4%. The outcome is consistent with the literature sources identifying burnout as a significant factor in the turnover of healthcare personnel. Workload was also found to be a significant positive predictor ($B = 0.328$; $p = 0.026$; $Exp(B) = 1.389$). Higher perceived workload leads to a 38.9% increase in the likelihood of leaving, highlighting the need for managerial intervention to regulate workload. Nursing experience proved to be a significant negative predictor ($B = -0.476$; $p = 0.004$; $Exp(B) = 0.621$), with each additional year of experience reducing the likelihood of leaving by approximately 37.9%. This relationship suggests that more experienced nurses are more likely to stay.

In contrast, specialization education ($p = 0.290$) and the hospital ownership status ($p = 0.313$) did not show statistical significance in the multivariate model, suggesting that, after controlling for other variables, these factors by themselves do not have a significant impact on the decision to stay. Generating the ROC curve made it possible to determine that the model has excellent discriminative ability (AUC value of 0.822). The VIF values of the individual factors in the model indicate that the variables do not overlap, and therefore the regression coefficients can be considered reliable. The ROC curve analysis demonstrated that the model possesses excellent discriminative power (AUC value of 0.822). Additionally, the VIF values for the individual factors indicate minimal multicollinearity, supporting the reliability of the regression coefficients.

4. Discussion

The study provided valuable insights into the issue of nurse turnover in Slovak hospitals, a threat to the sustainability of hospital staffing. By applying binary logistic regression, the research identified major predictors that significantly affect nurses' decisions to either stay in or leave their jobs. The results demonstrate the strong influence of psychological and work-related factors, including engagement, burnout, and perceived workload, along with the length of professional experience. However, some of the anticipated predictors such as specialized education and hospital ownership status were not found to be statistically significant in the model. Therefore, this section will focus on a deeper interpretation of the findings, their potential practical implications, and possible directions for future research in this important area. The findings from the literature review conducted by Montayre et al. (2023) underscore the necessity of adopting a holistic approach to mental health interventions, emphasizing the importance of supporting both the psychological and physical well-being of nurses. This underscores the imperative to implement comprehensive strategies rather than isolated, piecemeal interventions. Similarly, research by

Zhang et al. (2024) highlights the critical role of fostering a supportive work environment within the nursing profession. Facilitating work-life balance has been shown to enhance psychological resilience and improve job satisfaction among nurses. Moreover, Moore et al. (2024) assert that prioritizing the mental well-being of hospital nurses is fundamental to establishing a stable and proficient nursing workforce capable of addressing evolving healthcare challenges. Healthcare organizations that actively promote nurse engagement in specialized mental health support programs are more likely to achieve optimal overall well-being among their staff.

Hospitals that prioritize enhancing nurses' engagement may anticipate a decline in turnover rates, thereby contributing to a more stable workforce. Ren et al. (2024) investigated engagement within the context of working conditions, emphasizing the relevance of the two-factor theory. Their findings indicate that motivational factors play a critical role in fostering work enthusiasm. Furthermore, Higher perceived social support correlated with greater work engagement, likely due to the mitigation of burnout and stress.

The duration of clinical experience among nurses has been identified as a significant predictor of a reduced intention to leave their current employment. Nurses with extended tenure at the same healthcare institution may demonstrate lower motivation to seek alternative positions, likely influenced by factors such as impending retirement and the job security afforded by long-term service. Consequently, particular attention should be directed towards early-career nurses, who are at a heightened risk of turnover. Sugawara et al. (2023) reported that self-compassion contributes to lower levels of stress and burnout among nurses, while simultaneously enhancing their work engagement. While workplace conflicts and excessive workloads were found to exacerbate burnout, engaging and meaningful work served to mitigate it. Notably, role conflict exhibited a paradoxical effect, being associated with decreased burnout and increased engagement. Although burnout was linked to a higher intention to leave, engagement did not significantly affect this intention. Therefore, fostering self-compassion among younger nurses may prove beneficial in reducing both stress and turnover intentions within this vulnerable group.

Morales-García et al. (2024) point to the need to implement strategies that strengthen nurses' work engagement and job security while effectively managing job demands to prevent depression. These findings also highlight the importance of the Job Demands-Resources (JD-R) theory for understanding and improving nurses' job satisfaction and performance. The findings from the study investigating predictors of nurse retention offer valuable practical implications for interventions grounded in the JD-R (Job Demands-Resources) theory. Specifically, the results indicate that strategies focused on enhancing job resources such as fostering engagement, cultivating experience, and strengthening loyalty among veteran nurses as well as mitigating job demands through workload management and burnout prevention may serve as effective approaches to reducing nurse turnover.

Conclusion

The study aimed to identify variables that have a statistically significant impact on hospital nurses' decisions to either stay in their positions or leave. To achieve this, binary logistic regression was employed, with the dependent variable coded as a binary outcome (1 for staying, 2 for intention to leave). The model included six predictors: engagement, burnout propensity, perceived workload, level of specialized education, hospital ownership status, and the length of nursing experience.

The regression analysis results indicated that four of the predictors examined achieved statistical significance ($p < 0.05$). Nurse engagement exhibited a negative effect on the intention to leave, suggesting that increased engagement is linked to a reduced likelihood of turnover ($Exp(B) = 0.683$). This finding supports H1 hypothesis, which assumed a significant relationship between engagement and intention to leave. Next, burnout propensity and perceived workload showed positive and statistically significant effects, with higher burnout levels ($Exp(B) = 1.444$) and greater workload ($Exp(B) = 1.389$) associated with an increased probability of intending to leave. Consequently, H2 and H3 hypotheses predicting significant relationship between burnout, workload, and intention to leave were confirmed.

Another noteworthy result was the significant negative influence of nursing experience; each additional year of professional practice reduced the likelihood of leaving ($Exp(B) = 0.621$), suggesting greater stability among more experienced nurses. This confirmed H6 hypothesis, which stated a statistically significant relationship between the number of years worked and intention to leave.

In contrast, the variables representing specialized education and hospital ownership status were not identified as statistically significant predictors of nurses' decisions to stay within the multivariate logistic regression model. Nonetheless, the model demonstrated strong discriminative performance, as evidenced

by an area under the curve (AUC) of 0.822. Additionally, variance inflation factor (VIF) analysis indicated no substantial multicollinearity among the independent variables, thereby enhancing the robustness and interpretability of the regression coefficients. Accordingly, the findings support the acceptance of H4 and H5 hypotheses, indicating no statistically significant association between either specialized education or hospital ownership status and nurses' intention to leave.

In conclusion, nurse engagement and the duration of professional experience are key factors contributing to workforce retention in hospital settings, whereas elevated levels of burnout and excessive workload emerge as critical risk factors associated with increased turnover intentions.

The findings of this study offer robust empirical validation for the two central mechanisms articulated by the JD-R theory. Specifically, engagement conceptualized as a job resource was shown to exert a protective, motivational effect, with higher engagement levels significantly reducing the likelihood of nurses intending to leave their positions. Engagement (a job resource) demonstrated a strong motivational process, as higher engagement levels were associated with a lower likelihood of leaving. Conversely, burnout propensity and perceived workload (job demands) go hand in hand with the intention to leave.

By situating these dynamics within the hospital nursing context, the study underscores the explanatory power and practical utility of the JD-R framework. It highlights how distinct job-related resources and demands contribute to retention or attrition decisions among nurses, thereby offering a theoretically grounded foundation for the development of targeted and evidence-based strategies aimed at sustaining a stable nursing workforce.

Recommendations and Proposals for Hospital Management with an Emphasis on Nurse Retention

Drawing on the study findings, the following recommendations are proposed for hospital management to promote the retention of nursing personnel: (1) Enhancing nurse engagement: It is advisable to adopt strategies that improve the work environment, foster nurses' autonomy within their professional roles, ensure effective communication and transparency, and facilitate opportunities for continuous professional development. Conducting periodic assessments of job satisfaction and engagement can yield critical insights to inform and refine targeted intervention efforts. (2) Elevated burnout levels have been identified as a significant predictor of nurses' intention to leave their current employment. Consequently, the implementation of proactive burnout prevention initiatives and effective management strategies is imperative. Such interventions may encompass workshops and training programs centred on stress reduction, well-being enhancement, time management optimization, and resilience development. It is also important to foster a culture in which nurses feel safe, are allowed to discuss their challenges openly, and receive necessary support from management and colleagues. (3) The finding that higher perceived workload significantly increases the likelihood of turnover highlights the need for a thorough analysis and optimization of work processes and staffing levels. Management should consider options for task redistribution, ensuring an adequate number of staff in relation to patient needs, and implementing efficient scheduling systems. The introduction of technological solutions to reduce nurses' administrative burden may also contribute to lowering their overall workload. (4) The pronounced impact of the length of professional experience suggests that more experienced nurses serve as a stabilizing factor within the hospital. Consequently, fostering a work environment that recognizes and appreciates their expertise is essential. Support strategies may encompass the implementation of mentorship programs for less experienced staff, active inclusion of experienced nurses in organizational decision-making, and the provision of continuous professional development and career progression opportunities.

Although specialized education and hospital ownership status were not identified as statistically significant predictors in this model, their potential influence should not be entirely disregarded. t is possible that indirect effects or interactions with other variables, not captured in this study, play a role. Consequently, ongoing monitoring of these factors is advised, alongside their integration within a comprehensive human resource management framework. Investing in strategies that enhance nurse engagement, prevent burnout, optimize workload, and support experienced personnel constitutes a critical approach for hospital administrators seeking to mitigate turnover and maintain a stable, motivated nursing workforce. Continuous evaluation of key performance indicators and the dynamic adjustment of interventions based on empirical data are imperative to ensure the sustained retention of nursing staff within hospital environments.

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Strategic Measures to Secure Financing for Schools and Educational Facilities during the Energy Crisis: The Case of the Slovak Republic

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Abstract

Research background: The year 2022 marked a watershed moment for the Slovak Republic, influenced by the lifting of COVID-19 restrictions, the onset of the conflict in Ukraine, and the beginning of an energy crisis affecting multiple countries. These events significantly impacted all sectors of the national economy, including education. This paper examines strategic measures implemented to mitigate the energy crisis's effects on schools and school facilitates in Slovakia. In response to rising energy costs, the Ministry of Education, Reasearch, Development and Youth of the Slovak Republic allocated substantial budgetary resources-exceeding EUR 12 million in 2022 and EUR 75.5 million in 2023-to compensate schools and school facilities for increased energy expenses. To ensure efficient and economical use of these funds, a comprehensive data collection process was established to verify the accuracy and validity of energy consumption reports submitted by schools.
Purpose of the article: This paper analyses the development and implementation of control mechanisms that enable monthly verification of energy consumption and unit prices, ensuring transparent and accountable state budget funding.
Methods: Particular emphasis is placed on the data collection, validation, and analysis processes, highlighting the importance of transparency and inter-ministerial and other relevant institution cooperation.
Findings & Value added: The findings demonstrate how systematic data evaluation can improve school financing and support the efficient operation of school facilities even during crises, thereby safeguarding conditions for quality education. The paper concludes by discussing prospects for enhanced inter-ministerial and other relevant institution collaboration to foster more effective educational financing solutions in the future.

Keywords: Energy crisis, Energy costs, Schools and school facilities, Educational financing

JEL classification: H52, H70

1. Introduction

The energy crisis, which has intensified significantly in recent years due to global geopolitical and economic factors, has had a major impact on the operating costs of all economic actors, including public and educational institutions (Xu et al., 2022; Paone and Bacher, 2018). Increased energy prices, including electricity and heating, place a significant financial burden on schools, threatening their ongoing operations and the quality of education provided (Pinnington, 2025; Bertone et al., 2018). As public institutions, schools are often dependent on government funding, which may not always adequately reflect rapid changes in energy costs (Anglum, Shores and Steinberg, 2021; Delardas and Giannos, 2022). In this context, the role of ministries of education and other government bodies in providing adequate financial support and implementing effective funding mechanisms to enable schools to cope with

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increased operational costs is crucial (Anessi-Pessina et al., 2020; Bellei and Contreras, 2024; Sulasmi, Prasetia, and Rahman, 2023).

In addition to direct financing of operating costs, the literature also highlights the importance of investing in energy efficiency in school buildings, which can reduce costs and contribute to environmental sustainability in the long term (Chaer et al., 2025; Wang et al., 2022). The use of intelligent energy management systems and the implementation of renewable energy sources are additional opportunities to reduce schools' dependence on unstable energy prices (Benkhalfallah, Kouah, and Ammi, 2023; Taylor et al., 2008). This article focuses on an analysis of available financing mechanisms and measures that schools can use to deal with the energy crisis, with an emphasis on the role of government authorities in providing support.

The aim of the paper is to determine how assistance was provided to schools to eliminate the negative impacts of the energy crisis. This paper analyses the development and implementation of control mechanisms that enable monthly verification of energy consumption and unit prices, ensuring transparent and accountable state budget funding.

In Slovakia, there was a threat of schools closing again after the COVID-19 pandemic (Stoličná and Barjaková, 2023), but the Ministry of Education, Research, Development and Youth of the Slovak Republic (hereinafter referred to as “Minedu”) rejected this way of solving the energy crisis and proceeded to provide funds to compensate for the increased energy expenses for schools and school facilities. The Minedu decided to quickly provide targeted assistance to schools financed from the state budget, which included primary, secondary and special schools, as well as kindergartens with legal personality. There were 3 relevant ministries to provide the solution, namely the Minedu, the Ministry of Finance, the Ministry of Economy, which provided its own scheme of support to economic entities, but with some limitations that were insufficient for the support to schools (Economy, 2025).

In order to ensure efficient and effective use of budget resources, it was necessary to establish the control mechanisms applied before allocating funds to schools. Relevant data for verification were unit price and monthly consumption of commodities. The Ministry of Economy reported that it was not possible to check the specified range of data if it exceeded their aid scheme. For this reason, the Minedu had to develop its own control mechanisms to ensure the efficient use of the public funds, verifying the relevance of the data through 2 entities under the competence of the Ministry of Economy for the commodities gas and electricity, as energy is provided to schools by approximately 150 suppliers, which in the case of verifying the data directly with them could significantly prolong the whole process of control and fund´s distribution.

1.1 Literature Review

Research on energy cost financing in schools shows that there is a wide range of financial instruments that schools can use to reduce their operating costs during energy crises. Among the most commonly mentioned are state grants, donations, bonds, and leasing programs that allow for financing energy upgrades without an immediate financial burden on a school's budget (U. S. Department of Energy, 2020; Alam et al., 2019; Jackson, Wigger, and Xiong, 2021). Chaer et al. (2025) emphasize that effective energy management in school buildings involves not only technical measures, but also organizational changes and staff training. Almasri et al. (2024) and Rosato et al. (2019) summarize the complex relationship between energy efficiency and renewable energy systems within educational institutions.

Bertone et al. (2018) identify the main barriers to the implementation of energy savings, which include lack of financial resources, administrative burden and low awareness of available funding opportunities. Similarly, Pinnington (2025) and Delardas and Giannos (2022) point out that volatility in energy prices complicates school budget planning, which requires flexible and fast funding from the state.

Investments in renewable energy and smart energy management systems are a promising path to long-term sustainability, according to Wang et al. (2022) and Benkhalfallah, Kouah and Ammi (2023). These measures not only reduce costs but also improve the environmental profile of schools, which is in line with the Sustainable Development Goals (SDGs) globally.

Sweatman and Managan (2010) and Bellei and Contreras (2024) emphasize the role of government institutions, particularly ministries of education, in developing policies and providing financial support

that enable schools to respond to the energy crisis. Sulasmi, Prasetia and Rahman (2023) and Lee, Shores and Williams (2022) extend this perspective to the need for schools to build organizational resilience, which includes the ability to adapt to unexpected energy shocks through effective management and financing.

Life-cycle economic analyses of energy saving investments in schools (Hu, 2019; Stocker, Tschurtschenthaler and Schrott, 2015) confirm that despite the initial costs, these projects generate significant savings in the long term. It is therefore essential that government funding supports not only short-term compensation for increased costs, but also investment in sustainable solutions (Taylor et al., 2008; Hu, 2019).

2. Methods

Data were collected through controlled data collection from schools that were allowed to voluntarily complete an online survey form. The questionnaire collected basic information about the school and relevant information for the evaluation of the input data on energy consumption (electricity, gas, solid fuel), financial costs associated with energy consumption and the identification of the points of consumption (PODs and EIC codes). The collected data were systematically recorded in a database created in the Microsoft Excel programming environment, which allowed for efficient filtering, processing, consistency checking and further data analysis. Prior to the actual analysis, the following steps were performed:

1. Detection and elimination of random errors: data were checked for obvious errors (e.g. incorrect number formats, duplicates, unit mismatches etc.).
2. Data validation: Data entered by individuals where systematic errors or inconsistencies were found were extracted and, where necessary, removed.
3. Completeness check: All mandatory fields were checked for completeness and correct structure.
4. Data validation - the following procedures were carried out to ensure the quality and validity of the data:
    a) Logical check: Verification of the logical consistency of the data (e.g. impossibility of negative consumption, unusually high payments relative to average consumption, etc.).
    b) Cross-validation of data: comparison of data obtained with direct verification with suppliers (energy consumption).
    c) Application of internal rules: Setting and application of control conditions that had to be met (e.g. range of maximum and minimum energy consumption for a certain period, energy unit price values in line with market prices in the period under review, consistency between type of point of consumption and consumption, etc.).

Subsequently, data analysis and evaluation were performed. Statistical and analytical methods were applied to evaluate the data:

1. Descriptive statistics: calculations of average, minimum and maximum values of consumption and energy costs.
2. Outlier detection: identification of outliers or trends that would indicate anomalies.
3. Data segmentation: aggregation of data according to predefined criteria such as type of commodity (electricity, gas, solid fuels), type of financial assistance received (energy donations), region of operation of the school.

Data collection was conducted in several rounds. Each round of data collection involved up to 2,000 eligible applicants, the data was always filled in by the parent school and for all its components and sites, i.e. this number covers a realistically larger number of schools and school facilities. After each round of evaluation, the results were processed and submitted to the Ministry of Finance of the Slovak Republic together with the request for a budget measure. The results of each round were subsequently published on the official website with notification to schools. In cases of uncertainties or inconsistencies in the data, communication back to the schools was ensured. The purpose of verifying the data directly with the schools was to clarify the data and to ensure the correctness of the calculation of the financial aid intended to compensate for increased energy costs during the energy crisis.

3. Results

Compensation for increased energy costs covered a number of areas:

I. The 2022 arrears reimbursement (Minedu, 2023a)

The 2022 arrears reimbursement was intended for schools funded directly from the state budget. An electronic online form was launched on 26 January 2023 through the energy.iedu.sk website and was closed on 31 August 2023.

A total of 6 rounds were evaluated with a request for additional funding exceeding EUR 12 million. Under this aid, funding of over EUR 5.8 million was granted to schools and educational establishments after the introduction of controls.

The total amount of the arrears reimbursement was requested from the Ministry of Finance and delivered to the schools based on a completed form.

Controls that were put in place when assessing arrears for 2022:

- the amount of arrears/overpayment cannot be higher than the total cost for 2022,
- the total annual cost including VAT and distribution and other charges for all commodities combined was lower than the amount provided for energy financing in 2022,
- the unrealistic unit price of the commodity,
- the amount of arrears in relation to the total cost is too high,
- the request for the refinancing was less than 100 €,
- the data was not entered on the basis of the annual billing invoices, the identification data of the consumption points (EIC/POD codes) and the annual energy consumption,
- the requests have already been granted in previous refinancing rounds.

II. Full financial aid in 2023 (Minedu, 2023b)

The full financial aid for the increased energy rates in 2023 was intended for schools financed directly from the state budget (primary, secondary, special schools and all their units) under the jurisdiction of all founders.

The electronic form was launched on 1 March 2023 via the web. A total of 6 rounds were evaluated for schools financed directly from the state budget with a request for additional funding of more than EUR 75.5 million. Under this aid, funding of over EUR 41.7 million was granted to schools and educational facilities following the implementation of the controls.

The controls put in place for the evaluation were the same as in the previous case.

Aid scheme:

1. Financial aid for schools was provided by the Minedu as follows:
   - 80 % of eligible costs for electricity and natural gas consumed (commodity price excluding VAT and charges) as follows:
   - in case of natural gas, eligible costs were the product of the increase in the unit price for the commodity above EUR 99/MWh (capped price) and the consumption in MWh,
   - in case of electricity, eligible costs were the product of the increase in the unit price for the commodity above EUR 199/MWh (capped price) and the consumption in MWh.
2. Financial aid for schools supported by the Ministry of Finance
   - 20% of the eligible costs for electricity and natural gas consumed (commodity price excluding VAT and charges), in case the unit price of the commodity exceeded the capped price - electricity (199 €/MWh,) and gas (99 €/MWh) as follows:
   - in case of natural gas, the eligible costs were the product of the increase in the unit price for the commodity above €99/MWh and the consumption in MWh,
   - in case of electricity, the eligible costs were the product of the increase in the unit price for the commodity above €199/MWh and the consumption in MWh.

If the unit price of the commodity - electricity, natural gas both exceeded and did not exceed the capped price (199 €/MWh, resp. Minedu proceeded to compare the cost of the unit price of the commodity for 2023 with 2022 and the request to the Ministry of Finance was also subject to the financial support for schools, which will be the product of the year-on-year increase in the unit price of the commodity in € and the consumption in MWh. The amount of fees and VAT was added to the above eligible costs in points 1. and 2. (A+B).

All of the above calculations were made by the Minedu from data collected via an electronic form.

After the finalization of the electronic data collection “Full financial aid in 2023” for the period January-October 2023, when the control mechanisms were in place (checking of monthly consumption by EIC/POD codes, etc.), the requests of schools and state school establishments for the co-financing of the expected energy costs in the period October-December 2023 were additionally aggregated. The requests for co-financing under this aid amounted to more than EUR 21.0 million and more than EUR 20.8 million were granted through the ‘conciliation procedure’ without additional checks on monthly consumption based on EIC/POD codes.

III. Financial aid for kindergartens with legal personality in 2023 (Minedu, 2023c)

Financial aid for increased energy rates in 2023 was also intended for kindergartens with legal personality under the jurisdiction of municipalities and non-state founders.

The electronic form was launched on 15 March 2023 via the website and closed on 30 October 2023.

In total, 7 rounds were evaluated with a request for additional funding amounting to over EUR 500.000. Over EUR 400.000 of funding was granted under this support after the checks were put in place. The checks that were put in place during the evaluation were the same as in previous cases.

Aid scheme:

The financial aid was aimed to deliver funds to kindergardes with legal personality in the amount of 80 % of the eligible costs for electricity and natural gas consumed (commodity price excluding VAT and charges) as follows:

- in case of natural gas, the eligible costs were the product of the increase in the unit price for the commodity above EUR 99/MWh and the consumption in MWh,
- in case of electricity, the eligible costs were the product of the increase in the unit price for the commodity above EUR 199/MWh and the consumption in MWh.

IV. Financing of increased rents in 2023 (due to the increase in energy prices) (Minedu, 2023d)

Minedu also prepared the support for schools that are located in rented spaces and, in addition to the rent, pay the landlord the costs of energy consumed in the rented space. The founders of these schools could apply for an increase in payments due to the increase in energy prices through the “Conciliation procedure”, which was announced for this specific purpose.

A total of 6 rounds were evaluated with a request for additional funding of over EUR 800.000. Over EUR 450.000 has been provided under this aid.

The following criteria were taken into account when assessing the requests from schools/school facilities:

- accuracy and completeness of the completed form,
- assessment of the feasibility of the increase in rent including utilities - if the rent including utilities for the month in question represents more than 25% of the 2022 amount, funding was only proposed after an individual assessment of the utility bills,
- if the landlord had applied for a support from the Ministry of Economy, the amount of the proposed funding was reduced,
- funding was not provided if a school with the same commodity and off-take points also entered into other schemes of aid and funding was proposed up to a maximum of the recommendation of the regional office of the school administration.

V. Conciliation procedure - Costs of school operating swimming pools (Minedu, 2023e)

The Minedu also addressed assistance to schools operating school swimming pools as there were significant cost increases to run them, with similar rules in place and funding being provided in two rounds with controls in place.

Primary art schools, language schools and school facilities, that were not part of schools were not included in aid provided by Minedu but could use the energy grant for public administration through the Ministry of Economy (Economy, 2025).

Table 1. Overview of funding requested and provided under each type of financial support for 2023 by evaluation rounds

Financial support	1st round	2nd round	3rd round	4th round	5th round	6th round	7th round	8th round
	Funds requested (€)	Funds requested (€)	Funds requested (€)	Funds requested (€)	Funds requested (€)	Funds requested (€)	Funds requested (€)	Funds requested (€)
	Funds provided (€)	Funds provided (€)	Funds provided (€)	Funds provided (€)	Funds provided (€)	Funds provided (€)	Funds provided (€)	Funds provided (€)
I.	4 635 696	2 675 554	1 624 834	499 413	1 630 467	1 066 775	-	-
	1 693 345	998 864	1 033 333	336 556	735 295	711 445	-	-
II.	3 381 964	18 489 448	21 433 977	12 610 803	11 854 459	7 771 575	21 011 305	543 415
	1 177 555	8 683 647	12 391 683	7 188 329	7 255 626	5 045 820	20 816 751	450 660
III.	96 186	76 382	98 555	60 937	57 688	46 590	98 877	-
	60 769	56 731	83 185	57 531	51 520	42 788	76 361	-
IV.	186 052	121 865	150 890	73 487	130 044	227 994	-	-
	79 216	74 419	52 195	48 686	59 247	164 472	-	-
V.	3 108 814	53 682	-	-	-	-	-	-
	923 012	20 000	-	-	-	-	-	-
∑	11 408 712	21 416 931	23 308 256	13 244 640	13 672 658	9 112 934	21 110 182	543 415
	3 933 897	9 833 661	13 560 396	7 631 102	8 101 688	5 964 525	20 893 112	450 660
%	34	46	58	58	59	65	99	83

Source: own processing based on data from Minedu (2023a, 2023b, 2023c, 2023d, 2023e)

Table 1 summarises the requested and provided funding under the five types of financial assistance for each of the 2023 evaluation rounds. The types of financial assistance are indicated by the Roman numerals I to V, where:

I. The 2022 arrears reimbursement,
II. Full financial aid,
III. Financial aid for kindergartens with legal personality,
IV. Financing of increased rents in 2023 due to the increase in energy prices,
V. Conciliation procedure - cost of operating the school pools.

The data shows that when the first rounds of financial aid were launched, the application error rate from schools was relatively high. This may have been due to both random errors in filling in the applications, but also to the limited knowledge of the issues and the methodology that schools had to learn in a short time. The situation is very much reminiscent of the pandemic crisis, when schools and educational facilities had to adapt to the new administration and crisis measures.

However, a positive trend can be observed in subsequent rounds - an increase in the success (approval) rate of requests, which may be due either to a gradual improvement in the quality of the applications submitted or to a change in the evaluation and approval methodology.

While in Round 1 the approval rate was only 34%, in the following rounds (especially in Rounds 6 and 7) this rate increased up to 65% and 99% respectively.

This increase may be the result of better information to schools, the introduction of supportive guidelines, but also of formal adjustments in the evaluation processes. At the same time, it should be taken into account that over time there may have been a slight reduction in the control mechanisms, or administratively simpler and faster approval of applications - especially in rounds where there was increased pressure to distribute funds quickly.

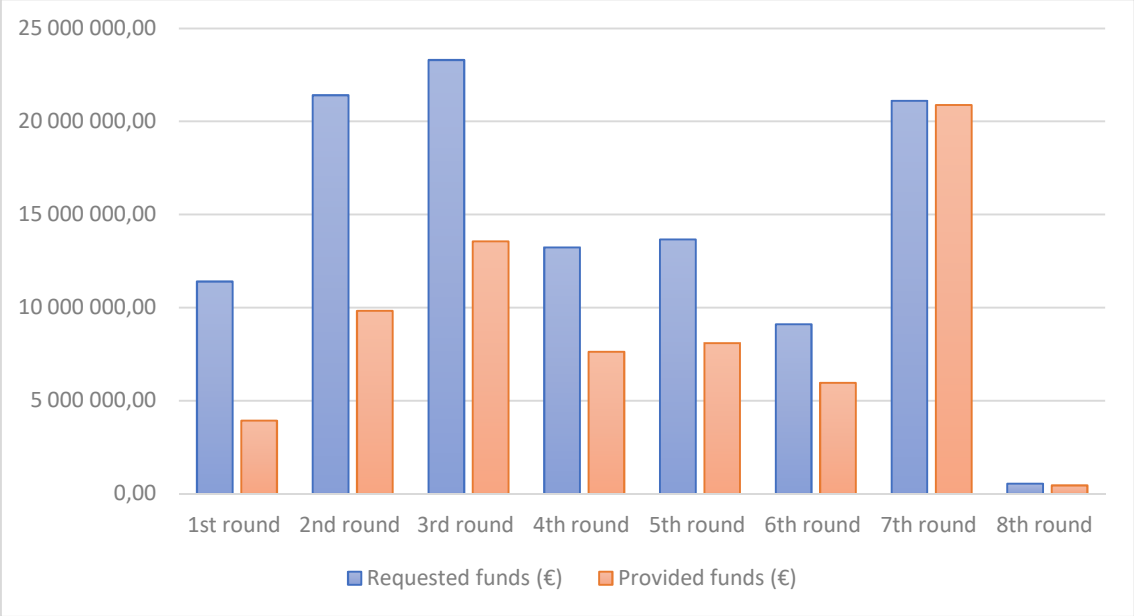

Figure 1. Graphical interpretation of requested and provided financial aid funds by evaluation rounds
Source: own processing based on data from Minedu (2023a, 2023b, 2023c, 2023d, 2023e)

Figure 1 graphically shows the data on the requested and provided funds within the 8th evaluation rounds. The 7th round of evaluation is particularly significant, in which up to 99% of the required funds were provided as part of the financial aid. This result may indicate the high quality of the submitted applications, but also the emphasis on formal approval without a more rigorous substantive or in-depth check, which was typical of earlier rounds. In the 8th round, there was a significant decrease in the volume of requests, which may be related to the previous round, where needed funds requested by schools were provided and therefore the interest in aid decreased rapidly.

It should be noted that Table 1 and Figure 1 do not include the advance payment for 2024 of almost EUR 16.8 million, which was provided separately to schools and educational facilities at the end of 2023 outside the above types of financial support (Minedu, 2024a and Minedu, 2024b).

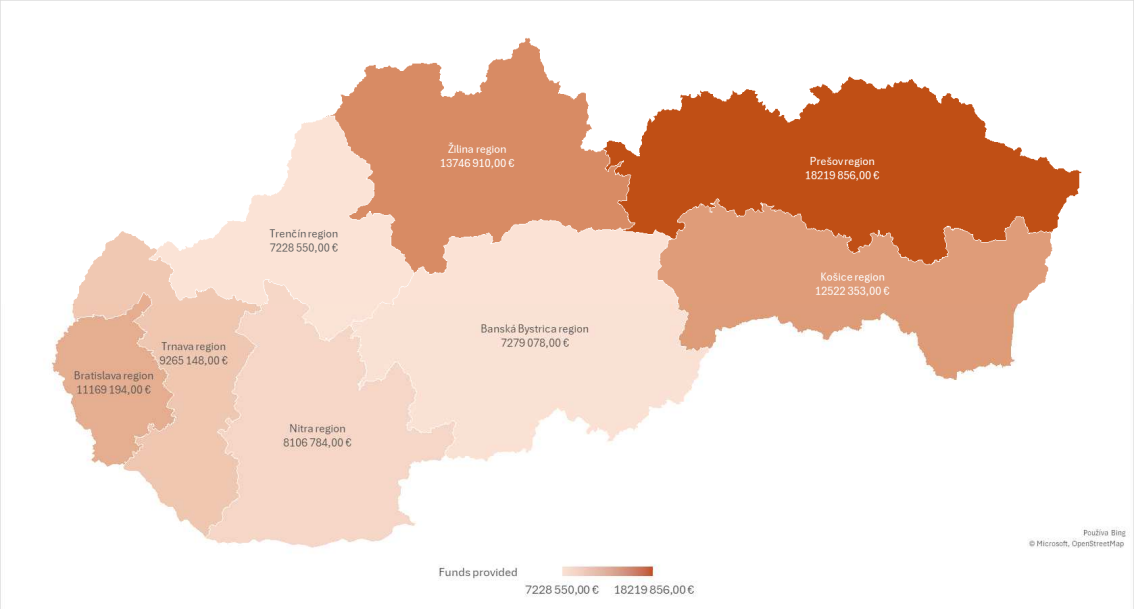

Figure 2. Funds provided to schools in regions in Slovak Republic in 2023 as part of aid to overcome the energy crisis
Source: own processing based on data from Minedu (2023a, 2023b, 2023c, 2023d, 2023e)

The data in Figure 2 show regional differences in the volume of provided funds, with the highest amount in 2023 being allocated in the Prešov Region (€18.2 million), followed by the Košice and Žilina Regions. On the contrary, the lowest volumes of aid were provided in the western part of the Slovak Republic.

Higher amounts allocated in more northern and climatically colder regions, such as the Prešov or Žilina regions, may be related to the higher energy demand of running schools during the winter months, as well as to the larger area and number of schools. These factors naturally increase the need for additional financing of costs associated with heating, energy and the operation of school facilities.

Despite the complexity of the situation and different conditions, it can be generally assessed that the Minedu approached the solution to the energy crisis in the school environment in a comprehensive and systemic manner, with an effort to cover the diverse needs of schools and school facilities across regions.

4. Discussion

The situation in Slovakia in 2023, when Minedu established the mechanism of financial aid to compensate for increased energy costs of schools, represents a practical example of a state intervention policy responding to the energy crisis. This system allows schools financed from the state budget and special school facilities to apply for additional financing of increased costs of electricity and natural gas above the capped price, with the financing supported by the Ministry of Economy of the Slovak Republic (80% of eligible costs) and the Ministry of Finance of the Slovak Republic (20% of eligible costs).

Similar state mechanisms are considered in the literature to be essential for ensuring the financial stability of educational institutions during energy crises, as rising energy prices can significantly threaten their operation and the quality of education provided (Paone and Bacher, 2018; Pinnington, 2025; Delardas and Giannos, 2022; Bertone et al., 2018). Efficient financing, which reflects the real amount of energy consumed and the year-on-year price increase, is in line with the recommendations of experts who emphasize the need for transparent and flexible financial instruments for public institutions (Anglum, Shores and Steinberg, 2021; Sweatman and Managan, 2010; Alam et al., 2019).

In the Slovak model, the “Conciliation Procedure” is also an important element, which ensures control and fair allocation of funds, thereby minimizing the risk of abuse and increasing the efficiency of the use of state resources. Control and transparency are often mentioned in the literature as key factors for successful public finance management, especially in the context of energy crises (Anessi-Pessina et al., 2020; Taylor et al., 2008; Hu, 2019; Jackson, Wigger and Xiong, 2021).

At the same time, it is clear that such short-term financial compensations should be complemented by longer-term investments in the energy efficiency of school buildings, such as modernization of heating systems, insulation, or the introduction of intelligent energy management systems (Chaer et al., 2025; Wang et al., 2022; Benkhalfallah, Kouah and Ammi, 2023), which bring benefits despite high initial costs (Stocker, Tschurtschenthaler and Schrott, 2015). Almasri et al. (2024) and Rosato, A., et al. (2019) also emphasize energy efficiency in the context of sustainable energy sources. These measures not only reduce the dependence of schools on unstable market energy prices, but also contribute to environmental sustainability and reduce operating costs in the long term (Hu; 2019; Xu et al., 2022).

However, a key aspect of the successful implementation of these measures is the need for interdepartmental cooperation. In addition to the Ministry of Education, coordination with the Ministry of Finance and the Ministry of Economy, which ensure financing and regulation of the energy market, is essential. Other departments, such as the Ministry of Environment, the Office for Spatial Planning and Development, and the Ministry of Informatization, Regional Development and Investments, play an important role in supporting the renovation and modernization of school buildings, ensuring environmental standards, and implementing digital solutions for efficient energy management. This comprehensive cooperation will allow schools to have sufficient financial resources not only to compensate for the increased costs, but also to renovate and transform their buildings into energy-efficient objects, thus preventing the liquidation consequences of the energy crisis without state intervention (Garcia and Torres, 2022; Anglum, Shores and Steinberg, 2021).

However, from an implementation perspective, it is also necessary to take into account the administrative burden associated with submitting applications and collecting data, which can be demanding for some schools (Bertone et al., 2018). Therefore, it is appropriate for state authorities to provide clear methodological instructions and support to schools in filling out forms and managing finances, which in the Slovak case is provided by the Minedu through a web platform.

Overall, the Slovak model of financing increased energy costs in schools is a prime example of a coordinated state approach to addressing the energy crisis in the education sector, reflecting the recommendations of international literature on the need for integrated financial and management strategies (Lee, Shores and Williams, 2022; Sulasmi, Prasetia and Rahman, 2023; Bellei and Contreras, 2024; Anglum, Shores and Steinberg, 2021). However, for sustainability, it will be essential to continue supporting energy efficiency while ensuring sufficient financing flexibility in the event of further price shocks.

Conclusion

The Slovak model of financing increased school energy costs in 2023 represents an effective example of state intervention that helped schools overcome the difficult period of the energy crisis. Coordinated cooperation between the Ministry of Education, the Ministry of Economy and the Ministry of Finance ensured a fair and transparent distribution of funds, thereby minimizing the risk of liquidation consequences for the school sector.

At the same time, experience and professional literature emphasize that short-term compensations are not enough. Systematic interdepartmental cooperation is necessary, which, in addition to financial support, also includes strategic investments in the energy efficiency of school buildings. The involvement of the departments of the environment, spatial planning, informatization, regional development and investment will enable a comprehensive approach to renovations and modernizations that will reduce the energy dependence of schools and contribute to their long-term sustainability.

Therefore, it is crucial that state authorities continue to develop integrated financial and management tools that will enable schools not only to cope with current challenges, but also to prepare for future energy shocks. Such an approach will ensure the stability and quality of education, while contributing to the environmental responsibility and economic efficiency of the school sector in Slovakia.

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The Impact of Working From Home on the Motivation of Technical and Economic Workers in the Nový Jičín District: Barriers, Motivation and Impacts on Work-life Balance

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Abstract

Research background: The COVID-19 pandemic accelerated the adoption of remote work across various sectors, raising questions about its impact on employee motivation, productivity, and work-life balance. In the Nový Jičín district, a predominantly industrial region in the Czech Republic, technical and economic workers represent a specific group whose experiences with home office arrangements remain underexplored.
Purpose of the article: This article analyzes the impact of working from home on the motivation of technical and economic workers in Nový Jičín, identifying key barriers, motivational factors, and consequences for work-life balance. The study aims to inform human resource management practices and optimize remote work conditions in industrial regions.
Methods: A mixed-methods approach was employed, combining quantitative data from a structured questionnaire (n = 151) with qualitative insights from semi-structured interviews (n = 4). The questionnaire included closed, open, and scaled questions on remote work experiences, motivation, and working conditions. Data analysis was conducted using MS Excel.
Findings & Value added: The main barriers to remote work were technical issues, disrupted communication, and poor home office equipment. Motivation was higher in the office, driven by direct communication and efficient problem-solving. While remote work offered time and cost savings and flexible scheduling, it also brought difficulties in maintaining discipline and separating work from personal life, especially for women. Most respondents reported no major changes in physical or mental health, though some noted improvements from less commuting. These findings offer insights for HR professionals aiming to balance productivity, motivation, and well-being in remote work, especially in industrial regions.

Keywords: Remote work, Employee motivation, Work-life balance, Technical and economic workers, Industrial region

JEL classification: J24, M54, J81, O15

1. Introduction

Theoretical literature on remote work highlights a number of advantages, chief among them being flexibility in organizing working hours, savings in time and commuting costs, the possibility of better reconciliation of work and family responsibilities, and reduced stress from the work environment (Allen et al., 2015; Eurofound, 2020). On the other hand, a range of disadvantages is frequently cited, such as social isolation, disruption of team collaboration, difficulty in separating work from private life, the risk of declining work discipline, and increased demands on self-management (Felstead & Henseke, 2017; Oakman et al., 2020). These aspects are particularly significant in industrially oriented regions, where there is traditionally an emphasis on workplace presence and teamwork.

Employee motivation is a key factor influencing work performance, satisfaction, and long-term loyalty to the organization (Herzberg, 1968; Deci & Ryan, 2000). According to Herzberg's two-factor

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theory of motivation, both motivational factors (e.g., recognition, interesting work, responsibility) and hygiene factors (working conditions, workplace relationships, salary) play an important role. Remote work can affect both types of factors-for instance, by reducing opportunities for direct feedback and social interaction, but also by increasing autonomy and flexibility (Gajendran & Harrison, 2007). Research shows that motivation during remote work is often lower than in the office, which is related to limited communication, more difficult collaboration, and a lower degree of supervision by managers (Vega et al., 2015; Wang et al., 2021).

Work-life balance is currently considered one of the most important aspects of working life (Greenhaus & Allen, 2011). Remote work can improve this balance thanks to greater flexibility, but it can also lead to blurred boundaries between work and private responsibilities, which may cause stress and negatively affect psychological well-being (Allen et al., 2021; Eurofound, 2020). Studies show that women more often face difficulties in separating work and family, especially in households with children (Craig & Churchill, 2021).

The Nový Jičín district is the second smallest district in the Moravian-Silesian Region in terms of population. As of January 1, 2024, it had 151,781 inhabitants, of whom 75,052 were men and 76,729 were women. The average age of men is 41.4 years and of women 44.3 years, making the district one of the youngest in the region (ČSÚ, 2024a). Of the total 122,249 inhabitants over the age of 15, only 19,070 people have a university or higher professional education, with the largest part of the population consisting of people with secondary vocational education without a school-leaving certificate (Regionální informační servis, 2021). The district is known as an industrial-agricultural area with a predominance of mechanical engineering and electrical engineering, focused mainly on automotive manufacturing; the production of rubber and plastic products is also significant (Úřad práce ČR, 2025). The industrial orientation of the region may limit the prevalence of technical and economic employees working from home and influence their experiences with this mode of work.

The aim of this article is to analyze the impact of remote work on the motivation of technical and economic employees in the Nový Jičín district and to identify the main barriers, motivational factors, and effects on work-life balance. The research is based on a combination of quantitative and qualitative methods and brings new insights that may contribute to more effective human resource management and the optimization of conditions for remote work in industrially oriented regions.

2. Methods

The methodological approach of this study is based on a combination of quantitative and qualitative research methods, which enables a comprehensive perspective on the issue under investigation. The main quantitative method employed was a questionnaire survey, aimed at obtaining representative data on the experiences of technical and economic employees with remote work in the Nový Jičín district-specifically, those who currently work remotely or have previous experience with this form of work. Three research questions were formulated:

RQ1: Are technical problems, disruptions in work communication, or inadequate work equipment the most common barriers to remote work in the Nový Jičín district? This question aims to determine whether the main obstacles to remote work are of a technical, communicative, or ergonomic nature.

RQ2: Do changes in work discipline and a decline in productivity constitute differences in work motivation between remote work and office work? This question examines whether and how employees' work motivation changes depending on the work environment, and whether remote work leads to changes in work discipline or productivity.

RQ3: Are disruptions to work-life balance and increased stress among the negative impacts of remote work? This question focuses on whether remote work negatively affects the balance between work and personal life and leads to increased stress among employees.

The questionnaire consisted of closed, open-ended, and scale-based questions, and also included filtering and screening questions to ensure the relevance of responses. Respondents were selected through a combination of purposive and random sampling, with recruitment conducted via social networks, online groups, direct contact with companies, the VŠB-TUO career center, and the snowball method. Due to the distribution method, it is not possible to determine the exact total number of respondents approached. Out of 254 individuals who completed the questionnaire, 151 responses were evaluated as relevant based on established criteria. The data were analyzed using MS Excel, including the use of pivot tables and graphical processing of results.

The qualitative part of the research was conducted through semi-structured interviews with four selected respondents with varying demographic characteristics. The interviews were designed to supplement and deepen the insights gained from the questionnaires and to enable a more detailed understanding of individual experiences, motivation, and perceptions of work-life balance when working from home. The interview results were thematically analyzed and integrated into the overall conclusions of the article.

The entire research process was supported by systematic data collection and analysis, with an emphasis on the validity and reliability of the information obtained. This mixed-methods approach made it possible not only to quantify the main trends but also to capture the subjective aspects and nuances associated with remote work among technical and economic employees in an industrial region.

3. Results

The research on the impact of remote work on the motivation of technical and economic employees in the Nový Jičín district has yielded several noteworthy findings. From the broad dataset, particular attention was paid to comparisons of work motivation between home and office environments, the identification of motivational factors for both settings, and the main barriers encountered. The presented data are closely linked to the research questions but also extend beyond them.

3.1 Comparison of work motivation when working from home and the office

The data presented in Figure 1. reveal surprising findings. Respondents report significantly higher work motivation when working from the office. In this case, the combined categories of high and very high motivation reach 67%. In contrast, these two categories account for only 46% when working from home. Based on these findings, employers could reasonably conclude that it is more effective to have employees physically present at the workplace rather than working remotely.

These results also provide an answer to the question concerning work discipline and productivity decline during remote work. If motivation to work from home is substantially lower, it is reasonable to assume that work discipline is also reduced, which in turn negatively affects productivity.

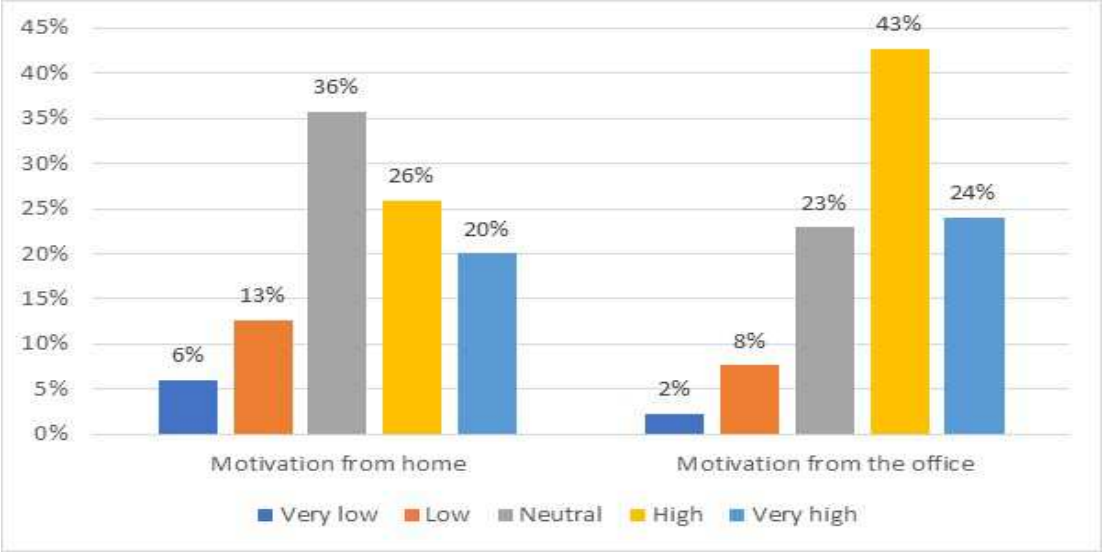

Figure 1. Work motivation from home and the office
Source: Nierostek et al. (2025)

3.2 Motivational factors for working from home

The data presented in Figure 2. to some extent, highlight the personal benefits employees perceive when working from home. The most valued advantage is the saving of time and commuting costs, with 31% of respondents of both genders identifying this as a key benefit. In second place, respondents appreciate the possibility of flexible work scheduling, a factor that is more important for women (28%) than for men (24%).

What lies behind this flexibility? On one hand, it reflects a positive optimization of the employee's work process when working remotely. On the other hand, it entails a degree of freedom that is often associated with lower discipline, which can consequently lead to reduced productivity.

An interesting gender difference emerges in the evaluation of the work environment. Men (23%) more frequently perceive a quiet and comfortable home workspace as a significant benefit compared to women (19%). Regarding stress reduction, both genders agree only at a level of 13%. This suggests that working from home reduces work-related stress only minimally.

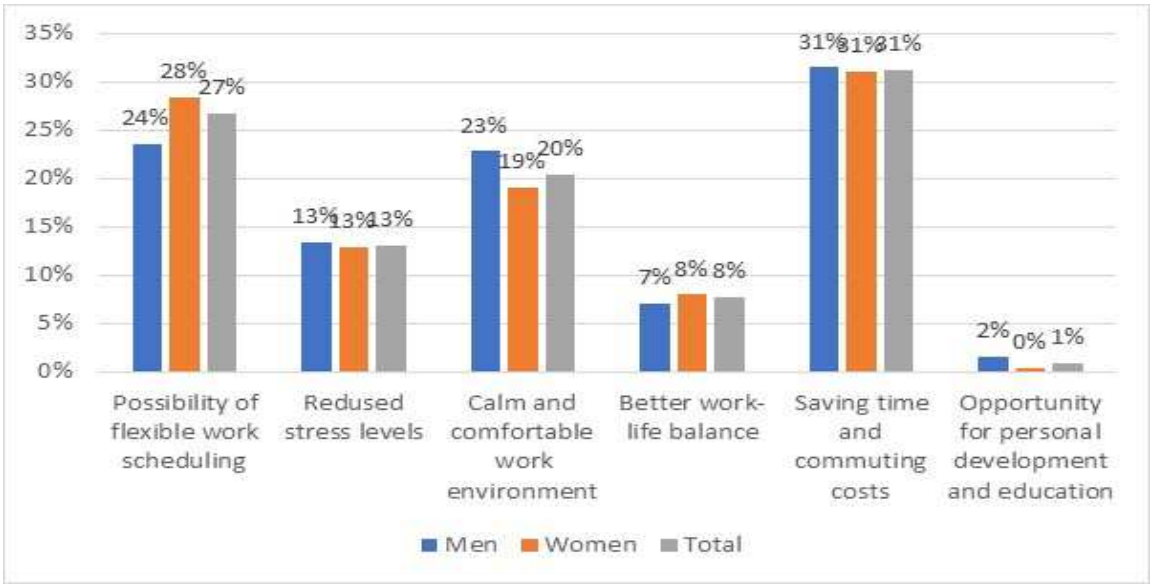

Figure 2. Beneficial factors of working from home
Source: Nierostek et al. (2025)

3.3 **Motivational factors of working from the office**

The most frequently cited positive factor of working from the office was direct communication with colleagues and supervisors (34%), indicating that social interaction with peers and the presence of management are highly important elements influencing employee motivation.

Another significant factor was the faster and more efficient resolution of problems (21%). This finding can be regarded as an established fact, not only supported by respondents in this particular study. It is evident that this factor enhances work efficiency, and consequently, productivity.

A clearer separation between work and personal life was identified by 17% of respondents as a motivational element of office work, whereas for remote work this figure is only 7% for men and 8% for women. Better work equipment and a more structured workday were noted by the remaining respondents-28%, 15%, and 13%, respectively.

3.4 Obstacles to working from home

The highest-rated obstacles to working from home, as illustrated in Figure 3., are difficulties in separating work and private life (19% of women, 17% of men) and distractions within the household environment (18% of women, 16% of men).

Slightly less problematic are maintaining work discipline (12% of women, 17% of men) and communication with colleagues (12% for both genders). Respondents perceive motivation as the least significant challenge, with 6% of women and 9% of men indicating issues in this area.

Technical equipment problems are reported by 13% of women and 10% of men, while difficulties in work-related communication are noted by 12% of both women and men. Insufficient workspace is generally considered a minor issue, affecting 6% of women and 5% of men.

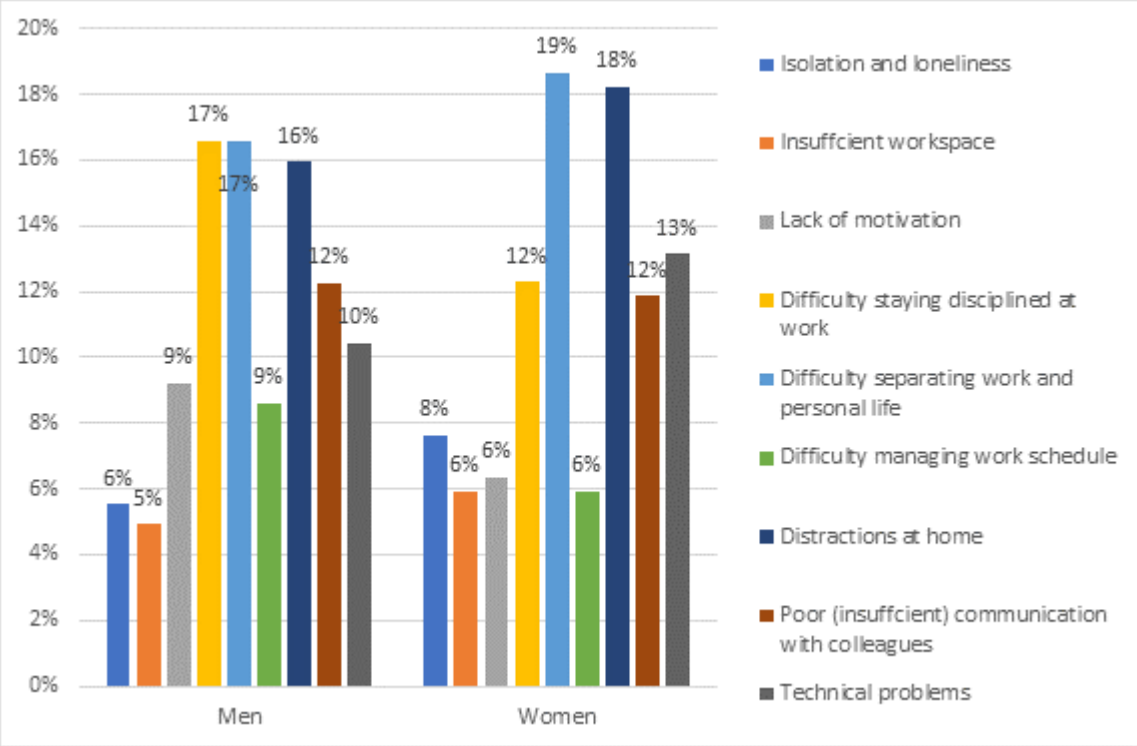

Figure 3. Obstacles to working from home
Source: Nierostek et al. (2025)

3.5 Additional Findings Related to the Research Questions

The data collection yielded a range of interesting findings (some illustrated in Figures 4., 5., and 6., while others are not graphically documented):

In response to the questionnaire item, "How often do you encounter technical problems when working from home?", 60% of respondents indicated that such issues occur only rarely. Only 8% reported experiencing technical difficulties frequently or very frequently.

Another question addressed whether work equipment constitutes one of the most common obstacles to working from home. In this regard, 14% of women and 22% of men rated this factor as rather negative or very negative.

Poor (insufficient) communication with colleagues was identified as the fourth most significant obstacle to working from home. In connection with a series of related questions, 45% of respondents indicated that they miss communication with colleagues.

The statement, "When working from home, my motivation to complete tasks within the planned timeframe often decreases," received strong agreement from 66% of respondents.

Moreover, 34% of respondents acknowledged the assertion, "I have difficulty maintaining work discipline when working from home."

Based on the conducted analysis, it can be concluded that 41% of respondents would prefer a hybrid work environment.

Only 21% of respondents strictly adhere to the working hours set by their employer.

Furthermore, 53% of respondents agree that they manage work-related stress better when working from home than in the office.

The majority of respondents (56%) reported no significant changes in either their physical or mental health while working from home.

However, 15% of participants indicated a deterioration in their mental well-being during remote work.

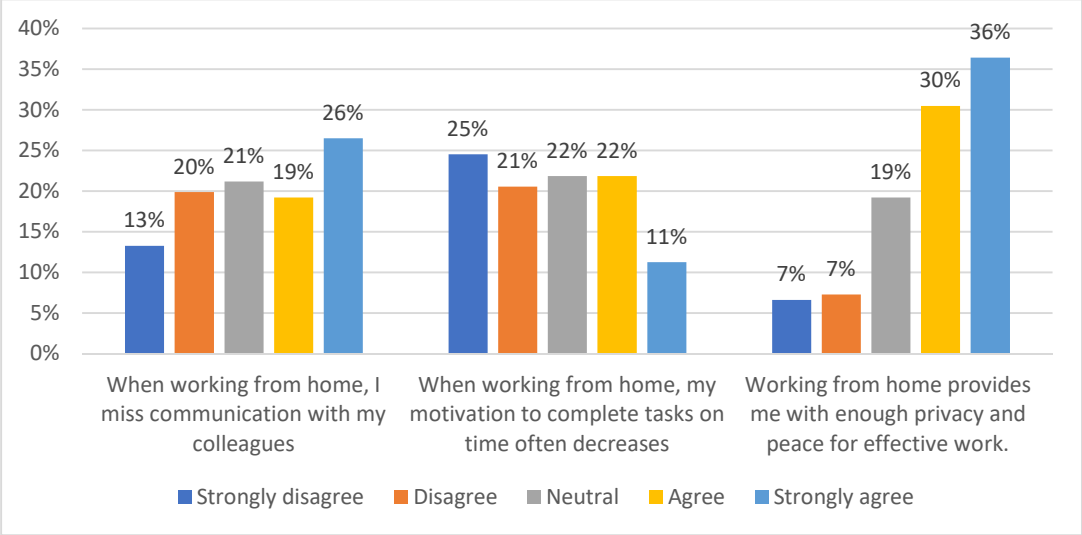

Figure 4. Respondents' attitudes toward the given statements
Source: Nierostek et al. (2025)

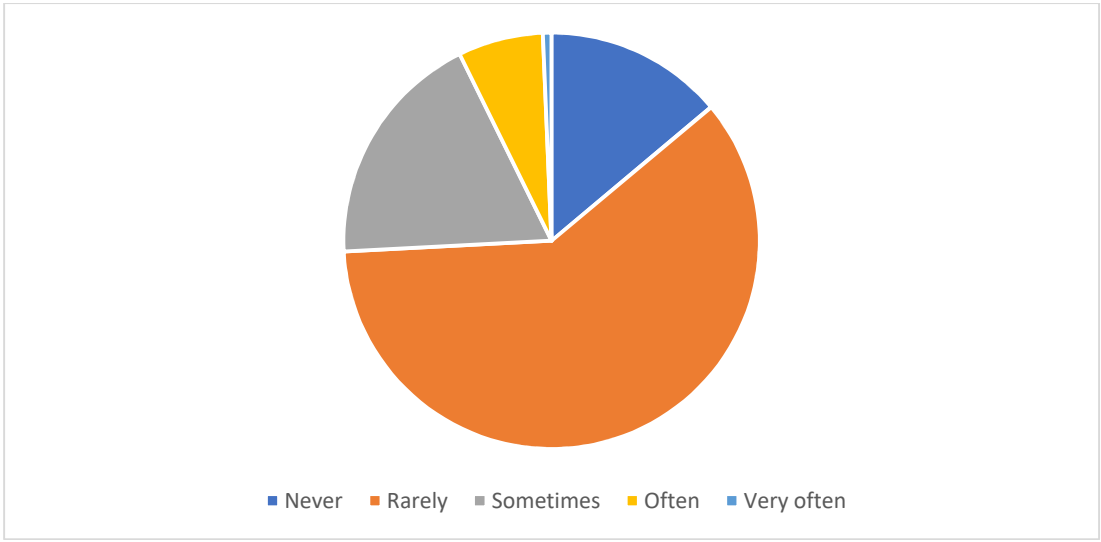

Figure 5. Technical problems when working from home
Source: Nierostek et al. (2025)

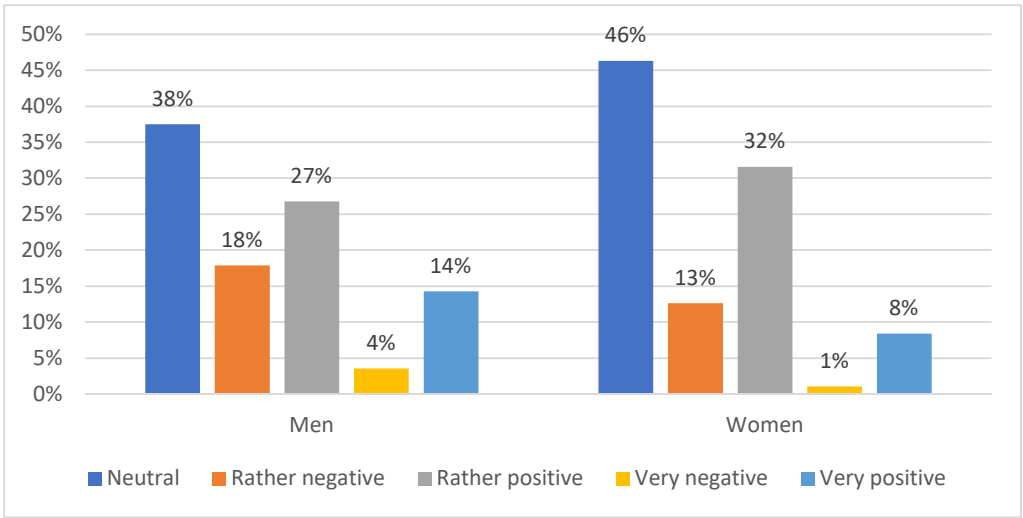

Figure 6. The influence of work equipment when working from home on motivation
Source: Nierostek et al. (2025)

4. Discussion

The research on the impact of working from home on the motivation of technical and administrative employees in the Nový Jičín district has a twofold significance. Firstly, it primarily benefits employers within the district, as well as the broader Ostrava region, which is the most industrialized region in the Czech Republic. Working from home is offered by employers as a benefit, and the research findings confirm that it is indeed a benefi-not only in the sense of its voluntary nature but also, to some extent, in terms of reduced efficiency, motivation to complete tasks, work discipline, contribution, and productivity, all of which have implications for the employer.

When an employer allows remote work, they tend to have employees who are, in many respects, more satisfied, less fatigued, and better able to manage work-related stress. Perhaps even more importantly, these employees experience a sense of partnership and freedom-they know they can work from home. They are not obliged to, but they have the option and are aware of it. This is no longer an exceptional circumstance, as it was in the recent past. The survey revealed that the largest proportion of respondents (41%) prefer a hybrid work model.

The benefit of this research for the respondents themselves lies mainly in the fact that they were prompted to engage in deeper reflection on the topic and the content of working from home, including broader contexts. While completing the questionnaire, respondents could better recognize the advantages and obstacles of remote work. The same applies to the semi-structured interviews.

This article offers many interesting and inspiring findings. It indicates the need to continue seeking more detailed answers as to why these phenomena occur, considering not only gender differences but also perspectives across different generations, among other factors.

One of the most significant and somewhat surprising findings is that employees report a much higher level of motivation when working in the office (67%) compared to working from home (46%).

The research posed three primary questions. Research Question V1 asked: Are technical problems, disruptions in work communication, or inadequate work equipment the most common obstacles to working from home in the Nový Jičín district? The answer regarding technical problems is found in Figure 3., where technical issues affect 10% of men and 13% of women. Figure 5., which focuses solely on the frequency of technical problems, shows that 74% of respondents encountered such problems rarely or not at all. The importance of disrupted work communication as an obstacle is evident from Figure 4., where 45% of respondents reported missing communication with colleagues. Inadequate work equipment, as shown in Figure 6., is perceived by 22% of men and 14% of women as a hindrance to working from home. The conclusion is that technical problems do not constitute the most frequent obstacle to remote work. Disruption of work communication is a crucial issue, and inadequate work equipment should be regarded as a significant obstacle, particularly relevant for certain professions.

Research Question V2 asked: Do differences in work motivation between working from home and working in the office include changes in work discipline and a decline in productivity? Partially, this question is addressed by data from Figure 1., which shows that motivation is significantly higher in the office (67%) than at home (46%). These data suggest a visible change in discipline and, to some extent, a decline in productivity. The statement "When working from home, my motivation to complete tasks within the planned timeframe often decreases," as shown in Figure 4., was agreed upon by 66% of respondents. This high proportion may indicate that most employees face motivational challenges when working remotely, which in turn reflects lower work discipline and subsequent productivity decline. Only 21% of respondents admitted to strictly adhering to working hours. Semi-structured interviews did not yield a clear consensus, with both positive and negative responses. One illustrative response came from a 30-year-old male who expressed dissatisfaction with both environments: in the office, he is often disturbed by colleagues, while at home he is contacted due to insufficient information or newly arising problems. Overall, the data suggest that significant differences between working from home and working in the office include changes in work discipline and productivity decline.

Research Question V3 asked: Are disruptions in work-life balance and increased stress among the negative impacts of working from home? Regarding work-life balance and its negative effects, Figure 3. clearly shows that difficulties separating work and private time rank among the highest impacts for both men (17%) and women (19%). Related to this, and to the question of increased stress while working from home, Figure 3. also shows challenges in planning work time (men 9%, women 6%) and distractions within the household (men 16%, women 18%), which significantly influence stress levels.

Most research questions were addressed through multiple questionnaire items, providing comprehensive insights.

Conclusion

The aim of this article is to analyze the impact of working from home on the motivation of technical and administrative employees in the Nový Jičín district and to identify the main barriers, motivational factors, and effects on work-life balance.

The article is based on a combination of quantitative and qualitative research methods, which allowed for a comprehensive perspective on the investigated issue. The primary quantitative method was a questionnaire survey designed to obtain representative data on the experiences of technical and administrative workers with remote work in the Nový Jičín district. Research of this nature is among the first of its kind in the Czech Republic.

The questionnaire consisted of closed, open-ended, and scaled questions and also included filtering and screening questions to ensure the relevance of responses. Respondents were selected through a combination of purposive and random sampling, with outreach conducted via social media, online groups, direct contact with companies, the career center of VŠB-TUO, and a snowball sampling method. Due to the distribution method used, the exact total number of contacted respondents cannot be precisely determined. Out of 254 individuals who completed the questionnaire, 151 responses were deemed relevant based on established criteria. The data were analyzed using MS Excel, including the use of pivot tables and graphical presentation of results.

The qualitative part of the research was conducted through semi-structured interviews with four selected respondents representing diverse demographic characteristics. These interviews were designed to complement and deepen the insights obtained from the questionnaires and to allow for a more detailed understanding of individual experiences, motivation, and perceptions of work-life balance when working from home. The interview results were thematically analyzed and integrated into the overall conclusions of the article.

The entire research process was supported by systematic data collection and analysis, with an emphasis on the validity and reliability of the information obtained. This mixed-methods approach enabled not only the quantification of major trends but also the capture of subjective aspects and nuances associated with working from home among technical and administrative employees in an industrial region.

The authors successfully answered all the established research questions.

A limitation of the article is its focus solely on the Nový Jičín district and the relatively small number of respondents. This was a rapid and timely data collection intended to reflect the current situation in a smaller area, which naturally involved a smaller sample size. For greater data validity, it is necessary to continue increasing the number of respondents and to expand the data collection perimeter. This research is suitable for bachelor's, master's, and doctoral theses.

Further research opportunities include focusing on specific work sectors, professions, and related employee performance.

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Deciphering Small Business Performance through Entrepreneurial Resilience: Empirical Findings from Sub-Saharan Africa

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Abstract

Research background: Small and medium-sized firms (SMEs) are seen as crucial to economic growth; despite their limited scale, they have substantially contributed to the advancement of major global economies. Due to their significant contributions, SMEs are considered the cornerstone of the Nigerian economy and indeed in Africa. Notwithstanding several initiatives and ongoing efforts by the Nigerian government in the business sector to assist SMEs in Nigeria, are yet to materialized, figures indicate that 70% of SMEs fail during their initial five years of operations, and large number of these enterprise lack entrepreneurial resilience.

Purpose of the article: Do small-business owners' entrepreneurial resilience enable them to swiftly recover from challenges and achieve performance? Is their entrepreneurial resilience heightened when they find the business environment as hostile? The objective of this work is to address this question. Therefore this study aimed to assess the impact of entrepreneurial resilience attributes on the business performance of selected small and medium-sized enterprises in Lagos State, Nigeria. An important market in Africa due to its large economy and population. This study contributes to addressing this research gap of entrepreneurial resilience in small businesses in sub-Saharan Africa.

Methods: The population consists of Small and Medium Scale Enterprises (SMEs) registered with the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) and operating in Lagos State. The target population was 4,535 small businesses in Lagos State. A sample size formula was used to select a sample size of 389 owner-managers. 389 copies of the questionnaire were properly filled out and returned through computer-assisted means (Google form).

Findings & Value added: The statistics indicate that entrepreneurial resilience traits substantially enhance performance. Risk-taking, innovativeness, and proactivity each yield significant advantages in profitability, competitive edge, and customer happiness, respectively. The research indicates that entrepreneurs must internalise and develop these resilience traits to enhance the success of their enterprises.

Keywords: Business performance, Entrepreneurial characteristics, Innovativeness, Pro-activeness, Risk-taking, SMEs

JEL Classification: JEL M10, M31, L25, O44

1. Introduction

As major corporations increasingly prioritise core competencies and implement extensive layoffs, the economic significance of Small and Medium Enterprises (SMEs) and entrepreneurship has markedly increased in recent decades (Van, 2005). Olubiyi (2024a) asserts that small and medium-sized enterprises (SMEs) have emerged as significant catalysts for economic growth and development in the rapidly evolving and competitive global economy. A strategy to sustain small and medium-sized firms (SMEs) is to enhance and fortify their entrepreneurial traits (Taneja, et al.,2025; Rahadhini & Lamidi, 2023). Entrepreneurial resilience (ER) is essential for business performance, especially during unpredictable periods (Shepherd et al., 2020). ER signifies a business's ability to surmount obstacles and adapt to

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unforeseen circumstances while upholding fundamental beliefs and modifying tactics to align with evolving market conditions, crucial for sustained success (Hillmann & Guenther, 2021). While the notion of ER has garnered interest in scholarly discourse (Salvato et al., 2020; Khurana et al., 2022), there is a need for more emphasis on small business performance and competencies with ER (Isensee et al., 2023; McElheran et al., 2024).

Numerous academics have recognised and demonstrated the vital significance of SMEs as a catalyst for development, job creation, competitiveness in global markets, and the general health and welfare of national and international economies (Elshaer, & Saad, 2022; Aremu & Lawal, 2012; Olubiyi 2024a; Olubiyi 2024b). Ogbuanu, Kabuoh, and Okwu (2014) assert that SMEs are fundamental to the Nigerian economy due to their significant contributions. The 2012 Enterprise Baseline Survey indicated that SMEs in Nigeria employed more than 32,414,884 individuals (SMEDAN, 2013). Approximately 58% of the global workforce can create job opportunities (Abor & Quartey, 2010). They also provide exceptional prospects for technological advancement, especially in companies with fundamental technology needs. Given the significance of entrepreneurial activity and SMEs to economic prosperity, it is essential to examine how small firms and entrepreneurs may enhance their performance and ensure their sustainability in an unstable economic environment. To navigate challenging situations, organisations may require certain talents, internal resources, or entrepreneurial characteristics such as creativity, adaptability, or flexibility (Ogbuanu, Kabuoh, & Okwu, 2014). The success of small and medium-sized enterprises is evaluated based on sales volume, profitability, return on capital, turnover rate, and market share acquired (Ahmad, Ramayah, Wilson, & Kummerow, 2010). Every small and medium-sized enterprise worldwide seeks sustainable competitive advantage and performance through entrepreneurial traits and behaviours that facilitate goal attainment (Taneja, et al.,2025; Fatoki, 2014). The Global Entrepreneurship Monitor Report (2015) indicates that the manner in which entrepreneurs demonstrate their attributes in everyday business interactions constitutes about 70% of a nation's economic prosperity and overall well-being. Ogundele, Olajide, and Ashamu (2008) assert that attributes of entrepreneurial resilience are essential for a nation's economic advancement. The impact of entrepreneurial resilience qualities has been examined by several researchers (Salamzadeh, Farjadian, Amirabadi, & Modarresi, 2014). As a result, the purpose of this study is to address the lack of knowledge by examining the impact of entrepreneurial resilience traits, such as risk-taking initiative, innovativeness, and proactiveness, on business performance, measured by profitability, competitive advantage, and customer growth.

2. Literature review

Entrepreneurial Resilience traits

Entrepreneurial resilience (ER) is essential for business performance, especially during unpredictable periods (Shepherd et al., 2020). ER signifies a business's ability to surmount obstacles and adapt to unforeseen circumstances while upholding fundamental beliefs and modifying tactics to align with evolving market conditions, crucial for sustained success (Hillmann & Guenther, 2021). While the notion of ER has garnered interest in scholarly discourse (Salvato et al., 2020; Khurana et al., 2022), there is a need for more emphasis on small business performance and competencies with ER (Isensee et al., 2023; McElheran et al., 2024). Numerous investigations have delineated the concept of entrepreneurial resilience capabilities in diverse ways. The several definitions provided cover a broad spectrum of dimensions and facets, from establishing a business to utilising entrepreneurial abilities and competences in virtually any context (Henry, Hills, & Leitch, 2013). Entrepreneurial resilience traits are generally regarded as a multidimensional construct at the organisational or entrepreneurial level, characterising the entrepreneurial behaviour of the entrepreneur or firm. This construct encompasses one or more of the following three dimensions: risk-taking, innovativeness, and proactivity (Njeru, 2013). An entrepreneurial feature is defined by the personal traits and abilities of the entrepreneur that contribute to their success (Abdulwahab & Al-Daman, 2015). Entrepreneurial resilience features emphasise the concrete, theoretical behaviours of individuals operating as solo entrepreneurs or within a team during the startup or initial phases of organisational development, often within the first six to seven years (Bird, 2012). It manifests as an independent entity comprising discrete activities that spectators may observe (Fisher, 2012).

Risk-Taking Initiative

Entrepreneurs must intentionally allocate resources to opportunities with varying probabilities of success or failure and be prepared to commit substantial resources to uncertain prospects (Baker &

Sinkula, 2009). Risk-taking necessitates a readiness to pursue opportunities that carry a significant likelihood of yielding losses or substantial performance variations (Morris, Kuratko, & Covin, 2008). Risk-taking is frequently associated with entrepreneurship, as the foundational definition of entrepreneurship encompasses the concept of personal risk-taking (Lumpkin & Dess, 2012). Risk-taking at the organisational level denotes the inclination to endorse initiatives with uncertain anticipated returns (Walter, Auer, & Ritter, 2006). According to Dess and Lumpkin (2010), organisations and their leaders face three categories of risks: business risk, financial risk, and personal risk. Longenecker (2006) categorises individuals as risk takers, risk minimisers, and uncertainty tolerators. They can also manage the stress of operating in such an environment, so enhancing their prospects for survival and success (Cunningham & Gorman, 2011). Rotter (2009) posits that individuals with a pronounced internal locus of control achieve their objectives through their own actions or unique resilience characteristics.

Innovativeness

Innovativeness is described as the ability to utilise natural resources to enhance productivity (Ogbuabu, Kabouh, & Okwu, 2014). It may also be described as the emergence or adoption of an innovative concept or practice within the organisation (Holland, 1997). Entrepreneurs leverage innovation to capitalise on change for the attainment of diverse companies or services (Mirela, 2008), and it is also a crucial element for a firm's survival, growth, and commercial success (Utterback, 2011). Innovation is an essential element of entrepreneurial mindset and a significant method for exploring opportunities (Lumpkin & Dess, 2012). Innovativeness has been recognised as the only constant theme in the literature on entrepreneurship. It is a fundamental element of any corporate strategy (Deakins & Freel, 2012).

Pro -activeness

Proactiveness is defined as the ability to take initiative, recognise and execute new business opportunities, and develop new markets (Auer & Ritter, 2006). Proactivity is characterised by the pursuit of possibilities or foresight (Lumpkin & Dess, 2012). Proactiveness is described as pioneering behaviour that entails taking the initiative to investigate opportunities (Lumpkin & Dess, 2008). Proactive individuals believe they can influence their environment (Li, Liang, & Crant, 2010). Individuals of this kind often assume the initiative to shape their environment instead of passively observing and reacting to surrounding occurrences (Bateman & Crant, 1993).

Business Performance

Assessing performance in enterprises is a significant challenge for scholars, policymakers, and real business proprietors/managers. Small enterprises frequently represent entrepreneurial ventures driven by the owner's objectives (Taneja, et al.,2025; Edmunds, 2012). Micro and small enterprises have significant challenges for survival, resulting in elevated failure rates. Business performance is defined as the efficiency of organisational management and the value delivered to consumers and other stakeholders (Wu, 2009). Owolabi and Makinde (2012) assert that an organization's commercial performance may be evaluated by minimising its environmental effect, enhancing employee health and safety, and augmenting consumer satisfaction. Adeoye and Elegunde (2012) defined business performance as the evaluation of how managers utilise organisational resources effectively and efficiently to attain objectives and fulfil stakeholder expectations. Business performance is characterised by the comparison of actual production to anticipated output and is classified into three categories: financial business performance, product market business performance, and shareholder return (Adeoye & Elegunde, 2012).

Profitability

The terms 'profit' and 'profitability' are occasionally utilised synonymously. Nonetheless, a contrast exists between the two concepts. Profit is an absolute notion, but profitability is a relative one (Olubiyi, 2024c; Tulsian, 2014). Profitability is an essential metric for assessing efficiency; yet, it cannot only be relied upon to ascertain efficiency. Profitability denotes an organization's ability to generate profit from its commercial activities. It illustrates how management may successfully leverage all available market resources for gain. Profitability, as defined by Harward and Upton (2014), is "the capacity of a specific investment to generate a return from its utilisation."

Competitive Advantage

Competitive advantage is characterised as a situation where issues arise in the reaJlm of competitive tactics, leading to several disagreements on its definition. Consequently, providing a concise description of competitive advantage is difficult (Rumelt, 2013). Competitive advantage refers to a corporation's ability to surpass its competition and achieve performance significantly above expectations (Peteraf, 2010). In the domainJ of competitive strategy and value creation, the predominant definition of competitive advantage is any factor that leads to revenue growth exceeding expenses (Rumelt, 2013). Besanko (2010) asserts that a firm possesses a competitive advantage if it generates an economic profit exceeding the market average. Hakkak and Ghodsi (2015) assert that competitive advantage fundamentally signifies a business's ability to produce goods or services that customers see as more valuable than those provided by competitors. Competitive advantage is now predicated not on tangible assets and capital, but on the efficient utiJlisation of intellectual capital and the customer's capacity to distinguish a company's product from its competitors (Antoncic & Hisrich, 2004; Reguia, 2014). Conversely, Esen & Uyar (2012) characterised competitive advantage as a strategy for establishing barriers that hinder competitors from replicating the organization's sources of strength.

Customer growth

Customer satisfaction is perceived as the response resulting from an evaluative process, since consumers must assess the gratification derived from a product or service (Al-Msallam, 2015). This is seen as an essential element of the organization's strategy, focussing on how a product or service fulfils or surpasses consumer expectations (Majida, Mohamadb, Zawawi, & Jamaluddin, 2017). Irfan (2014) posits that satisfaction is a reaction from a consumer who has attained fulfilment. Notwithstanding extensive research on customer happiness, a consensus on definitions remains elusive. 2010 (Cardozo). Halstead, Hartman, and Schmidt (2010) characterised customer growth as a transaction-specific emotional response resulting from the consumer's evaluation of product performance against a pre-purchase standard. Customer growth, as articulated by Mano and Oliver (2013), is an evaluative judgement resembling an attitude that fluctuates along the hedonic continuum post-consumption.

Entrepreneurial Resilience Traits and Business Performance

Researchers have determined that attributes of entrepreneurial resilience contribute to performance (Engelen, Gupta, Strenger & Brettel, 2015; Sarwoko, Surachman, Armanu, & Hadiwidjojo, 2013; Real, Roldan & Leal, 2014; Wijetunge & Pushpakumari, 2010). The examination of entrepreneurial resilience characteristics has garnered attention due to the significance of SMEs in economic advancement, particularly in developing countries. Syed, Muzaffar, and Minaa (2017) documented that attributes of entrepreneurial resilience enhance performance. This discovery is consistent with the results of Makinde and Asikhia (2017) and Quince and Whittaker (2003). Fairoz, Hirobumi, and Tanaka (2010), as well as Matsuno, Zhu, and Rice (2014), indicated a detrimental effect of entrepreneurial resilience attributes on performance. It was determined that attaining performance via entrepreneurial resilience attributes is contingent upon additional variables (Fatoki, 2012). Engaging in risk-taking initiatives results in enhanced performance (Jalali, Jafaar, Talebi & Halim, 2014; Naldi, 2011). Entrepreneurs who embrace risk consistently grow their businesses, and their propensity for risk-taking contributes to both financial and non-financial success (Osman, Ahmad, Rashid & Hussain, 2011). Lim (2010) and Wijetunge & Pushpakumari (2013) identified a favourable although negligible correlation between risk-taking initiatives and performance. Hughes and Morgan (2011) and Kreiser, Marino, Kuratko, and Weaver (2013) identified an inverse correlation between risk-taking and performance. Research indicates a significant correlation between innovativeness and performance (Arisi-Nwugballa, Elom & Enyeizugbe, 2016; Baldwin & Johnson, 2016; Kumarpeli & Semansinghe, 2015; Masona, Floreania, Miania, Baltramea & Cappellettoa, 2015; Ndalira, Ngugi & Chepkulei, 2013; Salavou, 2012).

Theoretical Review

The Discovery Theory

The theory referred to as the individual/opportunity nexus approach, focusses on the identification, discovery, and utilisation of possibilities, together with the influence of entrepreneurs on these

opportunities (Kirzner, 1973; Shane & Venkataraman, 2000; Shane, 2003). The Individual/Opportunity Nexus posits that opportunities are objective, individuals are unique, and entrepreneurs are risk-takers. The individual opportunity nexus elucidates entrepreneurship by analysing the connection between distinct individuals and objective possibilities. This perspective asserts that every price, invention, and piece of information have objective opportunities. Individuals identify and disseminate opportunities, but they do not generate them. This method involves entrepreneurs reconfiguring resources using a novel means-ends framework. Although the success of the opportunity at the time of discovery remains uncertain, the nature of the employed discovery allows for probabilistic anticipation of the outcome. Consequently, from this viewpoint, the entrepreneurial process pertains to risk rather than uncertainty.

Conceptual Model

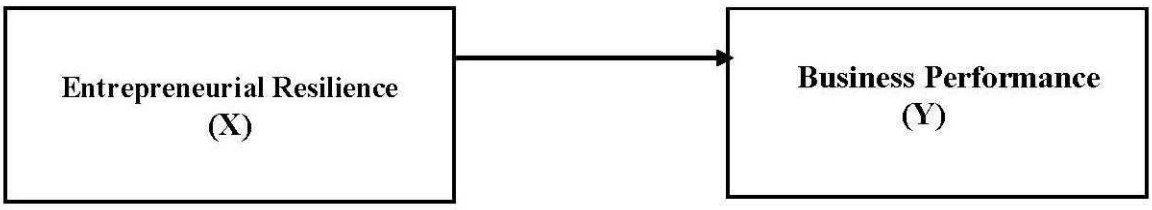

Figure 1. Author's Conceptual Model
Source: author (2025)

The model sheds light on the relationship between Entrepreneurial resilience traits and business performance, which is the research framework.

3. Methodology

This study employed a survey research design. This paper relied on the prior study methodology of Taneja, et al., 2025; Darda, et al., (2025); Olubiyi, (2024b),Adeyemi, and Olubiyi, (2023); Olowoporoku, and Olubiyi, T.O. **(**2023); Olubiyi, Lawal, and Adeoye, (2022). Olubiyi, Lawal, and Adeoye, (2022), Olubiyi, (2022a), and Olubiyi, (2022b). The study's population comprised 2,465 Small and Medium Scale Enterprises registered with SMEDAN and functioning in Lagos State, Nigeria. Small and Medium Enterprises Development Agency of Nigeria (SMEDAN, 2017). The SMEs utilised are those that have been in operation for more than five years. The study's sample size was 395, as estimated using the Krejcie and Morgan sample size table (1970). The study employed a mixed sample strategy, incorporating stratified, proportional, and basic random sampling techniques. The state was partitioned into four divisions: Yewas, Egba, Ijebu, and Remo (Bogunjoko, Hassan, Ogunro, Akanbi & Abudu, 2019).

4. Results and discussion

Data Analysis

389 copies of the questionnaire were properly filled and returned through computer-assisted means (Google form). This represented an overall positive response rate of 98% as presented in Table 1 from a distribution of 395 copies of questionnaire. Bryman and Bell (2011) posit that a response rate of ≥50% is appropriate to analyze the study's findings. A response rate of 98% was deemed to be very good for this study, thus, the researcher proceeded with the data analysis. The detail of the responses is shown in Table 1.

Table 1. Response Rate

Response Rate	Frequency	Percent (%)
Returned and used	389	98
Unreturned	6	2
Total	395	100

Source: Researchers' computation (2025)

Testing Study Hypothesis

To test hypotheses, a linear regression analysis was used to analyze the relationship between the entrepreneurs' resilience traits and business performance among selected small and medium-scale enterprises in Lagos State, Nigeria.

H_{01}: Risk-taking initiative does not significantly affect the profitability of the selected small and medium scale enterprises in Lagos State, Nigeria.

Table 2. Regression Results for Risk-Taking Initiative and Profitability

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.617[a]	0.381	0.379	3.20599
a. Predictors: (Constant), RISKT				

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2210.037	1	2210.037	215.018	0.000[b]
	Residual	3597.438	350	10.278		
	Total	5807.474	351			
a. Dependent Variable: PROFIT						
b. Predictors: (Constant), RISKT						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.124	0.487		12.587	0.000
	RISKT	0.559	0.038	0.617	14.663	0.000
a. Dependent Variable: PROFIT						

Source: Field Survey (2025)

Table 2 indicates that risk-taking significantly enhances profitability, with P = 0.000 (R = 0.617 and P < 0.05). This indicates that risk-taking directly enhances profitability in the SME sector. The model R2 (coefficient of determination is 0.381) indicates that the risk-taking initiative influences SMEs' performance, accounting for 38.1% of the variance in profitability. The F statistic is 215.018, significant at P<0.05, demonstrating that the hypothesis 1 model significantly determines the impact of risk-taking initiatives on profitability. A positive and substantial standardised B coefficient ($\beta = 0.559$, t = 12.587, P<0.05) substantiates this claim. The null hypothesis, asserting that risk-taking does not significantly affect the profitability of the chosen small and medium-sized enterprises in Lagos State, Nigeria, is rejected. Arisi-Nwugballa, Elom, and Enyeizugbe (2016); Baldwin and Johnson (2016); Kumarpeli and Semansinghe (2015); Masona, Floreania, Miania, Baltramea, and Cappellettoa (2015); Ndalira, Ngugi, and Chepkulei (2013); Salavou (2012). Wijetunge and Pushpakumari (2013) also support it. Nonetheless, it contradicts the findings of Hughes and Morgan (2011) as well as those of Kreiser, Marino, Kuratko, and Weaver (2013). The variance in these results may be ascribed to the characteristics of the business environment and other inherent resilience attributes that vary between research contexts. Profitability is contingent upon the owner/manager's propensity to assume risks. Consequently, the flexibility to undertake a new, potentially hazardous project may enhance profitability.

H_{02}: There is no significant effect of innovativeness on the competitive advantage of the selected small and medium-scale enterprises in Lagos State, Nigeria.

Table 3. Regression Results for Innovativeness on Competitive Advantage

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.649[a]	0.421	0.419	3.06968
a. Predictors: (Constant), INNOV				

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2397.728	1	2397.728	254.457	0.000[b]
	Residual	3298.020	350	9.423		
	Total	5695.747	351			
a. Dependent Variable: COMPAD						
b. Predictors: (Constant), INNOV						

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	5.367	0.509		10.538	0.000
	INNOV	0.622	0.039	0.649	15.952	0.000
a. Dependent Variable: COMPAD						

Source: Field Survey (2025)

Interpretation

Table 3 indicates that innovativeness exerts a significant positive effect on competitive advantage, evidenced by a P-value of P = 0.000 (R = 0.649 and P < 0.05). This indicates that in the SME sector, innovativeness directly enhances competitive advantage. The R^2 model, with a coefficient of determination of 0.421, indicates that innovativeness influences SME development, accounting for 42.1% of the variation in competitive advantage. The F statistic is 254.457, significant at P < 0.05, demonstrating that the model for hypothesis 2 effectively identified the impact of innovativeness on competitive advantage. A substantial and noteworthy standardised B coefficient (β = 0.622, t = 10.538, P < 0.05) corroborates this finding. The null hypothesis is rejected, indicating that innovativeness significantly influences the competitive advantage of selected small and medium-sized enterprises in Lagos State, Nigeria. The findings of this study align with the research conducted by Arisi-Nwugballa, Elom, and Enyeizugbe (2016), Baldwin and Johnson (2016), Kumarpeli and Semansinghe (2015), Masona, Floreania, Miania, Baltramea, and Cappellettoa (2015), Ndalira, Ngugi, and Chepkulei (2013), and Salavou (2012). The discovery indicates that when a management or organisation exhibits innovativeness, the company acquires a competitive advantage, since innovativeness fosters competitive superiority.

H_{03}: Proactiveness has no significant influence on the customer growth of the selected small and medium-scale enterprises in Lagos State, Nigeria.

Table 4. Regression Results for Pro-Activeness on Customer growth

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.739[a]	0.546	0.545	2.71679
a. Predictors: (Constant), PROACT				

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3112.413	1	3112.413	421.682	0.000[b]
	Residual	2583.334	350	7.381		
	Total	5695.747	351			
a. Dependent Variable: CUSTGWT						
b. Predictors: (Constant), PROACT						

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.721	0.477		7.798	0.000
	PROACT	-0.739	0.036	0.739	20.535	0.000
a. Dependent Variable: CUSTGWT						

Source: Field Survey (2025)

With a P-value of P = 0.000 (R = 0.739 and P < 0.05), Table 4 indicated that proactiveness exerted a highly significant positive impact on customer growth. This indicates that proactivity directly enhances customer growth in the SME sector. The R^2 model, with a coefficient of determination of 0.546, indicates that proactiveness influences SMEs' performance, accounting for 54.6% of the variance in customer growth. The F statistic is 421.682, significant at P < 0.05, suggesting that the model for hypothesis 3 effectively identified the impact of proactivity on customer growth. A substantial and noteworthy standardised B coefficient (β = 0.739, t = 7.798, P < 0.05) corroborates this finding. The null hypothesis, asserting that proactiveness does not significantly affect customer growth in the chosen small and medium-sized enterprises in Lagos State, Nigeria, is rejected. The conclusion aligns with the study findings of Sturm, Hohenstein, and Hartmann, (2023), Hughes and Morgan (2011), Kusumawardhani (2013), and Muhammad (2014), which indicated that proactiveness significantly influences SME performance, especially with customer growth. The results align with those of Aremu and Lawal (2012), who identified a positive correlation between proactiveness and performance. This indicates that proactive decision-making by an entrepreneur enhances the enterprise's performance. Nigerian business experience indicates that organisations exhibiting robust entrepreneurial proactiveness positively correlate with performance metrics, continually expanding in size and hiring qualified, competent personnel. A proactive corporation may resolve client complaints, fostering customer loyalty and enhancing satisfaction.

Conclusions and recommendations

The study findings indicate that most respondents concurred that attributes of entrepreneurial resilience affect the performance of SMEs. The attributes of entrepreneurial resilience positively influence the success of SMEs, demonstrating a link at a 95% confidence level. The research examined the impact of entrepreneurial resilience qualities on the business performance of selected small and medium-sized enterprises in Lagos State, focusing on sub-variables such as risk-taking initiative, innovativeness, and proactiveness. The study concludes that risk-taking initiatives significantly impacted the profitability of selected small and medium-sized enterprises in Lagos State, Nigeria (β = 0.559, t = 12.587, P < 0.05). Additionally, innovativeness significantly affects the competitive advantage of these enterprises (β = 0.622, t = 10.538, P < 0.05), and proactiveness significantly influences customer growth among the selected small and medium-sized enterprises. Consequently, it is advisable for entrepreneurs to undertake calculated risks to enhance their company's success. In this technologically advanced day, innovation must not be overlooked to remain aligned with reality and provide the necessary product or service to consumers promptly. Ultimately, they must adopt a proactive approach to satisfy client requests. Entrepreneurs must to be motivated to anticipate and actualise novel opportunities, as well as to establish new markets among business environmental challenges, to satisfy existing consumers and entice prospective customers.

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Sports Management in the Dimensions of Managerial Functions

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Abstract

Research background: Sports management emerged as a response to the needs of sports practice and is constantly evolving in line with the demands of modern society. It is a multidisciplinary field that includes elements of management, marketing, communication, economics and sports expertise.
Purpose of the article: The aim of the paper is to highlight the importance and basic structure of sports management, focusing on key management functions such as planning, organizing, leading, motivating and controlling. The paper outlines the requirements for a sports manager – his/her competencies, roles and abilities necessary for effective management of sports teams and organizations. At the same time, it analyses team management and change management in the context of current trends in sports.
Methods: The paper uses a combined research design. In the quantitative part, a questionnaire survey was conducted to determine the level of public interest in sports in the Trenčín region. The qualitative part of the research was conducted in the form of semi-structured interviews with representatives of the Secondary Sports School and the Hockey Academy in Trenčín with the aim of mapping the level of management in sports teams and clubs.
Findings & Value added: The research results show that sports management plays a significant role in supporting and effectively functioning sports organizations. Quantitative analysis showed different levels of public engagement depending on the quality of sports infrastructure and the activity of local governments. Qualitative data revealed different approaches to team management - from an educational-sports model to a professional performance-oriented environment.

Keywords: Sport, Management, Dimensions, Functions, Leading

JEL classification: I20, J50, J58

1. Introduction

The managerial function is a relatively separate but integrated part of the work activity in management, each function has a specific role. By harmonizing the managerial functions with each other, the set goals can be achieved (Anglin et al. 2022). Kilíková and Jakušová (2008) state that in practice there are certain barriers that prevent the successful implementation of managerial functions. These are mainly:

- limited resources - lack of finances, need for quality human resources and others,
- technological limitations,
- attitudes and expectations of others, their willingness to adopt the manager's intentions or willingness to tolerate them,
- and others.

1.1 Management Functions

The application of basic management functions to the process is the basis for successful management of managers. The basic management functions are planning, organizing, leading people, and controlling.

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- **Planning in management**

Jakušová (2017) emphasizes that planning is a basic managerial function that takes up a significant part of the working time of top managers. The key task of planning is the process of formulating goals and determining ways to achieve these goals at the desired level in a given time.

The output of planning is a plan that is effective when the set goals are achieved at appropriate costs. According to the time horizon, we divide plans into:

- operational plans – compiled for a week, month, quarter, etc.,
- budget plans – oriented to a period of one year,
- business plans – mainly prepared for one to two years,
- strategic plans – compiled for three to five years, even for a longer period.

- **Organizing as a management function**

Lednický (2000) writes that the organizing process can be expressed in the form of a chain of requirements known as OSCAR. It consists of:

- O – Objectives,
- S – Specialization,
- C – Coordination,
- A – Authority,
- R – Responsibility.

- **Leading people in modern management**

Leading people is an important managerial function, as the results of the entire team depend on the leadership style (Courtright et al. 2025). Krause and Miller (2020) state that leading people should be understood as a complex work with human resources. Managers acquire the ability to lead people through management education and also based on experience in practice. The classic leadership styles are based on the use of the manager's authority:

- autocratic: he decides himself what and how to do. Kilíková and Jakušová (2008) state that it is not essentially about leading people, but about their mechanical directing.
- rational-empirical: this style assumes management by the individual's own reason. The manager reviews various proposals and strives to apply them in practice.
- democratic: the manager makes decisions only after talking and discussing with others, takes into account the opinions of others.
- participative: it is essentially a compromise between the autocratic and democratic style, the manager requires others to express their opinion and criticize.
- Laissez-faire style: it is essentially a free-hand style, where the manager leaves events to their own devices. There is no order, discipline, or mutual respect.
- power-coercive: it is essentially a top-down method, the manager orders and issues instructions. This style prevents initiative and creativity.
- normative-re-educational: the manager strives to involve everyone in all processes (Jakušová 2017).

Spicer and Alvesson (2024) emphasize that the effectiveness of leadership depends on the situational conditions in which it is carried out. Which leadership style a manager should prefer depends on the characteristics and abilities of the manager, as well as the specific management conditions in a particular organization (Moriarty, 1984).

- **Control in management**

Sedlák (2012) states that controlling is closely related to planning, the essence of control lies in monitoring and evaluating the progress and status of implementation of plans. Without evaluating and controlling the achieved results, it is impossible to assess the effectiveness and success of other management functions, and therefore the work of the manager.

Varmus and Adámik (2023) write that management in sports includes managerial skills and activities in managing a sports organization in achieving goals that are specific to the sports environment.

Management in professional sports is an important element that affects the performance of teams and athletes, the financial sustainability of the organization and the overall success in sports. Sports management can include:

- developing players, coaches and staff,
- increasing revenue through ticket sales and sponsorships,
- improving the fan experience,
- an effective marketing and promotional strategy,
- a sustainable budget,
- implementing strategic plans,
- monitoring performance measures to evaluate success,
- improving community engagement and awareness,
- brand recognition and sports promotion
- risk management and safety,
- and others.

Sports management is a complex, dynamic field that is constantly evolving. Growing competition between sports organizations creates new challenges but also opportunities.

Sports marketing in the digital era plays a significant role, as various social media and mobile platforms have emerged, the internet has spread, and fans have instant access to sports-related content. This includes live broadcasts of matches, as well as exclusive behind-the-scenes footage. This is of great importance for sports marketing and brand building.

An important role in sports management is played by performance management and training processes, as well as the personnel management of athletes.

The specifics of sports management as follows:

- Irrational passions,
- Profit or win,
- Competitive balance,
- Variable quality,
- Anti-competitive behavior,
- Brand loyalty,
- Identification and imitation,
- Blind optimism,
- Technologies,
- Availability.

As for sports management, its development in our country, we cannot precisely define the division of development in Slovakia. We only follow changes in the relationship between state policy and sports towards its financing. We distinguish the following historical periods:

1. period of the Czechoslovak Socialist Republic (1948–1989),
2. period of the Czechoslovak Federative Republic (1990–1992),
3. period of the Slovak Republic (since 1993).

The basic division of sports management is presented by Cimboláková and Melichar (2023) as follows:

o **Management and commerce**

- functions of a managerial nature: planning, organizing, leading people, control,
- other areas such as marketing, accounting, economics, finance, law,
- sport through the eyes of a sports manager,
- spectators: this means entertainment consumption,
- active participation of participants in sports and physical education activities.

1.2 Team management, roles and levels of a manager

In modern management, we encounter various theories of motivation, whether they are:

- theories of need – they examine the knowledge of the causes of motivation,
- theories of the motivation process (Kilíková, Jakušová 2008).

Part of the internal environment of an organization is a team, which is made up of individuals with different characteristics, abilities, skills, etc. A very important aspect is the composition of the team and the relationships and dynamics taking place within it (Mahajan, 1992).

Every concept of teamwork must be built on certain features of teamwork. In the process of team formation, we distinguish the following developmental phases of the team.

Hekelová (2012) describes the main roles of a manager in change as follows:

- executor - changes come to the manager from the outside environment,
- mediator - changes come from the environment to the manager, who moves them forward,
- initiator - the manager himself implements the change, which is aimed at improving the process.

Veber (2003) states that communication forms a significant part of the manager's work activities. The basis of communication as a managerial function is simplicity, clarity, conciseness and initiative of all forms of expression.

We classify sports management as an interdisciplinary science, as it uses methodological procedures from various disciplines:

- economics,
- psychology,
- sociology,
- law,
- management,
- other system sciences.

The role of a manager consists of a complex of many complex tasks, functions, and responsibilities. We list the individual levels of a sports manager:

- Managers at the level of sports activities management (leaders of sports teams, individuals in higher competitions, experts in the preparation of sports events, etc.),
- Managers at the level of sports club management, organization (leaders of sports centers, union secretariat, members of executive sports and physical education unions),
- Managers in the business sector (manufacturing of sports products, fitness managers, marketing agency workers, and others) (Čáslavová 2020).

Management in sports represents the management of all processes associated with sports organizations, teams, events, or athletes.For example:

- planning – it is about setting performance, economic and strategy goals,
- organizing – it is related to creating team structures, managing coaches, athletes, employees,
- leadership – we mean motivating athletes, building team culture,
- control – it is about monitoring performance, finances, training results, competitions and others.

When managing, it is necessary to focus on whether it is about managing:

- the entire sports organization: National Sports Federation,
- a sports event: organizing a marathon,
- an athlete: personal manager of an athlete, skier and others,
- a professional team: football club, hockey club and others.

1.3 Characteristics of a manager in sports

A manager in sports must have many factors:

- communication skills – has knowledge of clear and effective communication (with athletes, media, fans, sponsors, etc.).
- organizational skills – has the ability to plan training, matches, events, manage time and priorities.
- leadership skills – can inspire and motivate athletes, coaches, the rest of the team, has responsibility for leadership and can set goals.
- professional skills – has knowledge of training and competition principles, understands sports processes, rules in sports.
- financial and marketing literacy – can build a club brand, get sponsors, work with a budget, plan income and expenses.

- emotional intelligence – can handle stress and pressure, especially in situations of ongoing matches, tournaments. Has empathy for athletes and colleagues.
- flexibility and adaptability – can deal with a quick response to changes such as player injuries, rule changes and unexpected situations.

The work of a sports manager requires a number of complex and gradual steps, approaches, solutions and is also tied to the specialization itself.

The field of sports is currently demanding on the quality of management functions, on the professionalism of the manager.

A successful manager, write Cimboláková and Melichar (2023), is a person who has excellent knowledge, experience and authority in his/her given area. A successful manager is:

- self-confident, intelligent, initiative-taking,
- has the ability to recognize the abilities of other people,
- knows how to rise above the situation and see it in a broader context (this is a helicopter trait).

2. Methods

In the empirical part, we used a mixed methods research design, which, as Ondrejkovič (2017) states, combines quantitative and qualitative approaches in order to obtain a more comprehensive view of the research issue. The combination of both approaches allowed us not only to capture broader trends in public attitudes, but also to gain a deeper understanding of the management of sports clubs at the institutional level.

The quantitative part of the research was carried out through a questionnaire survey. The aim was to determine the public's interest in sports in the Trenčín region. The questionnaire was anonymous and its aim was to map the attitudes and opinions of the residents of the Trenčín region on the level of sports infrastructure, support for sports activities by the local government, and their expectations in the area of sports development. High-quality infrastructure is the basis for the effective functioning of services, which is also needed by Bočáková and Potočný (2018).

In the qualitative part of the research, we used semi-structured interviews. We conducted these with participants from the Trenčín Secondary Sports School and the Trenčín Hockey Academy. The aim of this phase was to map the level of governance in a sports team/club and to understand the inner workings of these organizations. The interviews focused on areas such as organizational structure, leadership style, planning of the training process, cooperation with parents and the community, as well as the challenges that sports clubs face. The participants' statements allowed us to identify the strengths and weaknesses of the current governance and provided a deeper context for interpreting the quantitative findings.

3. Results

The following section provides an overview of the main results of quantitative and qualitative research, the aim of which was to map the state of sports infrastructure, the perception of support for sports by local governments, and the level of governance in sports organizations. The results provide a valuable insight into the current situation in the Trenčín region from the perspective of both the public and representatives of sports institutions.

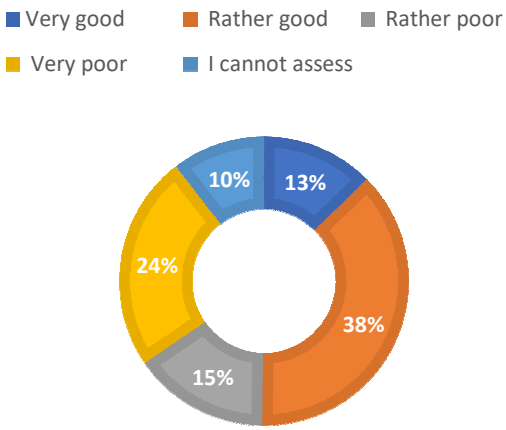

Figure 1. Evaluation of the offer of sports facilities and opportunities for the public in your city (e.g. playgrounds, sports halls, running tracks)
Source: own processing (2025)

Most respondents (39.6%) consider the offer of sports facilities in their city to be rather good, which indicates general satisfaction, but with room for improvement. 25.5% of respondents expressed great dissatisfaction (marked the assessment as very poor), which points to a significant share of residents who perceive a lack or poor quality of sports infrastructure. 15.9% marked the assessment as rather poor, which together with the previous category means that more than 41% of respondents perceive the offer of sports facilities negatively. Only 13.2% of respondents marked the offer as very good, which represents a low share of strongly positive assessments. 10.9% could not comment on the question, which may indicate either a lack of interest in the topic or insufficient information about the options in the city.

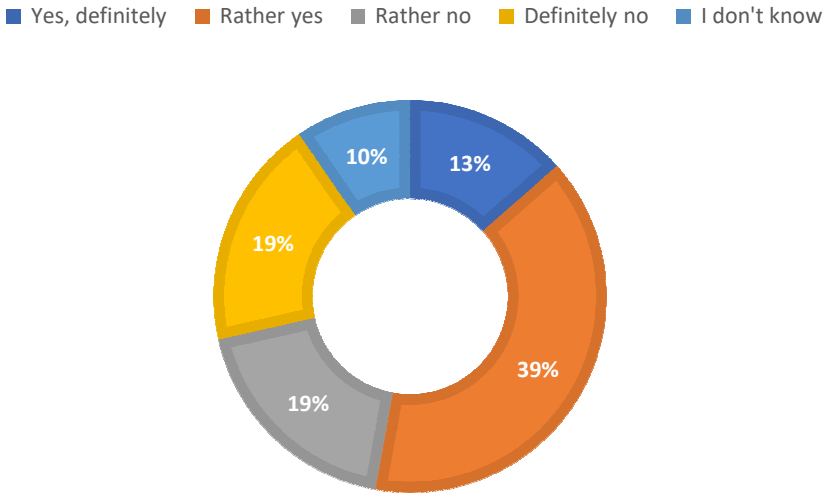

Figure 2. Support for the development of sports and physical activities of residents by the local government
Source: own processing (2025)

A positive assessment (sum of “Yes, definitely” and “Rather yes”) was expressed by 122 respondents (52.6%), which indicates that more than half of the public perceives some form of support for sports from the local government. A negative assessment (sum of “Rather no” and “Definitely no”) was expressed by 87 respondents (37.5%). This group represents a significant proportion of residents who are convinced of insufficient support for sports activities. 9.5% of respondents (22 people) could

not express an opinion on the question, which may indicate either low awareness of the local government's activities in this area or poor communication and promotion of these initiatives.

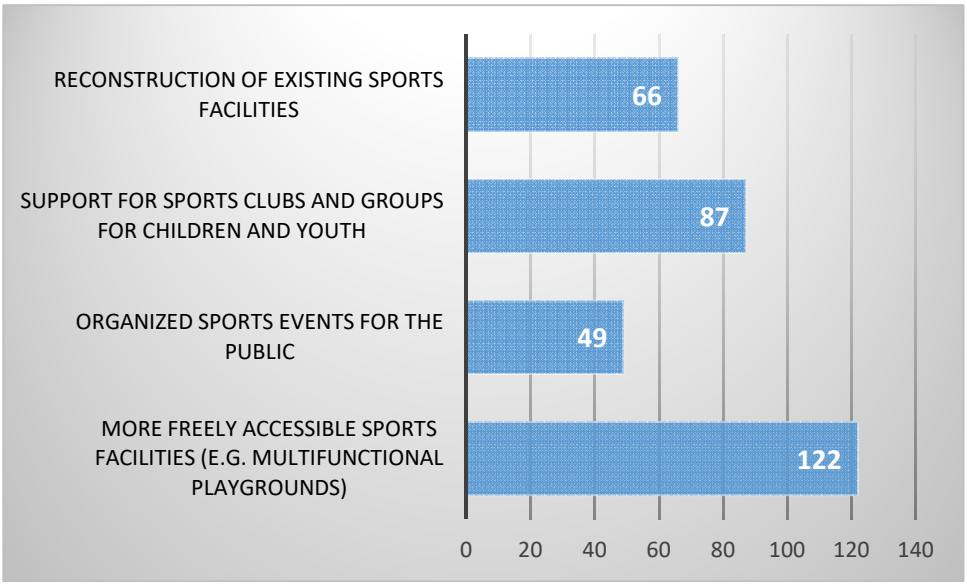

Figure 3. Missing forms of support for sports from the local government (multiple answers possible)
Source: own processing (2025)

The public expressed the greatest interest (122 responses) in increasing the number of freely accessible sports facilities, which indicates a strong need for accessible and non-commercial spaces for sports activities. 87 respondents would welcome greater support for clubs and groups for children and youth, which indicates the public's emphasis on systematic and long-term building of sports habits in the younger generation. Reconstruction of existing sports facilities was also a significant requirement (66 responses), which may be related to the perceived obsolescence or neglected state of the infrastructure. Organized sports events for the public received relatively fewer responses (49 responses), which may indicate that long-term accessible spaces are more important to the public than one-off events.

Table 1 provides an overview of the key differences between the management of a Secondary Sports School and a Hockey Academy. It compares their focus, structure, leadership style, values, and challenges that affect the functioning and development of both types of sports institutions.

Table 1. Comparison of management levels in qualitative research

Management area	Secondary sports school	Hockey academy
Focus	Educational-sports model	Performance-professional model
Management Structure	Links the school with the training process, cooperation with teachers	Clearly hierarchical, team of experts (coaches, analysts, psychologists)
Leadership Style	Support for discipline, planning and systematicity	Performance orientation, use of analyses and technologies
Communication	Regular assessments, school-coach-student cooperation	Intensive communication with players and parents, feedback
Values	Individual development, responsibility, school success	Performance, professionalization, mental resilience
Strengths	Linking education and sport, stable environment	Professional background, specialized support team
Challenges	Financial resources, infrastructure, coordination with the school	Long-term planning, acquisition of experts, financing
Level of Management	High, with emphasis on pedagogical context	High, with emphasis on performance and professional growth

Source: own processing (2025)

4. Discussion

Movement is a fundamental aspect of human life, as it significantly influences the physical, mental and social health of an individual. It is an integral part of a healthy lifestyle and overall human development. (Draková 2024). The results point to an uneven assessment of sports infrastructure, with a significant proportion of the public perceiving gaps in the availability or quality of sports facilities. These findings may be important in deciding on future investments in sports infrastructure within the cities of the Trenčín region.

As Vojtech et al. (2019) point out, successful cooperation and coordination between various entities are essential for achieving common goals and effective development.

The results point to a slightly prevailing positive perception of local government support for sports, but a large proportion of critical responses and hesitant respondents indicate that there is room for improvement – especially in the areas of transparency, communication and effectiveness of sports initiatives for residents.

Respondents most often pointed to the lack of accessible sports facilities as the most significant gap in local government support for sports. These results may be an important recommendation for local authorities when planning investments and developing sports infrastructure. Emphasis should be placed in particular on accessibility, sustainability and support for youth sports.

A qualitative analysis of management in sports organizations – in the case of a secondary sports school and a hockey academy in Trenčín – showed that both institutions face several challenges in the area of organizational and strategic management. The secondary sports school focuses on an educational-sports model with an emphasis on discipline, school success and cooperation between teachers and coaches. Management is oriented towards pedagogy and systematicity. On the contrary, the Hockey Academy operates on a performance-professional model, emphasizing performance, analysis, technology and a professional team of specialists. Communication is more intensive, with the aim of achieving a high sports level and mental resilience. Each area has its strengths and challenges, with the school dealing with finances and infrastructure, the academy focusing on experts and long-term planning.

As Vojtech et al. (2019) state, effective management and strategic planning are cited as crucial for the development and stability of regions.

Effective management also includes managing employees' psychosocial risks, which, according to Slovák et al. (2022), significantly contributes to better work well-being and team performance.

Conclusion

Currently, the field of sports is demanding on the quality of management functions and is related to the professionalism of the manager, because management is not only an art, but also a science.

The research findings point to the need for systematic support for sports at the level of local government and in the sports organizations themselves. On the one hand, there is an obvious public need for better accessibility and quality of sports infrastructure, on the other hand, an analysis of the internal functioning of sports institutions revealed weaknesses in management, planning and support of professional background.

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Microcredentials and Their Potential for Lifelong Learning and Human Resource Management

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Abstract

Research background: Rapid technological advancement, automation, and changing labour market demands necessitate the continuous renewal and enhancement of individual skills. Traditional forms of education often lack the flexibility to respond effectively to these shifts. In this context, microcredentials emerge as an innovative tool that can facilitate access to relevant and customized lifelong learning opportunities.
Purpose of the article: The aim of this paper is to present the potential of microcredentials as a tool for fostering lifelong learning within a digital and flexible educational environment and to identify emerging trends in the use of microcredentials from the perspective of educational policy, practice, and human resource management.
Methods: From a methodological perspective, this paper is based on desk research and draws on a systematic analysis of scientific literature as well as documents and reports produced by European and international organizations. The research focuses on two closely interconnected areas: (1) mapping the current state of the perception of microcredentials in the context of lifelong learning, and (2) identifying emerging trends related to microcredentials.
Findings & Value added: The paper offers a contemporary perspective on emerging trends in the field of microcredentials and their linkage with the concept of lifelong learning. It contributes to the discussion on the possibilities of effectively integrating microcredentials not only as a complementary tool in adult education, but also as a strategic instrument in human resource management, enabling organizations to flexibly respond to skill shortages, and strengthen economic adaptability in a changing environment.

Keywords: Microcredentials, Lifelong learning, Trends, Potential

JEL classification: I00, I25, I28, I29

1. Introduction

The contemporary world of work is undergoing dynamic changes driven by globalization, technological advancement, automation, and digitalization. These changes fundamentally impact the structure of employment, the nature of jobs, and the skills required of workers. One of the main challenges employers face is the insufficient supply of relevant skills in the labour market. The World Economic Forum's Future of Jobs Report 2023 forecasts that 61% of workers will require retraining between now and 2027 (World Economic Forum, 2023).

Continuous upskilling and reskilling are essential for workers to respond to the demands of their current jobs or to transition to new employment opportunities. Traditional forms of education may not respond quickly enough to these changes. This creates a need for more flexible and accessible forms of learning. In this context, the importance of lifelong learning is increasingly emphasized. The concept of lifelong learning is based on the premise that learning does not end with initial formal education but continues throughout an individual's life in various forms - formal, non-formal, and informal (Council of the European Union, 2022). Documents from the European Union and international organizations (e.g., OECD, UNESCO) highlight the importance of lifelong learning as a strategic tool for enhancing

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workforce adaptability and responding to the megatrends of the 21st century (Council of the European Union, 2022; European Commission, 2021c; OECD, 2023; UNESCO, 2022; UNESCO, 2023).

The 21st-century education system requires a rethinking of various areas of learning to ensure quality education that meets the growing needs of society (Ironsi & Ironsi, 2025). In response to new challenges and needs, the concept of microcredentials has come to the fore as an innovative tool (European Commission, 2021a; European Commission, 2021b) that enables individuals to quickly and purposefully develop specific skills. According to the Brookings research group, microcredentials can benefit people of all ages, educational backgrounds, and origins (Masterson, 2022).

Compared to traditional educational programs, they can reduce the risks associated with mismatches between skills and labour market needs and contribute to the efficiency of the labour market. For employers, microcredentials represent an opportunity to align employee competencies with business needs. For employees, they increase employability and adaptability. According to the 2025 report by the Lumina Foundation, 94 % of students indicated that they are willing to obtain microcredentials recognised as credit-bearing within their study programs, reflecting a growing interest in such forms of learning (Lumina Foundation, 2025).

From a managerial perspective, the skills gap represents not only a challenge for employees but also a strategic issue for organizations. Companies face rising recruitment and training costs, reduced productivity, and difficulties in maintaining competitiveness in global markets. Effective human capital management therefore becomes one of the key factors influencing organizational performance. In this context, microcredentials can be understood as a management tool that supports workforce development and long-term competitiveness.

In the context of an aging population, microcredentials offer an important opportunity for older workers to maintain their employability. Given that traditional forms of education are often time-consuming and financially demanding, microcredentials can also provide older workers with more opportunities to adapt to technological and organizational changes through short, specialized courses or modules. This reality supports active aging and longer participation in the labour market.

The aim of this paper is to present the potential of microcredentials as a tool for fostering lifelong learning within a digital and flexible educational environment and to identify emerging trends in the use of microcredentials from the perspective of educational policy, practice, and human resource management.

1.1 The importance of microcredentials for the development of lifelong learning

Microcredentials are playing an increasingly significant role in lifelong learning, as they offer highly flexible and personalized learning opportunities that enable individuals to quickly update their skills or acquire new competencies in response to labour market demands.

One of the main advantages of microcredentials is their more targeted nature compared to macrocredentials, which are traditionally linked to comprehensive educational programs that cover a broad spectrum of knowledge, transferable skills, or professional competencies and often take several years to complete (Thi Ngoc Ha et al., 2022; Department of Education, Skills and Employment, 2021; Oliver, 2022).

The growing importance of microcredentials emerged during the COVID-19 pandemic. During the pandemic, traditional universities faced a complete halt to in-person teaching, whereas open and distance learning universities were able to continue delivering their programs digitally. A key lesson from the lockdown was that higher education institutions began to implement online programs (Raghavan, Subramaniam, & Awang, 2025).

Microcredentials represent a form of recognized proof of learning outcomes achieved through short learning activities. Their goal is not to replace traditional qualifications but to complement and expand them within diverse educational contexts (Council of the European Union, 2022). In this way, they become a key element of modern lifelong learning strategies. Given their potential to respond to current labour market needs, enhance employability, and increase educational accessibility, microcredentials are becoming an important component of education policy in the European context.

Although short-term accredited courses have existed in various forms for many years, only recently have universities begun to systematically incorporate microcredentials into their offerings. These courses typically serve as preparatory or supplementary education to full bachelor’s or master’s degree programs and are rarely fully integrated into core curricula (Ferguson, 2025).

Microcredentials can encompass various forms of learning activities and recognition. Among these are digital badges, which represent an online form of skills and competency recognition backed by clear evidence (Alt, 2021). They also include industry/professional certifications issued by professional associations or sectoral organizations based on examination processes and demonstration of the knowledge, skills, and abilities required for specific occupations (Boo & Kim, 2020; Thi Ngoc Ha et al., 2022).

It is also important to note that although the use of microcredentials in the European context is gradually increasing, a unified framework for their implementation at the European Union level has been lacking until recently. This gap was addressed in 2022 with the adoption of the Council Recommendation of 16 June 2022 on a European approach to microcredentials for lifelong learning and employability, which established a common definition. According to this definition, a microcredential is a record of learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes are assessed against transparent and clearly defined standards. Upon completing a course, learners acquire specific knowledge, skills, and competencies that reflect societal and labour market needs. They can be shared and are portable. They may stand alone or be combined into larger credentials. In this regard, the Recommendation also set out common European standard elements that describe a microcredential (European Commission, 2021d). This common European approach to the development and use of microcredentials is desirable, as it can significantly enhance their transparency and cross-border comparability.

2. Methods

From a methodological perspective, this paper is based on desk research and relies on a systematic analysis of scientific literature as well as documents and reports from European and international organizations. The research focuses on two closely related areas: (1) mapping the current perception of microcredentials in the context of lifelong learning, and (2) identifying new trends related to microcredentials. To achieve the aim of the paper, we formulated two research questions:

RQ1: What are the emerging trends in microcredentials within lifelong learning?
RQ2: Based on the analysis of documents and scientific literature, how can the main potentials of microcredentials be categorized?

The intention was to provide an evidence-based overview of the current state of knowledge in the field. For the purposes of this paper, a systematic literature review was conducted, involving the search, selection, and analysis of relevant publications based on a predetermined time criterion (publication years 2020 - 2025), which allowed us to capture the evolution of the discourse over time. The systematic analysis of sources consisted of the following steps:

- *Search for relevant sources:* To address the research question, reputable scientific databases were used, and a systematic analysis of scientific literature, documents, and reports from European and international organizations (European Union, UNESCO, OECD, CEDEFOP, and the World Economic Forum) was carried out. Particular attention was given, as noted above, to publications from the period 2020 to 2025 in order to reflect current trends and discussions in the research area.
- *Selection of publications:* Based on the predefined criterion (time criterion: year of publication; relevant scientific articles, documents, and reports were included).
- *Content analysis:* Publications were analyzed with a focus on identifying the potentials of microcredentials, their practical applications, and defining current trends.

3. Results

Microcredentials are not a completely new phenomenon. They have been used for decades in various countries and educational sectors, for example in IT and healthcare. Nevertheless, in many countries, a unified official definition or consistent terminology for the term "microcredential" is still lacking (they are often referred to differently, e.g., as microqualifications, partial qualifications, or module certificates). It is important to note, however, that several countries already apply them in ways that partially or fully correspond to the definition derived from the Council Recommendation of 16 June 2022 (Cedefop, 2022).

From a developmental perspective, it can be stated that microcredentials are currently undergoing significant changes in their structure, format, and intended use (Cedefop, 2022). This dynamic is further

supported by our analysis of the reviewed documents and reports, from which we were able to identify emerging trends in the area of microcredentials. The following trends underscore their growing role as a strategic tool to support lifelong learning and enhance employability within the European Union:

- **Diversification of areas of application** - Microcredentials are no longer used solely as supplementary training in specific sectors (such as IT and healthcare); they are increasingly integrated into higher education, vocational education, and lifelong learning.
- **Transition to digital formats and platforms** - With the advancement of digital technologies, there is a shift from traditional paper-based formats to digital formats.
- **Harmonization of definitions of microcredentials** - The 2022 Council Recommendation signals an effort to align national definitions with the European framework for microcredentials and to strengthen mutual recognition.
- **Shift in intended use** - Microcredentials are being incorporated into higher education, vocational education, and lifelong learning to quickly develop targeted skills and as a tool for reskilling and upskilling various population groups.

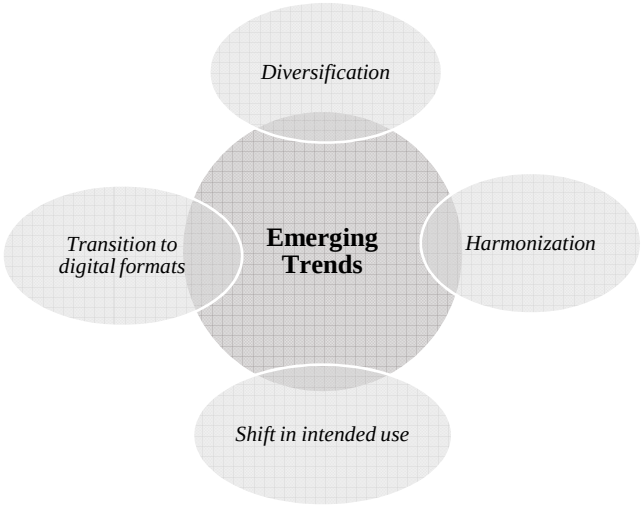

Figure 1. Emerging Trends in Microcredentials
Source: own processing (2025)

An analysis of relevant documents and reports concerning microcredentials in the context of lifelong learning and workforce adaptability has made it possible to identify several key potential benefits. These benefits have been systematically classified into three key dimensions: flexibility, inclusivity, and transferability. The *flexible potential* of microcredentials enables educational programs to respond quickly to changing employer demands in the labour market. Their *inclusive potential* refers to providing access to education for a broader segment of the population, including older individuals and other disadvantaged and vulnerable groups (e.g., persons with disabilities, individuals with low levels of qualification, minorities, and migrants). The *transferable potential* of microcredentials refers to their recognition and transparency among employers, educational institutions, and policymakers. However, this potential requires mutual coordination and collaboration between these actors.

4. Discussion

Microcredentials can make a significant contribution to achieving the European Union's main target indicators set for 2030, which include ensuring that at least 60 % of the adult population participates annually in vocational education and training, and reaching an employment rate of at least 78 %. In this context, however, it is essential that policymakers perceive microcredentials not merely as an innovation but as an integral part of a comprehensive lifelong learning ecosystem that reflects demographic changes, supports digital transformation, and fosters an inclusive approach for all population groups (Council of the European Union, 2022).

Although microcredentials offer considerable potential, their implementation faces challenges related to standardization, recognition (both cross-sectoral and cross-border), and quality assurance. These three

aspects are critical prerequisites for establishing the credibility and value of microcredentials in the labour market. Addressing them ensures that microcredentials will not remain fragmented solutions but will instead become an important systemic tool for supporting the development of lifelong learning and workforce adaptability.

One of the main challenges that needs to be overcome is to ensure that governments recognize microcredentials as legitimate and accepted learning pathways that can lead to the attainment of equivalent education. Such acceptance is essential so that students can transfer their microcredentials between educational institutions without having to repeat the same courses (World Economic Forum, 2022). The European Qualifications Framework, as a common standard reference framework for transparency, portability, and comparability, is open to microcredentials provided they are first integrated into national qualifications frameworks (Council of the European Union, 2022).

Successful implementation of microcredentials in practice requires robust institutional process management. Key actions include the regular evaluation of institutional educational programs, analysis of stakeholder needs, assessment of the effectiveness of individual learning programs, and monitoring the satisfaction of educational stakeholders. Equally important is using the results of these evaluations to analyze the achievement of set objectives, identify areas for improvement, and strengthen the satisfaction of all stakeholders involved (Rodríguez-Mantilla, Martínez-Zarzuelo, & León-Carrascosa, 2025). To maximize the potential of microcredentials, it is essential to promote their wider uptake and popularization among employers, educational institutions, and individuals. A crucial step in achieving this objective is the active involvement of industry and professional associations, working in collaboration with educational institutions, in the process of developing and recognizing microcredentials (Thi Ngoc Ha, Van Dyke, Spittle, Watt, & Smallridge, 2024).

Conclusion

Microcredentials play a significant role in adult education, as they make it possible to recognise and document acquired competencies, including in areas related to emerging labour market and societal needs, such as digitalisation, automation, and technological change (Cedefop, 2022). In these areas, formal qualifications may be lacking, or - if they do exist - obtaining them often requires several years of study. Given that practice often demands these competencies immediately, microcredentials offer a flexible and rapid means to acquire and verify specific (usually narrowly defined) specialised skills. Microcredentials enable the precise documentation of acquired competencies, expressed in the European Credit Transfer and Accumulation System (ECTS). From the perspective of further educational development, microcredentials thus represent a significant step forward.

Current discussions on the role of microcredentials in education and the labour market are ongoing, and expert opinions vary. In general, however, microcredentials are not perceived as a replacement for formal education systems. They are primarily intended for adults who already possess a certain qualification, work experience, or both. Microcredentials can be considered a complementary tool that enhances the formal education system’s capacity to respond flexibly to dynamic labour market changes. However, there is still an ongoing debate on how formal education systems and microcredentials can effectively collaborate (Cedefop, 2022).

These characteristics of microcredentials acquire particular importance in the context of current trends identified in this paper. Firstly, there is a clear diversification in the areas of their application: microcredentials are no longer limited to specific sectors but are increasingly being integrated into higher education, vocational education, and lifelong learning. Secondly, there is a shift from traditional paper-based formats to digital platforms, which enhances their accessibility and flexibility. Moreover, the harmonisation of microcredential definitions, supported by the EU Council Recommendation of 2022, represents a step towards aligning national frameworks with the European system and strengthening mutual recognition. However, it is essential to emphasise that the harmonisation of definitions is only the first step towards their full integration into educational and qualification systems. Prior to this, their development at the national level is crucial, requiring a coordinated and harmonised approach among the country’s education providers. Microcredentials need to be linked to national qualification frameworks to facilitate their subsequent integration into the European Qualifications Framework. Such linkage is key to ensuring their recognition not only at the national but also at the European level, thereby supporting labour mobility within the European labour market. This process requires close cooperation between public institutions, educational institutions, and employers. Equally important is the systematic promotion

of awareness among employers and their involvement in defining needs and expectations, in order to identify areas where micro-credentials can most effectively support employability and workforce development. In addition, it is essential to raise awareness of microcredentials among the general public. Individuals should be informed about the possibility of obtaining microcredentials, their utility in the labour market, and the concrete procedures by which they can acquire or expand them. Closely related to this is the existence of publicly accessible databases that can serve as information sources for all those interested in upgrading or complementing their qualifications - not only for job seekers but also for those wishing to continuously develop their skills or considering a career change. Microcredentials thus become a tool not only for rapidly acquiring specific skills but also for retraining and developing skills for various population groups.

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Do Social Issues Matter? A Survey on Socially Responsible Behaviour of Businesses in the Czech and Slovak Republics

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Abstract

Research background: The socially responsible behaviour of businesses within their corporate social responsibility (CSR) activities can benefit both the businesses themselves as well as the communities affected by their operation. However, socially oriented efforts can be very costly, and the involvement of businesses in them can vary significantly.
Purpose of the article: The paper investigates the socially responsible behaviour of a sample of businesses in the Czech and Slovak Republics to evaluate the involvement of surveyed businesses in social issues and to identify the factors that differentiate the involvement.
Methods: The investigation comes out of a questionnaire survey of representatives of twice a hundred businesses in the Czech and Slovak Republics declaring CSR efforts within their operations. The Czech and Slovak Republics were chosen as representatives of developed market economies of Central Europe with strong political, economic, and social relations. The data were processed and hypotheses were verified using selected statistical tests, such as Cronbach's alpha validity test, Shapiro-Wilk test of normality, and Kruskal-Wallis H test.
Findings & Value added: The findings confirmed the involvement of surveyed businesses in various social issues, such as respect for equal opportunities in the workplace, application of principles of business ethics, support of the work-life balance of employees, or public rejection of child labour. The business size and scope of operations were identified as factors differentiating the involvement of surveyed businesses in particular social issues. The findings are beneficial for the surveyed and other businesses involved in CSR efforts. To achieve expected CSR benefits, surveyed businesses should apply a more strategic approach to socially responsible behaviour.

Keywords: Corporate social responsibility, Social pillar, Stakeholder communities, Czech Republic, Slovak Republic

JEL classification: D20, M1, O30

1. Introduction

The concept of corporate social responsibility (CSR) within the business environment promotes socially, environmentally, and economically oriented efforts of businesses to achieve sustainable economic prosperity concerning human well-being and nature conservation (Grzegorczyk, 2022). Following socially, environmentally, and economically responsible behaviour has become both a legal obligation and a business necessity for businesses (Rosak-Szyrocka et al., 2022). More and more stakeholders, from government institutions through business partners to final customers, expect businesses to be socially, environmentally, and economically sustainable (Hosta & Zabkar, 2021). Targeted socially, environmentally, and economically oriented efforts determine public interest in businesses as such and thereby determine their competitiveness and profitability (Catalao-Lopes et al., 2023).

Being socially responsible means being concerned with social issues related to people and their living and working conditions to ensure that people are treated well and fair (Urbancova & Vrabcova, 2020). Being environmentally responsible means being concerned with environmental issues related to the planet and its animate and inanimate nature to ensure the effective and efficient use of natural

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resources concerning future generations (Zhang et al., 2021). Being economically responsible means being concerned with economic issues related to the profitability of businesses and their business models to ensure prosperous operations concerning sustainable competitiveness (Waniak-Michalak et al., 2018).

The involvement of businesses in social, environmental, and economic issues needs to be balanced, not to challenge the profitability of businesses, but at the same time, benefit people and the planet (Isacowitz et al., 2022). In other words, the socially, environmentally, and economically responsible behaviour of businesses needs to be both rational and voluntary. Businesses must be aware that society expects their social, environmental, and economic involvement (Vveinhardt & Sroka, 2021). However, particular socially, environmentally, and economically oriented efforts must be incorporated into business strategies voluntarily and have to bring rational benefits to the majority of stakeholders (Mukherjee & Nunez, 2019).

On the one hand, efforts towards socially responsible behaviour bring many benefits to businesses, such as a better image, satisfied customers, and engaged employees, but on the other hand, they require investing a lot of time, money, and energy. In other words, businesses may have different motives for acting socially responsibly. For this reason, the involvement of businesses in socially responsible behaviour can be significantly different. Therefore, the paper investigates the socially responsible behaviour of a sample of businesses in the Czech and Slovak Republics to evaluate the involvement of surveyed businesses in social issues and to identify the factors that differentiate the involvement. For these purposes, two research questions are defined:

RQ1: Which social issues indicate the strongest involvement of surveyed businesses?

RQ2: Which factors differentiate the involvement of surveyed businesses in social issues?

The Czech and Slovak Republics were chosen as representatives of developed market economies of Central Europe with strong political, economic, and social relations founded on the history of the common state (Fitzova & Zidek, 2015). They have been independent states since 1993 and member states of the European Union since 2004. Politically, economically, and socially, they benefit from cooperation among themselves as well as with their neighbours, such as Germany, Austria, Poland, or Hungary. Their membership in the European Union leads to compliance with specific political, economic, and social initiatives promoting social, environmental, and economic responsibility (Kazharski, 2019). Such initiatives impact particular businesses that need to behave socially responsibly to meet all political, economic, and social obligations to stakeholders, such as government institutions, outside investors, business partners, inside employees, direct customers, or local communities (Brozyna et al., 2020). Investigating the involvement of businesses in social issues and factors differentiating the involvement of businesses in social issues meets the research gap within the CSR research. The paper contributes to the findings of existing research studies on CSR efforts by focusing specifically on the social issues of different businesses in different political, economic, and social environments, which could be beneficial for other researchers and practitioners involved in CSR issues.

Within the paper, first, a literature review on CSR issues and factors affecting the involvement of businesses in them is presented. Second, the way of investigating the involvement of businesses in the Czech and Slovak Republics in social issues and factors differentiating the involvement of businesses in social issues is described. Third, the authors' research results on the socially responsible behaviour of businesses in the Czech and Slovak Republics are presented and discussed. Finally, conclusions about the authors' research findings and proposals are made.

2. Literature review

Research on corporate social responsibility (CSR) has long been popular all over the world. Researcher studies focus on the overall CSR systems (Khan et al., 2020) as well as on particular CSR issues (Velte and Stawinoga, 2020) within various businesses sorted by business size (small, medium-sized, large), area of operations (production, trade, services), or scope of operations (local, national, international).

The findings of most research studies confirm the constantly increasing involvement of various businesses across business sizes, areas of operations, or scopes of operations in many social, environmental, and economic issues (Javed & Husain, 2021). The most common motive for CSR efforts is the improvement of the business brand (Wei & Jung, 2022). From a business size, area of operations, or scope of operations perspective, investment in CSR efforts is most common in large service-oriented businesses operating in international markets (Heath et al., 2023). These businesses invest the most in CSR efforts that bring the greatest value to stakeholders, primarily customers and employees (Zhao et al., 2021). These stakeholder groups mean the most to business development. They are the source of required

know-how and needed profitability (Lee et al., 2018). The concern for the well-being of customers means offering quality goods and services or building good customer relationships (Olsanova et al., 2021). The concern for the well-being of employees means creating a safe and healthy working environment, preventing discrimination in the workplace, providing equal job opportunities, supporting people with disabilities, applying flexible working arrangements, or promoting work-life balance (Guzzo et al., 2022). These and similar concerns about customers, employees, and other communities represent social issues within business CSR efforts.

In the Czech Republic, for example, Paulik et al. (2015) examined the application of the CSR concept in commercial banks in the Czech Republic using a sample of the four largest commercial banks according to the number of customers and considering social, environmental, and economic issues. They revealed an average involvement of surveyed commercial banks in CSR efforts and confirmed no significant association between CSR efforts and the financial performance of surveyed commercial banks. Bartok (2018) analysed the impact of CSR on e-commerce small and medium-sized businesses in the Czech Republic using a sample of sixty-three businesses and revealing a positive association between the implementation of CSR and sales, as customers prefer businesses with beneficial CSR efforts. Kostalova and Tetrevova (2018) examined whether sugar-producing businesses in the Czech Republic use the option of co-financing their socially, environmentally, and economically oriented CSR efforts from EU funds. They found out that only two out of five surveyed sugar-producing businesses used the option in the 2007-2013 programming period. The main barrier was the lack of know-how in project management. Macgregor et al. (2020) analysed the perception of corporate social responsibility by front-line employees of luxury fashion businesses in Prague, Czech Republic, using a sample of ten top businesses. They uncovered a lack of awareness and involvement of front-line employees in CSR issues, which leads to not meeting the benefits of CSR efforts. Vrabcova and Urbancova (2021) surveyed representatives of one hundred and seventy-nine businesses and interviewed representatives of eight agricultural businesses in the Czech Republic to compare the approaches of selected businesses to the issue of corporate social responsibility and identify the main factors of their competitiveness. They concluded that selected businesses pay attention to process orientation, industry stability, and financial performance, together with quality relationships with stakeholders. Strihavkova et al. (2021) surveyed an awareness of the corporate social responsibility of businesses in the Usti nad Labem Region in the Czech Republic using a sample of fifty-two small and medium-sized businesses. They found a lack of information about the CSR principles, impacts, and benefits across surveyed businesses, as well as a lack of involvement of employees in the CSR efforts of surveyed businesses. The most frequently perceived issue of voluntarily implemented CSR efforts was the difficulty of measuring financial effects. Fuchsova (2022) investigated whether businesses with a strategic approach to CSR achieve better economic results than businesses with a rather intuitive approach to CSR using a sample of 404 businesses in the Czech Republic declaring CSR efforts. The findings revealed a positive association between a strategic approach to CSR and achieved economic results. Implemented CSR strategies resulted in positive impacts on employees and local communities.

In the Slovak Republic, for example, Ubreziova and Moravcikova (2017) analysed the involvement of agricultural-food businesses in the Slovak Republic in CSR issues using a sample of eighty-one businesses. They confirmed low awareness of the surveyed businesses of CSR principles and practices. However, more than two-thirds of surveyed businesses declared CSR efforts in line with their business strategies. The strongest motive of surveyed businesses for CSR efforts was the improvement of their business reputation. Nadanyiova et al. (2020) surveyed differences in the perception of green marketing within environmentally responsible communication by different generations of customers in the Slovak Republic using a sample of two thousand thirty-five respondents. They confirmed a strong perception of green marketing and environmental responsibility by customers across generations. They also identified many benefits of environmentally responsible behaviour of businesses, from improving the business brand through attracting relevant investors to gaining a sustained competitive advantage. Tesovicova and Krchova (2022) analysed the association between the involvement in environmentally responsible efforts and the business size using a sample of five hundred and forty-four businesses operating in the Slovak Republic. They revealed the strongest involvement in environmentally responsible efforts in large businesses, which were mostly concerned with regional rather than global environmental issues. Igarova et al. (2023) surveyed how CSR efforts serve as a marketing tool for food businesses towards their customers in the Slovak Republic using a sample of one thousand two hundred and fifty-four respondents. They concluded that customers are generally familiar with the CSR efforts of food businesses, although

many would need more detailed information. It follows that food businesses should communicate their CSR efforts more actively. Customers mostly perceived the CSR efforts of food companies as a marketing tool, creating a positive business brand, which can attract and keep satisfied customers and so ensure sustainable competitiveness and profitability.

In international comparison, for example, Matysik-Pejas and Horska (2018) surveyed awareness of customers of CSR efforts of food businesses using samples of customers from Slovakia (two hundred and seventy-nine respondents) and Poland (two hundred and seventy-two respondents). They uncovered that both customers in Slovakia and Poland consider employee-oriented social issues to be the most important CSR efforts, including meeting legal obligations, ensuring open and honest communication, and improving the economic situation of employees. They confirmed that customers and employees represent the most important stakeholder groups affected by CSR efforts. If they do not satisfy the needs of customers and employees, it is difficult to develop the business reputation and achieve other CSR benefits. Krajnakova et al. (2018) analysed the association between economic conditions and the development of CSR activities using a sample of businesses in Slovakia, Lithuania, Latvia, and Estonia. They confirmed that changes in economic conditions may significantly impact the development of CSR activities in businesses. However, even in times of worse economic conditions, businesses may continue to invest in CSR activities to achieve long-term CSR benefits. Çera et al. (2020) investigated whether CSR efforts are affected by business size and age using a sample of eight hundred and twenty-two small and medium-sized businesses in the Czech Republic (four hundred and fifty-four businesses) and in the Slovak Republic (three hundred and sixty-eight businesses). They revealed that the CSR concept is not perceived similarly in both countries. They found no significant association between CSR efforts and business size. However, they found a significant association between CSR efforts and business age, namely in businesses in the Slovak Republic, where the older businesses were less involved in CSR efforts. Gavurova et al. (2022) analysed differences in CSR practices of micro, small, and medium-sized businesses in the V4 countries (Czechia, Slovakia, Poland, and Hungary). Their findings uncovered that CSR strategies were most used by businesses in Slovakia, Poland, and Hungary, in contrast to businesses in Czechia. The implementation of particular CSR practices was more common in agriculture or tourism than in manufacturing, construction, retail, or services. Managers of businesses confirmed the most important benefits of implementing CSR practices to be improving business reputation, gaining business contracts, and building a competitive advantage. The business size was found to be significant in the perception of the business as CSR-oriented. Medium-sized businesses were more likely to be perceived as CSR-oriented than small and micro businesses.

There are, of course, many other CSR surveys conducted in the Czech, Slovak, and international frameworks. However, most of them bring comparable results confirming that CSR efforts of businesses must be a voluntary, but strategic matter to bring relevant social, environmental, and economic effects to all stakeholders. In addition, certain factors such as business sizes, areas of operations, or scopes of operations affect the involvement of businesses in CSR issues.

3. Methods

The investigation of the socially responsible behaviour of a sample of businesses in the Czech and Slovak Republics comes out of a questionnaire survey of representatives of 100 businesses in the Czech Republic and 100 businesses in the Slovak Republic declaring CSR efforts within their operations. The questionnaire survey was carried out in the period January-November 2023 within the project supported by the Visegrad Fund (no. 22220149). Representatives of surveyed businesses were contacted by email, receiving a link to an online questionnaire, and included executive directors, CSR, HR, or PR managers, and other line managers. The selection of surveyed businesses was motivated by the desire to achieve a fairly equal number of businesses by business size, area of operations, and scope of operations.

The whole online questionnaire included five sections consisting of fifty-three questions researching current CSR practices in surveyed businesses. For this paper, three sorting questions and ten specific questions related to the involvement of surveyed businesses in social issues within their CSR efforts were chosen. The three sorting questions are related to (1) business size (small: 0-49 employees, medium-sized: 50-249 employees, large: 250+ employees), (2) area of operations (production, trade, services), and (3) scope of operations (one region, more regions, whole country). The ten specific questions are related to (A) respect for equal gender, age, and other opportunities in the workplace, (B) support of voluntary activities of employees, (C) application of principles of business ethics, (D) philanthropy and

sponsorship, (E) support of local communities, (F) care for employees beyond legal obligations, (G) training and development of employees beyond legal obligations, (H) assistance to dismissed employees beyond legal obligations, (I) support of the work-life balance of employees, (J) public rejection of child labour. The numbers and letters are used in the text to identify particular sorting characters and social issues. The involvement of surveyed businesses in particular social issues was evaluated on the scale very strongly, strongly, average, negligible, and not at all.

Table 1 describes the samples of businesses in the Czech and Slovak Republics sorted by business sizes (small, medium-sized, large), area of operations (production, trade, services), and scope of operations (one region, more regions, whole country). The samples of businesses in the Czech and Slovak Republics are more or less comparable, although the Czech Republic sample is dominated by service-oriented businesses, while the Slovak Republic sample is dominated by production-oriented businesses.

Table 1. The samples of businesses in the Czech and Slovak Republics

		The Czech Republic (N = 100)	The Slovak Republic (N = 100)
Business size	Small	40%	40%
	Medium-sized	20%	20%
	Large	40%	40%
Area of operations	Production	22%	39%
	Trade	45%	35%
	Services	33%	26%
Scope of operations	One region	37%	41%
	More regions	31%	37%
	Whole country	32%	22%

Source: authors (2025)

The data were processed and examined using selected statistical tests and the statistical application XLSTAT. The variables chosen were subjected to Cronbach's alpha validity test. Cronbach's alpha was created by Cronbach (1951) to quantify the internal consistency of a test or scale. It is represented as a number between 0 and 1. Internal consistency is a measure of how closely all of the test's items measure the same idea or construct, and it is thus related to how closely the test's items are related to one another. As a general rule, a Cronbach's alpha of 0.70 and above is considered good, 0.80 and above to be better, and 0.90 and above to be the best (Statistics Solutions, 2024). The Shapiro-Wilk test was done to compare the scores in the sample to a normally distributed set of scores with the same mean and standard deviation. Both the alternative and the null hypotheses, which assert that the variable from which the sample was taken has a normal distribution, were established. The alternative hypothesis assumes that there is a non-normal distribution of the variable from which the sample was taken. The null hypothesis was defined with the assumption that there would be some variations among businesses in their involvement in specified social issues. Three hypotheses were established and examined using a non-parametric Kruskal-Wallis statistical test (Kruskal and Wallis, 1952) following selected variables. When comparing more than two independent samples, this test works well as a generic nonparametric test (Ostertagova et al., 2014):

H0: Social issues indicated by variables A-J are not different among surveyed businesses.

H1: Social issues indicated by variables A-J are significantly different among surveyed businesses according to the business size.

H2: Social issues indicated by variables A-J are significantly different among surveyed businesses according to the area of operations.

H3: Social issues indicated by variables A-J are significantly different among surveyed businesses according to the scope of operations.

The data examination included a comparison of the relative frequencies of responses on the country, business size, area of operations, and scope of operations.

4. Results

The socially responsible behaviour of 100 businesses in the Czech Republic and 100 businesses in the Slovak Republic is investigated to find out which social issues indicate the strongest involvement of surveyed businesses (RQ1) and which factors differentiate the involvement of surveyed businesses in social issues (RQ2).

The data examination uncovered that not many of the surveyed businesses in the Czech Republic (27%), as well as in the Slovak Republic (43%), strategically plan their CSR efforts. In the Czech Republic, these are mostly large businesses (59%) operating in services (44%) or trade (38%) and in the whole country (50%) or more regions (38%). Only 41% of small and medium-sized businesses, regardless of their area or scope of operations, confirmed the strategic planning of their CSR efforts. In the Slovak Republic, these are mostly large businesses (72%) operating in production (55%) and in more regions (45%). Only 28% of small and medium-sized businesses, regardless of their area or scope of operations, confirmed the strategic planning of their CSR efforts. Strategic planning is standard in large businesses. However, small and medium-sized businesses, regardless of their area or scope of operations, should also strategically plan their CSR efforts to deliver valuable outcomes.

From the perspective of particular social issues within CSR efforts, in the Czech Republic, surveyed businesses declared strong involvement in (A) respect for equal gender, age, and other opportunities in the workplace (51%), (C) application of principles of business ethics (47%), and (J) public rejection of child labour (47%). On the other hand, surveyed businesses declared no involvement in (H) assistance to dismissed employees beyond legal obligations (27%), (E) support of local communities (20%), and (B) support of voluntary activities of employees (14%). In comparison, in the Slovak Republic, surveyed businesses declared strong involvement in (J) public rejection of child labour (60%), (A) respect for equal gender, age, and other opportunities in the workplace (57%), (C) application of principles of business ethics (54%). On the other hand, surveyed businesses declared no involvement in (H) assistance to dismissed employees beyond legal obligations (27%), (B) support of voluntary activities of employees (11%), and (E) support of local communities (11%).

Table 2 sums up the strongest involvement of surveyed businesses in particular social issues (A-J) according to the country (the Czech Republic, the Slovak Republic), business size (small, medium-sized, large), area of operations (production, trade, services), and scope of operations (one region, more regions, whole country). The data examination revealed that most surveyed businesses are more or less involved in all of the social issues (A-J). However, in the Czech Republic, the strongest involvement in particular social issues is mostly represented by small, service-oriented, and whole country-oriented businesses. On the other hand, in the Slovak Republic, the strongest involvement in particular social issues is mostly represented by large, production-oriented, and one-region-oriented businesses. This could indicate some differences between countries and businesses.

Table 2. The strongest involvement of surveyed businesses in particular social issues

	The Czech Republic			**The Slovak Republic**		
Social Issues	**Business Size**	**Area of Operations**	**Scope of Operations**	**Business Size**	**Area of Operations**	**Scope of Operations**
A	Small	Services	More regions	Large	Production	One region
B	Small	Services	Whole country	Large	Trade	One region
C	Small	Services	More regions	Large	Production	One region
D	Large	Services	Whole country	Large	Services	More regions
E	Small	Services	Whole country	Large	Production	One region
F	Small	Services	More regions	Large	Production	One region
G	Large	Services	Whole country	Large	Production	One region
H	Medium-sized	Services	Whole country	Large	Production	One region
I	Small	Services	One region	Large	Production	One region
J	Small	Services	Whole country	Small	Trade	One region

(A) Respect for equal gender, age, and other opportunities in the workplace
(B) Support of voluntary activities of employees
(C) Application of principles of business ethics
(D) Philanthropy and sponsorship
(E) Support of local communities
(F) Care for employees beyond legal obligations
(G) Training and development of employees beyond legal obligations
(H) Assistance to dismissed employees beyond legal obligations
(I) Support of the work-life balance of employees
(J) Public rejection of child labour

Source: authors (2025)

Differences in the involvement of surveyed businesses in particular social issues indicated by variables A-J were tested according to the business size, area of operations, and scope of operations using a non-parametric Kruskal-Wallis statistical test. Before a test is used for study or examination, its internal consistency needs to be established to guarantee its validity (Tavakol and Dennick, 2011). Cronbach's alpha was computed for this reason, and a validity of 0.817 indicates acceptable validity. For every variable, the Shapiro-Wilk test returns a computed p-value less than the significance alpha=0.05 and a risk of less than 0.01% for rejecting the null hypothesis H0 when it is true. The alternative hypothesis—that the variable from which the sample was taken did not follow a normal distribution—is accepted since the Shapiro-Wilk test indicates that the distribution is non-normal (see Table 3).

Table 3. Cronbach's alpha and Shapiro-Wilk test

Variable\Test	Cronbach's alpha	Shapiro-Wilk
For all the tested variables	0.817	< 0.0001

Source: authors (2025)

Hypothesis H1 that social issues indicated by variables A-J are significantly different among surveyed businesses according to the business size was proved for the Czech Republic in several variables (see Table 4), namely (D) philanthropy and sponsorship, (H) assistance to dismissed employees beyond legal obligations, (I) support of the work-life balance of employees, and (J) public rejection of child labour. The involvement of surveyed businesses in these social issues differs significantly according to the business size, which means that surveyed businesses of different sizes deal with these social issues differently. This makes the factor of business size fairly important when examining the involvement in social issues within CSR efforts.

Hypothesis H2 that social issues indicated by variables A-J are significantly different among surveyed businesses according to the area of operations was not proved at all for the Czech Republic and was rejected completely.

Hypothesis H3 that social issues indicated by variables A-J are significantly different among surveyed businesses according to the scope of operations was proved for the Czech Republic only in two variables, namely the (D) philanthropy and sponsorship, and (E) support of local communities.

Table 4. Kruskal-Wallis test for surveyed businesses in the Czech Republic

Variable\Test	(1) Business Size	(2) Area of Operations	(3) Scope of Operations
(A) Respect for equal gender, age, and other opportunities in the workplace	0.074	0.225	0.150
(B) Support of voluntary activities of employees	0.428	0.839	0.743
(C) Application of principles of business ethics	0.212	0.325	0.221
(D) Philanthropy and sponsorship	**0.028**	0.485	**0.012**
(E) Support of local communities	0.414	0.185	**0.036**
(F) Care for employees beyond legal obligations	0.267	0.998	0.115
(G) Training and development of employees beyond legal obligations	0.162	0.218	0.493
(H) Assistance to dismissed employees beyond legal obligations	**0.011**	0.888	0.542
(I) Support of the work-life balance of employees	**0.011**	0.980	0.272
(J) Public rejection of child labour	**0.023**	0.680	0.436

Source: authors (2025)

Hypothesis H1 that social issues indicated by variables A-J are significantly different among surveyed businesses according to the business size was proved for the Slovak Republic in half of the variables (see Table 5), namely (C) application of principles of business ethics, (E) support of local communities, (G) training and development of employees beyond legal obligations, (H) assistance to dismissed employees beyond legal obligations, and (I) support of the work-life balance of employees. The last two –(H) assistance to dismissed employees beyond legal obligations and (I) support of the work-life balance of employees – are significant in both countries. This confirms that the factor of business size is important when examining the involvement in social issues within CSR efforts.

Hypothesis H2 that social issues indicated by variables A-J are significantly different among surveyed businesses according to the area of operations was proved for the Slovak Republic in two variables, namely (F) care for employees beyond legal obligations and (H) assistance to dismissed employees beyond legal obligations. This differs from the Czech Republic, where there was no difference revealed.

Hypothesis H3 that social issues indicated by variables A-J are significantly different among surveyed businesses according to the scope of operations was proved for the Slovak Republic only in one variable, namely (D) philanthropy and sponsorship. This is the same as for the Czech Republic, which makes (D) philanthropy and sponsorship an important social issue for surveyed businesses in both countries.

Table 5. Kruskal-Wallis test for surveyed businesses in the Slovak Republic

Variable\Test	(1) Business Size	(2) Area of Operations	(3) Scope of Operations
(A) Respect for equal gender, age, and other opportunities in the workplace	0.273	0.355	0.520
(B) Support of voluntary activities of employees	0.326	0.304	0.447
(C) Application of principles of business ethics	**0.013**	0.292	0.847
(D) Philanthropy and sponsorship	0.106	0.367	**0.042**
(E) Support of local communities	**0.025**	0.288	0.306
(F) Care for employees beyond legal obligations	0.309	**0.017**	0.333
(G) Training and development of employees beyond legal obligations	**0.004**	**0.037**	0.328
(H) Assistance to dismissed employees beyond legal obligations	**0.009**	0.338	0.370
(I) Support of the work-life balance of employees	**0.013**	0.170	0.466
(J) Public rejection of child labour	0.765	0.188	0.540

Source: authors (2025)

5. Discussion

The investigation of socially responsible behaviour of 100 businesses in the Czech Republic and 100 businesses in the Slovak Republic uncovered that the strongest involvement of surveyed businesses in particular social issues (RQ1) in both countries indicates (A) respect for equal gender, age, and other opportunities in the workplace, (C) application of principles of business ethics, and (J) public rejection of child labour. Moreover, the comparison revealed significant differences in the involvement of surveyed businesses in particular social issues (RQ2) according to business size (hypothesis H1) in both countries, namely in (H) assistance to dismissed employees beyond legal obligations and (I) support of the work-life balance of employees. This confirms that the factor of business size is fairly important when examining the involvement of businesses in social issues within their CSR efforts.

The factor of the scope of operations could be similarly important. The comparison revealed significant differences in the involvement of surveyed businesses in particular social issues (RQ2) according to the scope of operations (hypothesis H3) in both countries, namely in (D) philanthropy and sponsorship. The factor of the area of operations was found as not so important. The comparison revealed significant differences in the involvement of surveyed businesses in particular social issues (RQ2) according to an area of operations (hypothesis H2) only in the Slovak Republic, namely in (F) care for employees beyond legal obligations and (H) assistance to dismissed employees beyond legal obligations, not in the Czech Republic.

In general, it appears that surveyed businesses display evident CSR efforts involving social issues, which can have many reasons, from following current trends through meeting specific needs to showing pure altruism (Rim & Song, 2017). Factors differentiating the involvement of surveyed businesses in particular social issues are business size and the scope of operations. Certain differences were found in the case of strategic planning of CSR efforts, confirmed mostly only by large businesses operating in services, trade, or production, and in the whole country or more regions. This could mean that most of the other surveyed businesses do not consider CSR efforts as a strategic matter and that they deal with particular social issues ad hoc if worthwhile (Machales & Blanch, 2022). This could be a potential

problem in the long run, as CSR efforts that are not aligned with the business strategy may not bring the expected benefits to both the business and the target stakeholders (Dang et al., 2022).

The findings suggest that any CSR efforts of businesses dealing with social issues could meet the essential purpose of socially responsible behaviour, which concerns the well-being of communities affected by business operations (Attah & Amoah, 2023). This applies in particular to employee communities, in which case businesses could be involved in respect for equal gender, age, and other opportunities in the workplace, training, and development beyond legal obligations, or support of the work-life balance (Kim et al., 2018).

In the case of customers and other communities, businesses should be involved in the application of principles of business ethics, philanthropy, and sponsorship, support of local communities, or public rejection of child labour (von Schnurbein, 2016). Dealing with similar social issues should be motivated by the intention to benefit a wide range of stakeholders while meeting the business needs (Boadi et al., 2018).

Conclusion

The investigation of the socially responsible behaviour of a sample of businesses in the Czech and Slovak Republics aimed to find out which social issues indicate the strongest involvement of surveyed businesses and which factors differentiate the involvement of surveyed businesses in social issues.

The comparison revealed that surveyed businesses are more or less involved in various social issues, such as respect for equal opportunities in the workplace, application of principles of business ethics, support of the work-life balance of employees, or public rejection of child labour. Most of these social issues are related to employee and customer communities that represent the most important stakeholders for the sustainable competitiveness and profitability of businesses. The business size and scope of operations were found as factors differentiating the involvement of surveyed businesses in particular social issues. A potential problem for most surveyed businesses could be a trendy rather than a strategic approach to socially responsible behaviour. Any CSR efforts should be integrated with business strategies to purposefully deliver the best value.

The findings are limited by the focus of the survey only on the Czech and Slovak Republics, as well as by a relatively small number of surveyed businesses of different business sizes, areas of operations, and scopes of operations. On the other hand, the findings contribute to the findings of existing research studies on CSR efforts by focusing specifically on the social issues of different businesses in different political, economic, and social environments represented by the Czech and Slovak Republics. Moreover, the samples of businesses in the Czech and Slovak Republics cover a diverse structure of small, medium-sized, and large businesses operating in production, trade, and services in one or more regions, which is a structure typical of most developed market economies across the European Union. The findings could thus be beneficial for other researchers and practitioners involved in CSR issues to achieve a higher level of socially responsible behaviour.

Further research could be aimed at the reasons businesses have for particular social, environmental, and economic issues within their CSR efforts and their effect on various groups of stakeholders, from investors and business partners through employees and customers to local communities and government institutions. Knowing their specific expectations regarding socially, environmentally, and economically responsible behaviour would be beneficial for more strategic and valuable CSR efforts of businesses.

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Transformation of Traditional Approaches and Practices in Human Resource Management

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Abstract

Research background: Human Resource Management (HRM) is undergoing a fundamental transformation, moving from predominantly administrative functions towards a more strategic role within organizations. This shift is driven primarily by digitalization, the integration of HR technologies, and global trends such as skills-based workforce planning, inclusion, and employee engagement. While traditional practices remain important, their effectiveness increasingly depends on technological support and the ability to generate and analyze high-quality data.
Purpose of the article: The article aims to examine the transformation of traditional HRM practices through the lens of digitalization and technology adoption. Specifically, it focuses on identifying the most frequently managed HR functions, the degree of HR software utilization, and the strategic implications of these trends for employee engagement, organizational effectiveness, and competitiveness.
Methods: The research is based on secondary data analysis of the Chartered Institute of Personnel and Development (CIPD) survey conducted among 1,174 HR leaders in the United Kingdom, combined with a systematic review of international academic and practitioner literature published between 2018 and 2024. Comparative analysis, content analysis, and causal interpretation were applied to contextualize the findings within broader global HRM trends and theoretical frameworks of strategic HRM and digital transformation.
Findings & Value added: The results reveal that while HR recruitment and HR information systems remain dominant HR functions, advanced practices such as workforce planning and people analytics are still underutilized. The article adds value by highlighting the gap between the strategic importance of HR activities and their actual technological support, emphasizing the need for data-driven workforce planning and digital integration.

Keywords: Human resource management, Transformation, Digitalization, Practices

JEL classification: M12, M50, M54

1. Introduction

The transformation of human resource management (HRM) is increasingly taking the form of a long-term and continuously evolving process that transcends the traditional understanding of HR as a purely administrative and supportive function. It is becoming a strategic pillar of organizations, tasked not only with securing the necessary resources and competencies but also with creating an environment in which human capital can develop in alignment with the dynamics of the external environment. (Ulrich & Brockbank, 2005; Boxall & Purcell, 2016) In this context, HR management must adapt to technological change, shifting employee expectations, and the growing need to link organizational performance with long-term sustainability. Thus, transformation cannot be understood merely as a set of tools, but a complex approach that integrates processes, culture, and strategies into a unified whole. This evolution involves the integration of advanced digital technologies, including AI and people analytics, which enable data-driven decision-making and personalized employee experiences. It also requires rethinking performance management to emphasize continuous feedback, learning, and adaptability rather than static

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annual evaluations. Furthermore, fostering diversity, equity, and inclusion has become an essential component of HR transformation, ensuring that organizational practices support fairness and psychological safety. (Svetozarovová et al., 2023) Ultimately, the transformed HR function acts as a catalyst for innovation, organizational agility, and sustainable competitive advantage.

1.1 The Transformation of Human Resource Management

A key driving force of organizational transformation is digitalization, which fundamentally alters the way organizations operate. The Industry 4.0 concept, associated with automation, the Internet of Things (IoT), augmented reality, and data technologies, creates new frameworks for work management. (Blštáková & Dědečková, 2021) For HR, this implies a shift from traditional personnel processes to so-called digital HRM, where technologies serve as a foundational infrastructure for strategic decision-making, process optimization, and enhancement of employee experience. (Bondarouk & Brewster, 2016) This shift is significant because digitalization is not merely an efficiency tool; it also shapes organizational culture, work structures, and the relationships between employees and employers.

A notable aspect of digitalization is the use of artificial intelligence (AI) and machine learning, which are progressively permeating all dimensions of HRM. These technologies enable the automation of routine tasks, accelerate decision-making, and generate personalized recommendations for employees. (Tambe, Cappelli & Yakubovich, 2019) AI thus becomes not only an optimization tool but also a means of fostering new forms of interaction between employees and the organization. At the same time, it raises critical ethical questions related to transparency, fairness, and the trustworthiness of algorithmic decisions. (Bogen & Rieke, 2018) This indicates that technological development is inseparable from trust, and responsible algorithm design becomes a prerequisite for the sustainable application of AI in HRM. Building on this foundation, the development of people analytics naturally follows. People analytics represents the systematic use of data to better understand processes related to employee performance, engagement, and development. (Angrave et al., 2016) It enables the integration of technological innovations with strategic decision-making by transforming large volumes of data into actionable insights that support long-term planning. While AI provides speed and automation, people analytics delivers the necessary context, validity, and strategic depth. (Aguinis, 2019) The potential of HR transformation lies in the synergy of these approaches: AI allows for scenario prediction and simulation, whereas analytics ensures that decisions are evidence-based and aligned with the real needs of the organization. This development inevitably affects performance management systems, which are evolving from traditional annual evaluations toward continuous and dynamic performance management. This approach relies on ongoing feedback, adaptive goals, and a focus on coaching. (DeNisi & Murphy, 2017; Aguinis, 2019) It creates an environment in which evaluation is not a one-off administrative task but an integral part of daily work. Integration with data analytics and AI further strengthens this process by enabling real-time monitoring of performance development and rapid response to deviations or emerging needs. Performance evaluation thus becomes a tool for continuous development directly linked to organizational effectiveness. In the context of performance, employee development and learning gain increasing importance. Modern learning platforms, including e-learning and adaptive learning systems, allow for personalized learning trajectories that enhance the transfer of knowledge into practice. (Shahzad et al., 2021) The development process is closely linked with onboarding, which is transforming into a systematic, data-supported process for integrating employees into the organizational environment. (Bauer et al., 2007; Klein et al., 2015) Learning therefore becomes continuous and directly connected to performance evaluation—the more effectively this cycle is managed, the higher the likelihood of employee engagement and loyalty. Another critical dimension of HR transformation is diversity and inclusion, which constitute one of the central pillars of modern people management. Diverse teams offer a broader spectrum of perspectives and are capable of generating higher-quality solutions; however, these benefits are realized only in an environment of psychological safety. (Nishii 2013 In: Sojka & Svetozarovová 2016) Inclusion complements technological and analytical innovations by ensuring equitable access for employees and fostering a culture of trust. In a digital environment, inclusion also translates into fair algorithm design, data process transparency, and equal opportunities, making it a necessary condition for the ethical implementation of digital HRM. These aspects logically lead to talent management, which is gradually transforming from an exclusive model focused solely on identifying high-potential employees toward a systemic approach that considers critical roles and key competencies. (Collings et al., 2019) This shift enables more effective management of internal labor markets, supports

organizational flexibility, and increases employee retention. (Cappelli & Keller, 2017) Talent management therefore becomes a natural continuation of preceding processes, it is integrated with performance evaluation, learning, analytics, and inclusion, creating a cohesive framework for building organizational competitiveness.

2. Methods

In this article, we outline the findings from the CIPD´s survey of 1,174 UK-based HR bosses to shed light on HR´s operating model from a technology and data perspective. The article is based on a secondary data analysis. Respondents were from organisations with 50 or more employees worldwide – the size we'd expect technology like HR information systems (HRIS) to become crucial for keeping track of employee records. This CIPD´s survey was selected for several reasons:

1. Relevance and credibility – CIPD (Chartered Institute of Personnel and Development) is one of the most recognized institutions in the HR field, and its surveys are widely cited in both academic and professional communities.
2. Representativeness – the inclusion of organizations of different sizes and industries allows for a nuanced analysis of HR practices and technology adoption.
3. Focus on digitalization – the survey specifically addresses the use of HR software, information systems, recruitment tools, and workforce planning platforms, which directly reflects the ongoing digital transformation of HRM.

3. Results

The results of a survey conducted by the Chartered Institute of Personnel and Development (CIPD) among 1,174 HR leaders in the United Kingdom provide a detailed insight into the structure and technological support of HR activities in organizations with more than 50 employees. Under these conditions, the use of Human Resource Information Systems (HRIS) has become a necessary prerequisite for effective human resource management. The data indicate that HR departments most frequently oversee recruitment (84.2%) and HR system administration (81.9%). Other key activities include diversity and inclusion, compensation and benefits, employee development and learning, performance management, and onboarding. (CIPD, 2023) Conversely, areas such as workforce planning (46.2%) or employer branding (22.8%) remain largely outside the direct scope of HR (Figure 1).

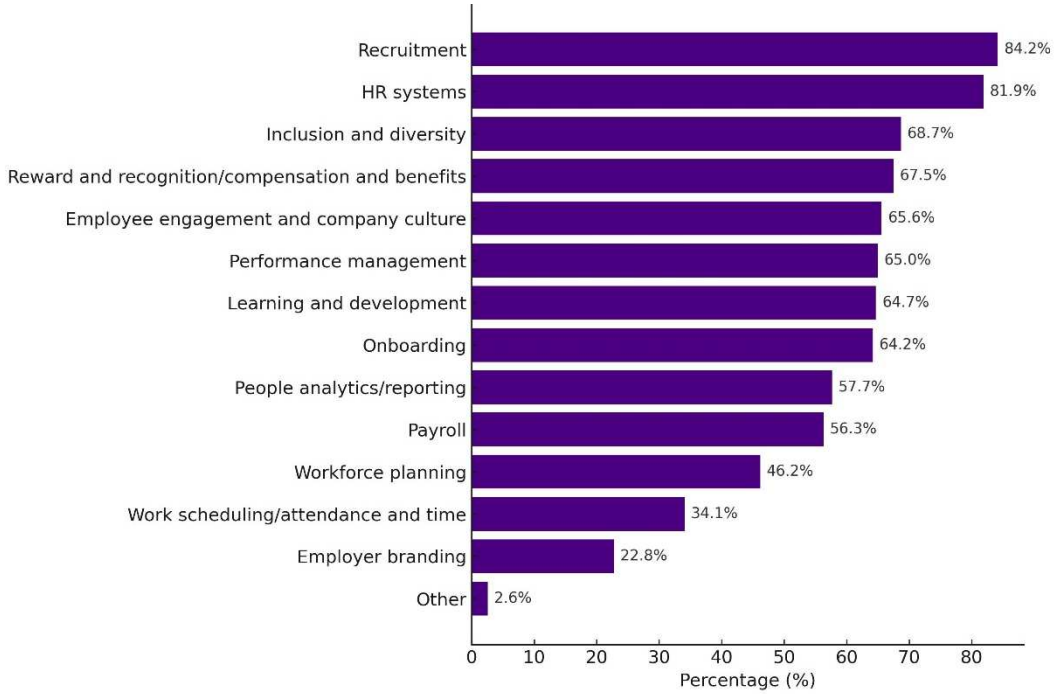

Figure 1. Activities the HR departments oversee in organisations
Source: Chartered Institute of Personnel and Development (2025)

In the context of digitalization and the use of HR software solutions (Figure 2), it is evident that the most widely adopted systems are HRIS (84.5%) and payroll software (82.9%). Fewer organizations make use of reward and recognition software (38.8%) or workforce planning tools (37.1%). This trend supports the theoretical framework emphasizing the importance of data-driven HR tools for strategic decision-making—particularly in workforce planning, where insufficient data collection (e.g., on skills gaps or talent availability in the labor market) can reduce the effectiveness of decision-making processes. (CIPD, 2023)

Figure 2. HR software or platforms used in your organisation
Source: Chartered Institute of Personnel and Development (2025)

An interesting finding is that although recruitment is among the most frequently managed HR activities, only 67% of HR managers reported the use of recruitment software. This discrepancy points to a potentially underutilized capacity of technological tools and suggests that the effective digitalization of HR processes has not yet been fully implemented across all organizations, which aligns with the theory of HRM digital transformation. (Marler & Parry, 2016) These findings correspond with the theory of Strategic Human Resource Management (SHRM), which emphasizes the importance of key processes related to the acquisition, development, and retention of talent as the main source of competitive advantage (Armstrong, 2020). The dominance of activities focused on recruitment and development also reflects the global trend toward so-called skills-based organizations, where skills represent the main criterion for workforce allocation and development. (World Economic Forum, 2023)

The results of the CIPD´s study confirm the existence of a causal relationship between technologies and the effectiveness of HR practices and processes. Larger organizations more frequently implement HRIS and payroll systems (82.9%), enabling them to collect comprehensive employee data and use it more effectively in decision-making. In contrast, weak data collection—particularly in the areas of skills and future workforce needs—limits the ability of organizations to engage in strategic workforce planning. CIPD highlights that as many as 46% of HR professionals do not collect any data on skills gaps or future labor market requirements. (CIPD, 2023) Similar conclusions are presented by Marler & Parry (2016), who stress that digitalization of HR processes alone does not guarantee higher efficiency. The decisive factor lies in the extent to which collected data are transformed into analytical outputs that support managerial decision-making. McKinsey (2021) further confirms that systematic people analytics contribute to reducing turnover, improving recruitment quality, and increasing employee productivity.

Another noteworthy aspect is the misalignment between the strategic importance of certain HR activities and the degree of technological support provided. While recruitment is the most frequently reported HR activity, only 67% of respondents confirmed the use of recruitment software or ATS. This technological deficit may lead to inefficiencies, as the absence of a digitalized system hampers the monitoring of recruitment metrics, reduces process transparency, and limits opportunities for optimization. (Parry & Strohmeier, 2014) A similar trend is observed in reward and recognition systems, where only 38.8% of respondents reported using dedicated software, despite its strategic importance for talent retention.

The CIPD findings should also be interpreted in the broader context of global HRM trends:

1. Digital transformation and AI in HR. Generative artificial intelligence is fundamentally reshaping recruitment, learning, and employee services. McCartney (2024) estimates that within five years, AI will impact more than one-third of the workforce.
2. Skills-based approach to talent management. The World Economic Forum (2023) highlights that by 2027 more than 40% of workers' skills will undergo significant change. Organizations that fail to implement systematic skills mapping through HRIS and analytics platforms risk mismatches between labor supply and demand, as well as increased talent shortages.
3. Reskilling and learning and developement as strategic priorities. Deloitte (2024) points to a shift from one-off training to continuous skills development, increasing the demand for integration of Learning management systems into HRIS. This trend supports the concept of learning in the flow of work, which enables employees to continuously upskill directly within their work processes.

4. Discussion

The results of the analysis highlight a clear transformation of the roles of HR departments within organizations. As illustrated by the first graph, the dominant activity of HR units remains recruitment (84.2%), followed by the implementation of HR systems (81.9%). This finding corresponds with trends that emphasize the digitalization and technologization of human resources. (Bondarouk & Brewster, 2016) Recruitment, as a key HR activity, also exerts a causal influence on the long-term performance of organizations, since the quality of newly hired employees determines the success of subsequent development, adaptation, and talent retention. The strong position of inclusion and diversity (68.7%) indicates a global shift toward value-driven HRM, which extends beyond purely administrative functions and aims to support organizational culture and social responsibility. Another significant category compensation and benefits (67.5%) points to the close relationship between a fair reward system and employee engagement. As highlighted in the literature, appropriately designed compensation schemes significantly influence not only retention but also employee satisfaction. (Kuvaas et al., 2017) An interesting finding is that employer branding appears in only 22.8% of organizations. This may indicate that while firms place emphasis on recruitment, they devote less attention to the long-term development of an attractive employer image. Such a misalignment may pose a strategic risk, particularly in the context of the global talent shortage and the phenomenon of the war for talent. (Collings et al., 2019)

The CIPD study demonstrated a strong technological dimension of HRM. The most widely used tools are HR information systems (84.5%) and payroll software (82.9%), confirming that the digitalization of administrative processes has become the standard. The high percentage of organizations using learning and development platforms (70.0%) reflects the trend of continuous learning (lifelong learning), which is a key response to the dynamic changes in the labor market. However, tools such as people analytics/reporting (55.0%) and performance management systems (53.2%) are used less frequently, pointing to gaps in the strategic use of data. Yet, the literature clearly emphasizes that HR analytics can deliver direct added value for decision-making and increase organizational effectiveness. (Angrave et al., 2016) Based on these results, it can be concluded that HR departments operate between two poles: on the one hand, they fulfill traditional administrative tasks (recruitment, HRIS, payroll), while on the other, they face increasing pressure for strategic transformation through data analytics, digital platforms, and skills-based approaches. The causal chains identified in the data underscore the need for systematic digitalization and the implementation of analytical tools.

From the perspective of HRM theory, these findings support the argument that HR has the potential to shift from an administrative center to a fully-fledged strategic partner. However, this shift is conditional upon technological readiness, data quality, and the ability to leverage analytics in decision-making. (Ulrich et al., 2008) Overall, the CIPD survey (2023) highlights that HR departments today combine traditional administrative functions with new, strategic tasks, with the effective use of HR

technologies becoming a key factor in supporting data-driven decision-making and strategic human resource management.

Conclusion

Based on the above, it can be synthesized that HRM transformation affects organizational performance through multiple interconnected channels. HR departments currently combine traditional personnel processes with digital solutions, with particular emphasis on recruitment, administrative HR systems, and compensation. Global trends such as diversity, inclusion, and employee development are gaining increasing importance; however, a disproportionality exists between the intensity of recruitment and the systematic development of employer branding. In the field of HR digitalization, it is evident that organizations concentrate primarily on the basic digitalization of processes, while advanced analytical tools and performance management platforms remain insufficiently widespread. This may represent a barrier to achieving a higher strategic level of HRM, which is conditional on the ability to work with data and link HR decisions to business outcomes. From a managerial practice perspective, it is therefore crucial to strengthen the use of HR analytics and to integrate digital tools not only into administrative but also into strategic HRM processes. At the same time, organizations should intensify efforts to develop employer branding and proactively build an inclusive organizational culture, which constitutes a significant determinant of employee engagement and loyalty.

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A Theoretical Analysis of Work Environment Factors in Relation to Healthcare Worker Engagement

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Abstract

Research background: Employee engagement is a key factor that influences employee performance, satisfaction and the overall functioning of healthcare facilities. This article contributes to a better understanding of how the work environment influences healthcare employee engagement.
Purpose of the article: The aim is to identify and analyze the work environment factors that influence health worker engagement.
Methods: The theoretical analysis presents a review of secondary data obtained from relevant articles and studies published in indexed databases in recent years.
Findings & Value added: The aim of this article is to summarize the literature on work environment factors in relation to health worker engagement and thereby contribute to the scientific debate on this issue.

Keywords: Work engagement, Work environment factors, Healthcare worker engagement, Nurses work engagement, Model JD-R

JEL classification: I18, J28, J81, M12

1. Introduction

The work environment has a significant impact on how employees feel about their work. If conditions are favourable, employees feel motivated, satisfied and willing to engage in their tasks. On the opposite, if the environment is unfavourable, employees may feel frustrated, exhausted and employee engagement is lower. In the healthcare sector, this is an important connection. Healthcare worker engagement is an important factor in the delivery of quality healthcare to patients and is influenced by many factors related to the work environment, such as workload, management style, physical conditions in the workplace, etc. The aim of this paper is to theoretically clarify and understand which conditions help employees to feel good at work and to give their full attention to it, based on a study of the literature.

In today's work environment, which is characterized by rapidly evolving professional demands and ever-changing organizational dynamics, work engagement has become a fundamental pillar of organizational health and individual well-being. Work overload, high work demands, long working hours and pressure can all lead to healthcare workers feeling overwhelmed and this can cause them problems not only physically but also mentally. They are also exposed to significant work challenges that can negatively affect their engagement in the long term (Ni, et al., 2024; Debets, M. et al., 2022). Huang et al. (2021) describe the work environment as the combination of factors that influence the work environment, such as job satisfaction, performance, involves, and intrinsic and extrinsic factors that make up the work environment.

Madden, Mathias, and Madden (2015) identify factors that positively influence the work environment and may reduce turnover intention and increase work engagement among nurses. These factors include autonomy, environmental control, physician-nurse relationship, and organizational support. There is a strong relationship between work environment characteristics and work engagement. Authors Li, Li, and Wan (2019) state that the work environment is a factor that can be used to determine an employee's level of engagement with the organization. Highly engaged nurses are energetic,

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enthusiastic about their work, which contributes to better job performance, achievement of work goals, and improved work-related outcomes.

1.1 Work engagement

In 1990, Willaim A. Kahn first introduced the concept of engagement and defined the concept of work engagement as using the members of an organization to play an active role in their work. He also stated that work engagement can affect personal growth and development at an individual level and equally have an impact at an organisational level (Muthmainnah et al., 2023).

Schaufeli et al. (2002) characterize work engagement as a work-related state of mind and is characterized by vigor, dedication, and commitment. Vigour is characterised by enthusiasm and perseverance in the performance of work tasks. Dedication is associated with engagement and a sense of importance that the employees attribute to their work. Absorption refers to the degree to which a person is immersed in his or her work (Sohrabizadeh and Sayfouri, 2014). They also mention burnout in the context of engagement, which is defined as a work-related syndrome and is manifested by exhaustion, cynicism, and ineffectiveness (Schaufeli et al., 2002). According to Bakker et al. (2011) work engagement reflects how employees perceive their job role and their work. High levels of work engagement are associated with doing better work due to experiencing positive emotions more often, as they motivate work performance. As well as this, engagement improves health and psychological wellbeing as a result of which employees are able to devote more energy to their work, further leading to valuing feedback and this has a positive effect on their future performance. At the same time, highly engaged employees are an asset to their colleagues because they are able to transfer their enthusiasm to them, thus increasing the effectiveness of the entire team (Bakker and Demerouti, 2008). Research has shown that work engagement acts as a mediator of the relationship between work environment and intention to change jobs (Szilvassy and Sirok, 2022). In a healthcare environment characterized by increasing work demands and limited resources, it is essential to provide a work environment that generates positive work attitudes and behaviours (Gupta et al., 2016).

Banerjee (2015) describes several important reasons why an engaged workforce is essential in 21st century healthcare. The first is the increased need for health services due to an ageing population, secondly it is the increased demand for health workers, and thirdly it is the ageing of the health workforce. The factors which are ageing population, urbanization and lifestyle have increased the number of people living with chronic diseases, this in turn will lead to a high demand for various health care services and will cause a shortage of health care workers. López-Cabaracos et al. (2020) point to the importance of an engaged health workforce specifically during the COVID-19 pandemic and as an example, they report that nurses with high levels of engagement experienced less burnout when faced with high work demands during the COVID-19 pandemic. When we talk about work engagement in healthcare, there are a number of factors related to it, these can be managed by organisations to improve the level of work engagement of their employees. Authors Van Bogaert et al. (2014) identify a number of reasons that affect nurses' work engagement, including: complexity of work, role ambiguity, high responsibility, psychological and physical workload, lack of job control, extent of control and workload, lack of opportunities for intellectual and professional growth, lack of leadership, lack of social support from supervisor and/or peers, challenging nurse-doctor collaboration, and imbalance between effort and reward.

1.2 Job Demands-Resources (JD-R)- model of work engagement

Schaufeli (2017) describes in more detail the JD-R model, which was introduced about fifteen years ago to understand burnout syndrome, a chronic work-related condition of psychological distress that is characterized by exhaustion and emotional exhaustion, mental distancing (i.e., cynicism and lack of enthusiasm), and diminished personal performance, which includes doubts about one's competence and contributions at work. After a few years, the model was expanded to include work engagement, the meaning of which we described in the previous subsection. This model determines how 2 specific sets of conditions can development employee welfare – these are job resources and job demand, which every job includes.

Job demand require physical and mental effort and all that comes with psychological and physiological costs (Lee, Shin, and Baek, 2017). Job demands represent the things at work that drain energy, such as work overload, conflicts with other people, and uncertainty of future employment. The

dimensions of job demands are divided into 7 dimensions: pace and quantity of work, psychological strain, emotional strain, physical effort, task changes, job ambiguity and future uncertainty. Job resources are aspects of work that help achieve work goals, that can reduce job demands, and that can enhance learning. Job resources are divided into seven dimensions: information, communication, participation, relationships with colleagues, relationships with supervisors, rewards, and autonomy at work (Lee, Shin, and Baek, 2017; Schaufeli, 2017).

The JD-R model is a validated model that specifies the relationships between both job and personal characteristics, leadership, employee satisfaction and performance. This model tells us that reducing work demands, increasing both work and personal resources, and stimulating engaged leadership prevents burnout and increases work engagement. If burnout is prevented and work engagement increases there are fewer negative and more positive outcomes for both employees and the organization (Schaufeli, 2017).

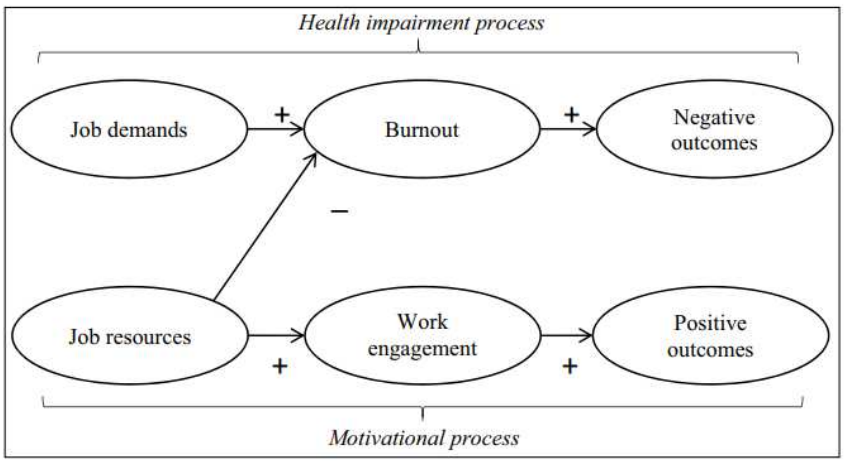

Figure 1. The Job Demands Resources Model
Source: Schaufeli (2017)

The JD-R model predicts 2 processes: a health impairment process and a motivational process. As we can see in Figure 1, high workload increases the risk of burnout and this leads to negative consequences (e.g., health problems, increased turnover) and on the other hand, work resources encourage work engagement and act as a motivator. Further in the model we can see that the absence of work resources also leads to burnout. Job resources can mitigate the impact of job demands on burnout (Bakker and Demerouti, 2017). Over the years, there have been several modifications to the model; however, the basic assumptions of the model have remained unchanged: job demands predict burnout, job resources predict job commitment, and job resources also have an impact on burnout (Lesener, Gusy and Wolter, 2019).

2. Methods

The paper has the form of a theoretical analysis aimed at a deeper understanding of the issue studied, which serves as a basis for further research. It provides a literature review and identifies key concepts and theoretical foundations of the issues of work environment factors and work engagement in the health sector, complemented by a review of research findings in this area. The literature was selected based on its relevance to the main topics of the working environment and work engagement in healthcare. We conducted a literature review, selecting peer-reviewed articles published in recent years that focused on studies relevant to the work environment and work engagement of healthcare workers. They were searched in academic databases such as PubMed, Scopus, and Web of Science.

The main objective of this paper is to examine how various factors in the work environment influence the level of work engagement among healthcare workers. In order to support the main objective, the article also focuses on the following sub-objectives:

- to identify which factors in the work environment have the greatest impact on work engagement,
- to examine differences in engagement by profession,
- to examine how different personal and organizational factors influence work engagement.

The resulting synthesis provides a comprehensive overview of the most important factors influencing the work engagement of healthcare workers. The factors analyzed include workload, emotional exhaustion, leadership, fairness, communication, working conditions, and psychosocial stressors, which are often mentioned in studies as key to the work engagement of healthcare workers.

3. Results

This theoretical analysis summarizes existing knowledge about the impact of the work environment on the engagement of healthcare workers. The following two subchapters present specific research findings - factors that influence engagement and the broader impact of the work environment on employees.

3.1 Factors influencing the work engagement of healthcare workers

Moreno-Matínez and Sánchez-Martínez (2024) conducted a survey through a questionnaire in which 321 professionals participated, 60.7% of whom were health professionals and 39.3% of whom were healthcare workers from the Central Catalonia region. They investigated what most influences health workers' engagement and how the work environment affects it. It was found that higher workload can be associated with higher work engagement - especially if health workers perceive their work as meaningful. On the other hand, emotional exhaustion has a negative impact on engagement. Job satisfaction was higher for those workers who had better pay conditions and more stable working arrangements. Another interesting finding was that doctors were more overworked than nurses and in general women showed higher levels of engagement but also emotional exhaustion. Factors such as irregular shifts and unpaid overtime contribute to decreased job satisfaction and work engagement.

Ge et al. (2021) in 2018 analysed the data of 1327 participants from The Chinese Sixth National Health and Services Survey in Sichuan Province. They found that the work environment plays a big role if workers are under pressure, work overtime, face stress, unpleasant relationships, and have no opportunity for career growth, their job well-being decreases. Further, their research has shown that workers who feel they put in a lot of effort at work but are not adequately rewarded financially or in the form of recognition feel less satisfied, are less engaged, and there is also an emphasis on perceived deterioration in health. If they are satisfied, motivated and engaged, they tend to rate their health better.

Sohrabizadeh and Sayfouri (2014) found that factors such as reward, management support, autonomy and feedback, opportunities for growth, and other positive job characteristics increase nurses' engagement. This exploratory study was conducted in 2 Iranian hospitals and 279 nurses participated.

A study by Shanafelt et al. (2019) showed that physicians in the U.S. have higher rates of burnout and lower satisfaction with work-life balance compared to other workers. This may significantly affect their motivation and work engagement.

An interesting perspective on the relation between work environment and nurses' work outcomes is provided by the research of Dutra, Cimiotti and Guirardello (2018), which was carried out in three hospitals in Brazil on a sample of 450 nurses working in 48 wards. Although this research focuses on burnout and intention to leave the job, these factors lead to reduced worker engagement. The aim was to investigate what aspects of the work environment influence job satisfaction, levels of burnout and nurses' intention to leave their jobs. Results showed that up to 26% of nurses reported high levels of emotional exhaustion, 28% were dissatisfied with their jobs, and 12% said they planned to quit within 12 months. The authors also identified key factors that negatively influenced job dissatisfaction - these were lack of control over the work environment and high levels of emotional exhaustion. Lack of staffing, emotional exhaustion and job dissatisfaction were related to the decision to leave employment. The quality of the work environment is a significant indicator of work engagement, job satisfaction and retention.

3.2 The impact of the work environment on work engagement

Debets et al. (2022) conducted a survey involving 385 doctors from academic and non-academic hospitals in the Netherlands. According to the research, work environment factors such as opportunities for professional development, participation in decision-making and good interpersonal relationships positively influence employee engagement. The factors mentioned above increase employees' motivation and engagement at work, resulting in better outcomes. High workload, lack of support, lack of development opportunities can reduce employee engagement and lead to burnout. These factors can reduce work capability and impair workers' well-being.

Hegazy et al. (2022) focused on examining the relationship between nurses' perceptions of the work environment in Egypt and their work engagement. The research was conducted on a sample of 400 nurses. The results showed that the majority of nurses (66.2%) perceived their work environment negatively. The factors that contributed most to this negative evaluation are:

- lack of support from supervisors,
- low level of participation in decision making,
- poor communication,
- high workload.

At the same time, more than half (55.5%) showed a low level of engagement. This research also showed a strong positive relationship between how nurses perceived their work environment and their work engagement.

The 630 primary care staff at the Ljubljana Community Health Centre (e.g. nurses, health assistants) showed a high level of engagement. Factors that supported this engagement were: good relationships with colleagues and supervisors, communication in the workplace, leadership style, space for professional development, and availability of resources needed for work. It was also confirmed in this research that soft factors of the work environment (e.g., appreciation, communication) can have a large impact on engagement as well as on the quality of care provided. This survey also looked at managers who were found to be less engaged, which they described as a surprising finding (Szilvassy and Sirok, 2022).

Kim, Lee and Lee (2023) found what work environment factors influence nurses' engagement in South Korea. They analyzed data from the 5th Korea Working Conditions Survey, which included 477 nurses. The aim was to identify how various factors such as leadership, work and personal resources affect nurses' engagement at work. The research shows that the most important factor is the quality of leadership - nurses showed higher engagement if they felt supported, acknowledged and treated fairly by managers. Further, perceiving their work as meaningful is important. Organisational justice is also an important factor, i.e. ensuring fair conditions (e.g. fair pay) and support from colleagues, which contributes to better teamwork. The factor representing involvement in decision-making was not a significant predictor of engagement. This article has shown that creating a positive, fair and supportive work environment is key to maintaining an engaged and motivated health workforce.

Since in the previous subsection we discussed the theoretical perspective on the JD-R model, we present research based on this model of job demands and job resources. Muthmainnah et al. (2023) in their study examined the relationship between job demands, job resources, job commitment and organizational commitment of nurses in a hospital setting. This model suggests that work engagement arises when work resources are sufficient to cope with work demands. The aim was to identify the factors that influence nurses' work engagement and how this influences their engagement with the hospital in which they work. The research showed that when there are positive work resources such as support from supervisors and peers, clear work assignments, and opportunities for professional development, they increase nurses' work engagement. Conversely, high workloads, lack of staff - which are part of the job demands - can lead to reduced engagement and even burnout. Further, it has been found that when nurses are more engaged, they are more loyal to the organization they work for and want to stay there, which also leads to lower turnover.These findings underscore the importance of creating a work environment that fosters nurse engagement. The research sample consisted of up to 200 nurses at Stella Maris Hospital in Makassar in Indonesia.

Healthcare workers face a variety of psychosocial stressors such as (Weyers et al., 2006):

- long working hours,
- night shift work,
- demands associated with patient care,
- medical disputes,
- workplace violence,
- emotional stress associated with poor interactions with patients and colleagues, and
- last but not least, they are plagued by poor career prospects.

4. Discussion

The findings of this theoretical analysis point to several key factors that influence the work engagement of healthcare workers, such as support from management, good workplace relationships, opportunities for growth, meaningful work, manageable workload, and fair conditions.

Positive factors include, for example, support from superiors, good interpersonal relationships, opportunities for professional growth, and fair working conditions (Debets et al., 2022; Kim, Lee, and Lee, 2023; Sohrabizadeh and Sayfouri, 2014). Healthcare workers who feel that their work is meaningful are more engaged, even when faced with a higher workload (Moreno-Matínez and Sánchez-Martínez, 2024).

Negative factors such as high workload, staff shortages, poor communication, and low involvement in decision-making contribute to reduced engagement, burnout, and dissatisfaction (Hegazy et al., 2022; Dutra, Cimiotti, and Guirardello, 2018; Shanafelt et al., 2019).

Some studies also point to differences between professions and genders. Differences between professions are confirmed, for example, by a study by Moreno-Matínez and Sánchez-Martínez (2024), which showed that doctors were more overworked than nurses and that women demonstrated higher work engagement but also higher emotional exhaustion. Similar findings were presented by Szilvassy and Sirok (2022), where managers were less engaged than other workers. Some studies point out that nurses felt a stronger need for support and communication (Kim, Lee and Lee, 2023; Hegazy et al., 2022; Sohrabizadeh and Sayfouri, 2014).

The job demands and resources (JD-R) model also provides an important perspective, stating that engagement increases when employees have sufficient resources, support, and conditions to cope with demanding work tasks. This is confirmed by research by Muthmainnah et al. (2023), which shows that positive job resources, such as support from superiors, clear tasks, and opportunities for development, increase nurses' engagement. In contrast, a lack of these resources leads to exhaustion and reduced engagement.

This means that the specific needs of different groups should be taken into account when improving the work environment.

The absence of empirical data represents a certain limitation. The results are based on studies with different methodological approaches, differing in context, sample, and geographical area. Not all professions or countries were equally represented in the analyzed studies, so the results cannot be fully generalized.

The results clearly show that a high-quality work environment influences the motivation, satisfaction, and retention of healthcare workers. Although this was a theoretical analysis, the results provide valuable insight and a basis for future research.

Conclusion

Several studies show that factors such as: support from management, good relationships among colleagues, meaning at work, opportunity for professional growth and adequate workload have the greatest impact on healthcare worker engagement. If employees feel supported at work, their efforts are valued and their opinions are heard they are more motivated and willing to stay in the job for the long term. These insights can help healthcare leaders to create better working conditions for employees.

Future research could focus on a deeper examination of work environment factors and which specific ones have the most significant impact on engagement, and on evaluating the effectiveness of specific practices that can improve the work environment.

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Conceptualizing Employee Engagement in Slovak Healthcare: A Basis for Empirical Research

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Abstract

Research background: This article addresses a crucial need to understand employee engagement within the Slovak healthcare system, given the sector's inherent challenges. It theoretically explores engagement's foundational principles, encompassing dimensions like organizational commitment and job satisfaction, and posits its critical role in fostering a high-performing and sustainable healthcare environment.
Purpose of the article: The primary objective of this paper is to highlight the critical role of engagement in fostering a high-performing and sustainable healthcare environment. By exploring the influence of factors like leadership, organizational culture, recognition, and professional development, this paper seeks to establish a conceptual understanding of how these elements can shape engagement levels within the Slovak context.
Methods: The research synthesizes existing academic concepts to establish a new conceptual model for employee engagement. This approach involves systematically analyzing foundational principles, dimensions, and potential influencing factors of engagement to apply them within the specific context of the Slovak healthcare system.
Findings & Value added: The article theorizes on the potential benefits of high employee engagement, including enhanced patient outcomes, reduced staff turnover, and increased innovation. It also concurrently theorizes on the unique challenges faced in cultivating such an environment within Slovakia's specific socio-economic and structural landscape. Employing a theoretical exploration method, the research systematically examines foundational principles to create a solid conceptual basis. The core value of this work is to systematically ground the issue of employee engagement within Slovak healthcare, offering a vital starting point for empirical studies and the formulation of hypotheses relevant to this national context.

Keywords: Employee engagement, Healthcare, Slovak healthcare

JEL classification: J53, M54

1. Introduction

Employee engagement stands as a cornerstone of organizational efficacy, wielding substantial influence over productivity, innovation, and employee retention (Lušňáková, 2022). Within the demanding and dynamic landscape of Slovak healthcare, the imperative of fostering heightened employee engagement is amplified due to the sector's direct impact on patient care and public health outcomes (Bharath & Sreedevi, 2020). Healthcare organizations that cultivate environments where employees are deeply connected to their work and committed to the organization's mission are more likely to exhibit continuous growth, demonstrating high levels of energy and a significant capacity for success (Halm, 2011). Slovak healthcare, characterized by its unique structure, funding mechanisms, and regulatory framework, presents specific challenges and opportunities for nurturing employee engagement. Recognizing and addressing these factors is critical for optimizing the performance of healthcare professionals and ensuring the delivery of high-quality, patient-centered care within the Slovak Republic.

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The complex interplay between organizational culture, employee well-being, and streamlined operational processes is fundamental to ensuring the long-term viability and excellence of healthcare services. This study seeks to provide a comprehensive exploration of employee engagement within Slovak healthcare, beginning with an examination of the current state, subsequently identifying critical challenges that hinder engagement, and culminating in the proposition of targeted strategies designed to cultivate a more motivated, connected, and productive healthcare workforce.

Several interconnected factors shape the landscape of employee engagement within Slovak healthcare. Workload and work-life balance exert a powerful influence, with the demanding nature of healthcare professions frequently leading to burnout and diminished engagement. Perceptions of fairness, encompassing equitable compensation, recognition, and opportunities for advancement, significantly impact how employees perceive their value within the organization (Hoxha et al., 2024). The availability of resources and support systems, including access to modern equipment, training programs, and supportive leadership, plays a vital role in enabling employees to perform their duties effectively and feel empowered in their roles. Organizational culture, defined by the prevailing values, norms, and leadership styles, profoundly affects employee morale and engagement. The sustained success and competitive edge of any healthcare organization are fundamentally dependent on its ability to attract, develop, and retain a highly skilled and engaged workforce, with strategic investment in human capital proving essential (Owusu & Gregar, 2021). Cultivating a healthcare environment where leaders prioritize and demonstrate support, compassion, respect, and appreciation for their staff is not merely beneficial but essential for achieving excellence in healthcare service delivery (West, 2013). Job satisfaction is not solely determined by isolated factors but emerges from a complex interplay of personal characteristics, managerial practices, and the overall work environment (Hoxha et al., 2024).

2. Literature review

Extensive research underscores the link between employee engagement and various positive outcomes in healthcare, including improved patient satisfaction, reduced medical errors, and enhanced organizational performance (Biddison et al., 2015). Engaged healthcare professionals demonstrate a greater commitment to their roles, exhibit heightened levels of energy and enthusiasm, and foster a deeper connection to their employers, ultimately translating into superior patient care and positive healthcare results (Armstrong et al., 2021). When employees are deeply connected to their work and the organization's mission, they are more likely to contribute innovative ideas, collaborate effectively with colleagues, and demonstrate resilience in the face of challenges. Conversely, disengaged employees may experience decreased productivity, increased absenteeism, and a higher likelihood of turnover, all of which can negatively impact the quality and efficiency of healthcare services. A positive, optimistic, and supportive workplace atmosphere, coupled with strong leadership trust, significantly elevates staff engagement, highlighting the importance of a nurturing organizational culture. Furthermore, studies indicate a clear correlation between staff well-being, patient safety, and the overall quality of care, reinforcing the necessity of prioritizing employee wellness within healthcare settings (Pavithra et al., 2022). Creating well-defined teams with clear objectives, interdependent working relationships, and regular performance reviews is critical for fostering teamwork, which is fundamental to delivering high-quality healthcare (West, 2013). It is ubiquitously recognized that healthcare professionals operate within inherently stressful environments, stemming from the gravity of their responsibilities, the emotional intensity of patient interactions, and the ever-present demands for precision and efficiency (Gümüş et al., 2021).

The analysis of Slovak literature on employee engagement in healthcare reveals a complex interplay between motivational factors, organizational culture, leadership, and remuneration. Engagement is not merely about job satisfaction; it encompasses the willingness of healthcare professionals to go beyond their formal duties, directly influencing the quality of patient care and organizational performance.

Across the reviewed studies, authors such as Jankelová, Psota, and Mucska (2019), Pažitný a Zajac (2021), Pažitný (2020), Szalay (2019) consistently highlight that engagement is shaped by both intrinsic and extrinsic factors. Intrinsic drivers include professional growth opportunities, recognition, and a sense of purpose, while extrinsic drivers involve adequate pay, supportive leadership, and a positive work environment.

However, the current state of engagement in Slovak healthcare is hindered by persistent barriers. Low remuneration, excessive administrative workload, limited career advancement, and hierarchical

management structures are repeatedly identified as key obstacles. These challenges not only reduce motivation but also contribute to staff turnover and the migration of healthcare workers abroad.

The literature also points to the pivotal role of leadership in fostering engagement. Leaders who communicate openly, involve staff in decision-making, and provide constructive feedback create conditions where engagement can thrive. Conversely, rigid and top-down management styles tend to suppress initiative and reduce commitment.

2.1 Strategies and Challenges to Employee Engagement in Slovak Healthcare

Specific challenges within the Slovak healthcare system may impede employee engagement. Limited resources and budgetary constraints can result in inadequate staffing levels, outdated equipment, and restricted access to professional development opportunities, all of which can contribute to employee frustration and disengagement. Bureaucratic processes and administrative burdens can further detract from employee satisfaction, diverting valuable time and energy away from direct patient care. Addressing these challenges requires a multi-faceted approach that encompasses systemic reforms, organizational interventions, and individual-level strategies. Systemic reforms may involve advocating for increased healthcare funding, streamlining administrative processes, and implementing policies that promote work-life balance for healthcare professionals (Karaferis et al., 2022).

Organizational interventions may focus on fostering a culture of open communication, providing opportunities for employee involvement in decision-making, and implementing recognition programs to acknowledge and reward employee contributions. Individual-level strategies may include providing stress management training, promoting self-care practices, and offering mentorship opportunities to support employee well-being and professional growth. The implementation of continuous feedback mechanisms and the development of targeted engagement and training programs are essential for integrating principles into the organizational culture, leading to tangible improvements in job satisfaction and healthcare quality (Hoxha et al., 2024). Exploring strategies for building a sustainable healthcare system necessitates a systems approach at every level (Al Shamry et al., 2024). This includes the integration of management strategies across domains such as resource allocation, quality control, workforce management, and technology implementation (Al Shamry et al., 2024). Healthcare organizations can foster settings that greatly enhance job satisfaction by mitigating workplace stress through optimized operations and waste reduction (Hoxha et al., 2024). A healthcare organization that cultivates a supportive environment, characterized by its attentiveness to the needs of its workforce and the provision of robust support systems, is statistically more likely to foster heightened job satisfaction, leading to increased career fulfillment and a stronger dedication to professional responsibilities.

By recognizing the achievements of healthcare workers, and supporting their performance, there will be improved job satisfaction and accepting the organizational change (Kim, 2021). Optimizing resource allocation through the strategic deployment of centralized procurement systems, integrated with real-time inventory management technologies, offers a concrete pathway to minimize waste generation and enhance operational efficiency, particularly within healthcare environments facing resource scarcity. Moreover, the implementation of quality improvement initiatives, such as Lean and Six Sigma methodologies, facilitates the reduction of errors and the streamlining of workflows, thereby enhancing both patient outcomes and operational cost-effectiveness. A robust and nurturing organizational culture serves as a critical buffer against the detrimental effects of demanding workloads, while simultaneously cultivating a profound sense of value, recognition, and belonging among healthcare professionals, thereby fostering enhanced engagement and commitment.

3. Methods and Conceptual Framework

The importance of sufficient staff in appropriate locations at the right times was made clear during the COVID-19 pandemic because of the unpredictable and high volume of patients (Yinusa & Faezipour, 2023). Workforce planning includes skill mix and appropriate staffing levels.

The systematic review will need to include staff from different disciplines and focus on hospital settings.

The purpose of this study is to explore the current state of employee engagement in Slovak healthcare, identify key challenges, and propose evidence-based strategies to foster a more engaged and motivated healthcare workforce. This research will utilize a mixed-methods approach, combining quantitative surveys to measure employee engagement levels with qualitative interviews to gain a deeper

understanding of the factors influencing engagement. The study population will consist of healthcare professionals working in various settings across Slovakia, including hospitals, clinics, and long-term care facilities. Quantitative data will be analyzed using statistical methods to identify significant correlations between employee engagement and various organizational and individual-level factors. Qualitative data will be analyzed using thematic analysis to identify recurring themes and patterns related to employee experiences and perspectives on engagement.

The expected outcomes of this study include a comprehensive assessment of employee engagement in Slovak healthcare, identification of key challenges and opportunities for improvement, and the development of practical recommendations for fostering a more engaged and motivated workforce. The study will also contribute to the broader body of knowledge on employee engagement in healthcare and provide valuable insights for policymakers, healthcare administrators, and other stakeholders seeking to improve the well-being and performance of healthcare professionals in Slovakia. Furthermore, the research findings aim to inform the development of targeted interventions and policies to address the specific needs and challenges faced by healthcare workers in Slovakia, ultimately contributing to improved patient care and a more sustainable healthcare system.

Addressing the multifaceted challenges within the healthcare sector necessitates a comprehensive approach. The development and implementation of training programs designed to enhance clinical skills are pivotal in equipping healthcare professionals with the requisite competencies to deliver superior patient care, while also fostering a culture of continuous professional development and lifelong learning. By investing in the professional growth of healthcare workers, organizations can enhance their capabilities and improve the quality of care provided.

In order to provide better well-being among Slovak nurses, further studies in different countries could be done to help (Gurková et al., 2011). Also to look at the demographic factors of each country in order to help with the shortage.

Based on the theoretical framework presented in the article, the following hypotheses are formulated for future empirical research:

H1: There is a significant positive relationship between the level of employee engagement and patient outcomes within Slovak healthcare institutions.

H2: There is a significant negative relationship between the level of employee engagement and employee turnover rates in Slovak healthcare institutions.

H3: Higher levels of employee engagement are positively associated with an increase in innovative practices and adoption of new technologies within Slovak healthcare institutions.

H4: The quality of leadership, as perceived by employees, is a significant predictor of employee engagement levels in Slovak healthcare.

H5: A positive organizational culture, characterized by trust, open communication, and shared values, mediates the relationship between leadership and employee engagement in Slovak healthcare institutions.

H6: The availability of professional development and recognition programs is positively correlated with higher levels of employee engagement among healthcare professionals in Slovakia.

Path to Empirical Validation

The theoretical exploration of employee engagement within the Slovak healthcare system provides a crucial conceptual foundation for a new and urgently needed research agenda. While our initial analysis identifies key relationships and potential benefits, these remain speculative until subjected to rigorous empirical testing. This discussion outlines how the formulated hypotheses can be addressed in future studies and explores the broader implications of their potential findings. It delves into the nuances of the Slovak context, arguing that any empirical investigation must be sensitive to the unique socio-economic and structural factors at play.

Validating the Engagement-Performance Link (H1, H2, H3)

The proposed relationship between employee engagement and key performance indicators—patient outcomes (H1), staff turnover (H2), and innovation (H3)—is the cornerstone of this research. The literature from other national contexts strongly supports these links. For example, studies in the United States and the United Kingdom have consistently shown that highly engaged nursing staff are associated with lower patient mortality rates, fewer medication errors, and higher patient satisfaction scores.

Similarly, the cost-benefit analysis of reducing staff turnover is a well-established economic argument for prioritizing engagement. The current theoretical model posits that these relationships are not only applicable but are critically important for the sustainability of the Slovak healthcare system, which grapples with both resource constraints and a talent drain.

Future research should seek to quantify these relationships. For instance, an empirical study could collect engagement data from a representative sample of hospitals and clinics across Slovakia using validated scales (e.g., the Utrecht Work Engagement Scale). This data could then be correlated with objective performance metrics. Patient outcomes could be measured using indicators like readmission rates, patient-reported experience measures, and adherence to quality protocols. Turnover could be tracked through human resources data, while innovation could be assessed via surveys on the adoption of new technologies, process improvements, or the implementation of new service models. Proving these links empirically would provide a powerful, evidence-based argument for policymakers and hospital administrators to invest in engagement-boosting initiatives.

Deconstructing the Antecedents of Engagement (H4, H5, H6)

Beyond simply measuring engagement's impact, a core purpose of this research is to understand its drivers. Hypotheses H4, H5, and H6 focus on the critical role of leadership, organizational culture, and professional development. In many Western European healthcare systems, transformational leadership—characterized by inspiring, motivating, and intellectually stimulating employees—has been identified as a key antecedent to high engagement. Our hypothesis (H4) suggests this holds true for Slovakia as well. However, the hierarchical and sometimes rigid management structures in Central and Eastern European public sectors could present a unique challenge to the widespread adoption of such leadership styles.

Furthermore, a supportive and positive organizational culture (H5) is not merely a "nice to have"; it is a vital mechanism that translates leadership behaviors into employee engagement. In a high-pressure environment like healthcare, where burnout is a constant threat, a culture of trust and psychological safety is paramount. An empirical study could use structural equation modeling to test whether a positive culture indeed mediates the relationship between leadership and engagement. This would not only validate the hypothesis but also provide a roadmap for interventions: it's not enough to train leaders; one must also actively cultivate the culture in which their behaviors can thrive.

Finally, the link between professional development and engagement (H6) is a critical one for a knowledge-based profession. Healthcare is constantly evolving, and a feeling of stagnation can quickly lead to disengagement. This is particularly relevant in the Slovak context, where access to continuous professional development might be unevenly distributed between urban and rural hospitals or across different specialties. Validating this hypothesis would underscore the need for strategic investment in training, skill-building, and career pathing as a key lever for improving engagement and, by extension, the quality of care.

The Unique Context of Slovak Healthcare

The theoretical grounding of this study in the Slovak context is what gives it its unique value, but also its primary challenge. The hypotheses must be tested with an acute awareness of the specific socio-economic and structural landscape. This includes:

- **Public vs. Private Sector Divide:** A significant portion of Slovak healthcare is state-funded, with a smaller but growing private sector. Engagement drivers and challenges might differ significantly between these two models due to variations in funding, management autonomy, and patient expectations.
- **Legacy Issues:** The healthcare system still carries some legacy structures from the socialist era, which may influence management styles, organizational culture, and perceptions of autonomy among staff.
- **Demographic Challenges:** Slovakia, like many Central European nations, faces an aging population and a "brain drain" of skilled medical professionals seeking higher wages and better working conditions abroad. Understanding how engagement can mitigate this talent flight is a crucial component of any future research.
- **Regulatory and Funding Environment:** The legal and financial framework of the Slovak healthcare system can limit institutional flexibility in rewarding employees, creating a potential barrier to engagement.

Future empirical research must account for these variables. A comparative study, for instance, could analyze data from both public and private institutions to see if the hypotheses hold equally true across both sectors. Similarly, demographic data and employee experience surveys could be used to explore how perceptions of leadership and culture vary across different generations of healthcare workers.

Implications and Future Research Avenues

The successful empirical validation of these hypotheses would have profound practical implications. It would provide policymakers and hospital administrators with concrete, actionable evidence to justify investment in human resource management strategies that prioritize employee well-being and engagement. This is not simply a matter of morale but of operational efficiency, patient safety, and long-term systemic sustainability.

Beyond the initial validation, future research could explore more nuanced questions, such as:

- The role of specific cultural factors within different regions of Slovakia in shaping engagement.
- The effectiveness of specific interventions (e.g., leadership training programs, flexible scheduling, peer recognition systems) on improving engagement metrics.
- The longitudinal impact of a highly engaged workforce on the financial health and reputation of healthcare institutions.

In conclusion, this theoretical paper has laid the groundwork for a robust and impactful research agenda. By transitioning from theoretical exploration to empirical validation, we can move from understanding *what* employee engagement is to providing concrete evidence for *why* it is indispensable for the future of Slovak healthcare. The hypotheses presented here are not just academic exercises; they are a call to action for a research community committed to improving the lives of both healthcare workers and the patients they serve.

4. Discussion

This article has established a conceptual foundation that bridges the theoretical understanding of employee engagement with its practical application within the Slovak healthcare system. While the current work is purely theoretical, it provides a critical roadmap for future empirical inquiry. The core of this discussion lies in articulating how the formulated hypotheses will guide researchers in validating the relationships proposed in our model and in uncovering the specific, nuanced dynamics at play in the Slovak context. It is essential to transition from a theoretical stance to an evidence-based one to provide actionable insights for policymakers and healthcare administrators.

The primary argument of our framework is that employee engagement is not merely a human resources metric but a fundamental driver of systemic performance and sustainability. The proposed links to improved patient outcomes (H1), reduced employee turnover (H2), and enhanced institutional innovation (H3) suggest that a disengaged workforce is a significant barrier to progress. Verifying these connections empirically would provide a powerful incentive for systemic change. Future research must, therefore, be designed to quantitatively measure engagement levels across various institutions and correlate them with objective data points on patient safety, staff retention, and the adoption of new medical technologies or operational efficiencies.

Furthermore, the article theorizes that engagement itself is shaped by a specific set of antecedent factors. The quality of leadership (H4) emerges as a central element, serving as a direct influence on how employees perceive their role and value within the organization. We also propose that a positive organizational culture (H5) acts as a crucial intermediary, translating effective leadership behaviors into tangible feelings of trust and commitment among staff. This highlights that simply mandating a new leadership style is insufficient; a supportive, open, and psychologically safe environment must be cultivated to maximize engagement. Finally, the role of professional development and recognition (H6) is identified as a key factor in preventing stagnation and fostering a sense of continuous growth and value among professionals. Empirical studies could use sophisticated statistical methods, such as mediation analysis, to confirm these causal pathways and provide a detailed understanding of how these factors work in concert.

The distinctiveness of this research lies in its focus on the Slovak context. Any future empirical study must acknowledge and control for the unique socio-economic and structural challenges identified in this paper, including the public versus private sector divide, the lasting impact of legacy organizational

structures, and the persistent issue of professional talent leaving the country. By taking these factors into account, empirical research will not only validate our theoretical model but also provide a tailored understanding that is relevant and applicable to the specific needs of Slovak healthcare.

Conclusion

In conclusion, the healthcare industry's pursuit of sustainability is intricately linked to the strategic integration of digital technologies within a supportive ecosystem, facilitating data-driven decision-making, optimizing resource allocation, and ultimately fostering a resilient, patient-centered healthcare paradigm (Fragão-Marques & Özben, 2022). Integrating sustainability principles into healthcare necessitates a comprehensive approach, encompassing resource efficiency, waste reduction, and workforce well-being (Woeber, 2013). Strategic workforce management, encompassing aspects such as recruitment, retention, training, and equitable compensation, constitutes a cornerstone of sustainable healthcare systems, ensuring a consistently skilled, engaged, and motivated workforce capable of meeting the evolving demands of patient care (Al Shamry et al., 2024).

This theoretical paper serves as a foundational step toward understanding the complex dynamics of employee engagement within the Slovak healthcare system. The conceptual model presented herein posits that engagement is not a standalone concept but rather a critical outcome influenced by several key factors. Our theoretical model posits that leadership behaviors, specifically those fostering motivation and trust, are central to cultivating an engaged workforce. A supportive organizational culture, which provides a psychologically safe and collaborative environment, is posited as an essential mediator in this process. Furthermore, the provision of robust professional development and consistent recognition for achievements are identified as vital levers for preventing stagnation and building a sense of purpose.

These factors are interconnected and must be addressed holistically, especially given the unique socio-economic and structural challenges of the Slovak context. Our work underscores that a successful strategy to improve engagement must be tailored to these specific national circumstances, rather than adopting generalized solutions from other healthcare systems. This paper's primary contribution is to systematically map these theoretical relationships, thereby creating a fertile ground for future empirical research. The validation of the hypotheses presented here will be crucial for moving this discussion from a theoretical framework to a data-driven imperative, providing actionable evidence for improving the sustainability and performance of Slovak healthcare.

Integrating sustainability principles into healthcare necessitates a comprehensive approach, encompassing resource efficiency, waste reduction, and workforce well-being (Woeber, 2013).

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How Artificial Intelligence is Changing the Future of Human Resource Management and the Labour Market

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Abstract

Research background: Artificial intelligence is revolutionising the field of human resource management. Traditional human resource management methods rely on manual processes and intuition, AI enables the automation and optimization of multiple processes in human resource management, especially in the areas of recruitment, selection, training and employee development. These technologies enable them to find, select, and train talented people faster and more efficiently, improving their overall results.
Purpose of the article: The aim of this article is to analyse and evaluate the potential impact of AI on the labour market, which is changing the future of human resource management to a high degree. At the same time, to highlight the results of surveys already conducted that assess the potential impact of AI in management.
Methods: The analysis of the theoretical knowledge of several foreign scientific research papers and studies points to the most interesting outcomes and claims in the area under study in the theoretical plane. At the same time, by analyzing these studies, the paper evaluates and presents the results of the research already conducted in the field of AI and HRM research, as an important trend of the present time and points out the possible implications in the future.
Findings & Value added: The benefits of AI in HR are immense, and it's time for companies to invest in these technologies to improve their workforce and stay competitive in today's rapidly changing business environment. The results of global surveys point to the fact that artificial intelligence is used more in some areas of HRM and less in others. However, it can only be concluded that the reasons for using AI in different areas of business will become more and more over time, despite the potential barriers and risks it brings with it. Finally, as AI becomes more integrated into HR practices, it will free up HR professionals to focus on more strategic initiatives and improve the overall effectiveness of the HR function.

Keywords: Artificial intelligence, Human resources management, Future trends

JEL classification: M00, M1, M12

1. Introduction

Artificial intelligence (AI) is key in human resource management in today's competitive business environment. Tecuci (2012; Soni 2022) states that AI is a rapidly developing technology enabled by the Internet that will soon have a profound impact on our daily lives. AI traditionally refers to an artificial creation of human intelligence that can learn, reason, plan, perceive, or process natural language. Such characteristics enable AI to bring enormous socioeconomic opportunities and socioeconomic challenges. According to Ilyas and Qadir (2024), AI is an emerging trend in human resources that has emerged as a recent phenomenon. However, it has significantly impacted people management and is seen as key to recruiting, training, developing and retaining employees in the workplace. Moreover, the current trend of incorporating machine learning and AI technologies into HR activities has the potential to lead to significant improvements in terms of increasing employee engagement and productivity in the workplace. Existing literature on artificial intelligence (AI) in human resource management (HRM) highlights its significant positive impact on the sector, with applications ranging from recruitment to

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training and development. However, there remains a significant research gap in a comprehensive understanding of the coherent and procedural structure governing the integration of AI into HRM. While studies acknowledge the potential benefits of AI, such as workload reduction, data analysis, and improved decision-making, deeper research on the strategic implementation and organizational impact of AI in different areas of HRM is lacking. Moreover, the literature suggests that despite the expectation of widespread adoption of AI, many businesses, especially in the recruitment process, have yet to fully embrace AI due to factors such as resistance to new technologies and lack of established applications (Ilyas & Qadir, 2024).

1.1 Artificial intelligence and human resources management

Artificial Intelligence is gradually becoming a phenomenon that is revolutionizing the area of HRM by providing efficient solutions for the management of people across industries. Most of the HR activities, for instance, recruitment, performance management, and employee training and development, have always been cumbersome and labor-intensive.

Human resource management is a separate and specialized function that all managers must perform. It is the branch of management that deals with the recruitment, selection, development and best use of employees. Thus, human resource management ensures that each employee makes the maximum contribution to the achievement of the organization's goals. Human resource management as we know it today is the result of several major interrelated developments since the industrial revolution (Soni, 2022).

Artificial intelligence consists of applications that operate autonomously, can adapt and make predictions or decisions, provide recommendations, or generate content such as text or images. AI enables automated problem solving to achieve a specific goal. Well-known AI applications include, for example, ChatGPT or Microsoft Copilot. Also consider using AI in the context of HR metrics, such as data-driven approaches to HR or HR analytics.

AI technologies offer significant opportunities to improve human resource management functions such as recruiting and talent acquisition, employee training, and more. We live in an era where AI capabilities are reaching new dimensions and are having a profound impact on how our businesses operate and will operate. HR leaders believe that the merging of AI with core HR functions will be an asset and a significant trend that will improve the overall employee experience. It will provide more capacity, more time and budget, and more accurate information to manage people decisively. According to Nilsson (2005), machines will be able to perform most of the tasks required by human intelligence, what we call human-level AI.

Existing literature points to several benefits of AI adoption, which include increasing business productivity by optimizing business operations and resources (Faulds, Raju 2020), business model transformation/reengineering (Duan et al., 2019), reducing employee costs and improving employee experience, job satisfaction, and customer service (Bughin et al., 2017; Faliagka et al., 2014). This has led to the increasing use of AI-based solutions in sub-functional areas of human resource management such as talent acquisition, video interviewing, employee training and development (Maity, 2019), performance appraisal, talent prediction (Upadhyay, Khandelwal, 2018). In this regard, recent reviews have outlined the role of AI in facilitating HR analytics and the impact of AI-based technologies on HR management processes and practices (Vrontis et al., 2021). These opportunities will be described in more detail in the following section.

1. Human Resources Strategy and Planning

Strategic human resource management planning is the initial function for human resource management. Managers use artificial intelligence technologies to assist in the decision-making process in order to achieve the most effective strategic planning. Data mining and knowledge discovery tools are used to gather data from both internal and external sources. This helps to aggregate the information needed to understand the current state of human resources and to predict, evaluate, and adjust the future management of the company. A report containing the necessary information is compiled with the help of statistical and modification functions of an intelligent decision support system (Kumari & Hemalatha, 2021).

2. Recruitment and Selection

As artificial intelligence can provide decision support systems that help map the most suitable professional profiles for a given job and reduce the average time to complete recruitment activities, it can be a powerful tool in recruiting and selecting suitable candidates. AI will help map the most suitable

professional profiles for a given job role. A decision support system could be developed using fuzzy logic, artificial neural networks, expert systems or genetic algorithms. AI can be used to create a virtual assistant that can answer questions posed by candidates, evaluate the actions of talented candidates in real situations (Jatoba et al., 2019). When it comes to recruitment and selection, AI enables the creation of a model of the ideal candidate by cross-referencing information about a company that has been profiled in the past. This approach then compares candidates for new job openings in terms of tests, experience, and information related to overall curriculum. It is useful to analyze each candidate in terms of how suitable they are to fill a vacancy in the (Jha et al., 2020).

3. Training and Development

During the training process, the robotic training instructor can use the visual scanning system to monitor each employee's daily learning progress, accurately calculate their overall level of attention as well as adjust the level and rhythm of instruction based on feedback from the employee being trained. In addition, a corporate trainer can use data analytics to decide which employees need to learn from a vast knowledge base, create customized curriculums for employees, and use technology to test and assess employee levels in a comprehensive manner. AI-enabled instructors can also become all-around helpers, capable of performing tasks such as assessing employee data and creating high-quality reports on their progress (Chen, 2022).

4. Performance Management

In an intelligent decision support system, the use of 360-degree approaches to performance appraisal as scientific methodologies can enable automated and successful employee performance appraisal. An intelligent decision support system is equipped with employee performance appraisal criteria and any other relevant data to develop performance appraisal findings (Tewari & Pant, 2020). At the beginning of the year, the goals of the enterprise can be mapped and written down. Subsequently, the system can perform a comprehensive analysis and evaluation based on individual performance goals, department head ratings, feedback from colleagues, and other selected criteria (Jia et al., 2018).

5. Compensation Management

The use of AI technologies in the employee remuneration process can help ensure fairness in reward management (Tewari & Pant, 2020). Using big data as input, artificial neural networks can be designed to be used as intelligent decision support systems, which can then be used to create a fair reward assessment system.

The following table (Table 1) provides an overview of the human resource management landscape before and after the integration of AI, highlighting the significant improvements and challenges that need increased attention in order to successfully manage this transition.

Table 1. An overview of the human resource management landscape before and after the integration of AI

Transformed HR Practice	Traditional Approaches	AI-Enhanced Approaches
Administrative Task Automation	Manual and laborintensive management of payroll, benefits administration, and data entry, with high error risk and timeconsuming processes.	AI automates repetitive administrative tasks, analyzing vast datasets to deliver conclusive results with consistent performance and without fatigue, significantly reducing errors and saving valuable time, allowing HR managers to focus on strategic objectives.
Recruitment and Selection	Manual, timeconsuming, and tedious process; difficulty in managing a large volume of applications; potential for selection bias.	AI facilitates the handling of large volumes of applications, enhances communication with candidates, organizes interviews, improves recruitment efficiency, reduces biases through skill matching and automated data analysis, saves time and money, and promotes diversity and inclusion in the recruitment process.
Career Management	Advancement is based on hierarchy and direct human interactions.	AI supports personalized guidance services, data analysis for tailored career paths, and proactive succession management through predictive analytics, optimizing guidance resources.

Training and Development	Traditional training methods do not meet personalized needs.	AI enables personalized training offerings through mobile coaches, optimizing learning efficiency. It also facilitates certification and skill acquisition via flexible programs tailored to individual needs.
Talent Management	Performance evaluations are primarily by supervisors, subject to subjectivity.	AI transforms dynamic talent management by predicting needs and customizing development paths and daily tasks, thus fostering better staff retention.
HR Planning	Focused on manually assessing future workforce needs.	AI uses predictive analytics and talent personalization to improve team collaboration and efficiency.
Workplace Quality of Life Management	Focus on manual evaluations and interventions, centered on ergonomics, health and safety, and employee satisfaction surveys.	AI leverages facial recognition, text analysis, and natural language processing technologies to assess psychoemotional states, improving understanding of employee needs and offering personalized solutions to enhance workplace quality of life.
Performance Management	Focus on past performances with annual evaluations.	AI is used for real-time feedback and data-based performance analysis.
Enhancing Employee Behavior	Approaches centered on reward equity, skill development through training, and managerial recognition.	AI's analysis of data, sentiments, and morale to predict and improve employee behavior, automated environments, and virtual assistants facilitate personalized interactions with HR departments.
Ethical and Legal Principles	Management of expectations and communication to prevent misunderstandings based on psychological and legal contracts.	AI integration while navigating ethical dilemmas (algorithmic bias, fairness, privacy, and discrimination) requires transparent AI systems, bias audits, clear data use policies, and a strong ethical culture.

Source: Benabou, Demraoui & Touhami, p.6 (2024).

2. Methods

The aim of this article is to analyse and evaluate the potential impact of AI on the labour market, which is changing the future of human resource management to a high degree. At the same time, to highlight the results of surveys already conducted that assess the potential impact of AI in management. The analysis of the theoretical knowledge of several foreign scientific research papers and studies points to the most interesting outcomes and claims in the area under study in the theoretical plane. At the same time, by analyzing these studies, the paper evaluates and presents the results of the research already conducted in the field of AI and HRM research, as an important trend of the present time and points out the possible implications in the future.

3. Results

The following section presents the results of surveys that have already been conducted to assess the potential impact of AI on human reource management. In this article, we would like to highlight a study that includes the report which is based on data from a representative survey of businesses in Austria conducted in November and December 2024. The baseline questionnaire was developed by The Service Desk for Artificial Intelligence set up at RTR. The survey was carried out by the Market Institute1 via telephone interviews using CATI (computer-assisted telephone interviewing). Due to the focus on internal human resources management, the survey focused on companies with 50 or more employees. The Market Research Institute carried out a random selection of undertakings and applied weighting adjustments to ensure representativeness. A total of 701 interviews were conducted with the selected enterprises. The interviews focused on the head of the department responsible for human resources. Prior knowledge of AI or AI law was not a requirement for participation. The following Figure 1 shows the fact that: *For what purposes does your company, or an external service provider acting on your behalf, utilize AI in the area*

of HR? We can observe that the surveyed companies, to a large extent, do not use AI for any human resource management purposes, or, alternatively, use AI in the process of solving routine administrative tasks.

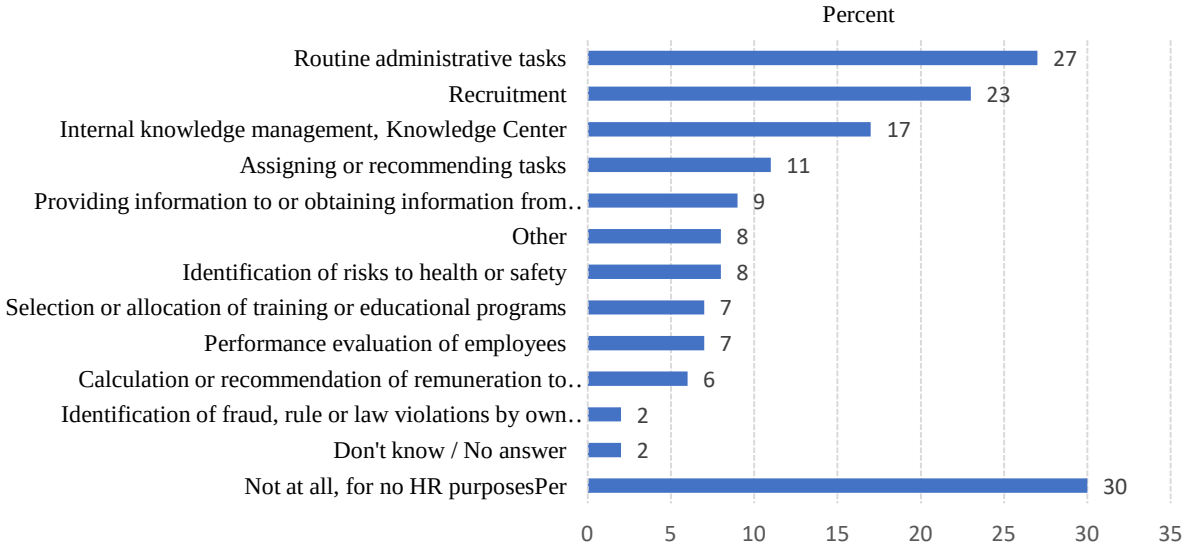

Figure 1. Areas of human resource management where artificial intelligence is used
Source: own processing according to www.rtr.at (2025)

Artificial intelligence provides a number of benefits to human resources. In an ever-changing business environment, staying competitive can be challenging. That's why artificial intelligence is becoming increasingly important in HR, providing professionals with the tools to offer scalable, immersive, and personalized learning solutions for their work teams. From streamlining recruitment processes to reducing unconscious biases in hiring, implementing AI in HR can bring a number of benefits to companies, ultimately leading to increased efficiency and productivity. Why the companies surveyed most often use AI in the HR area can be seen in the following Figure 2. Almost half of the company indicated cost saving, reduction in personnel costs, time savings.

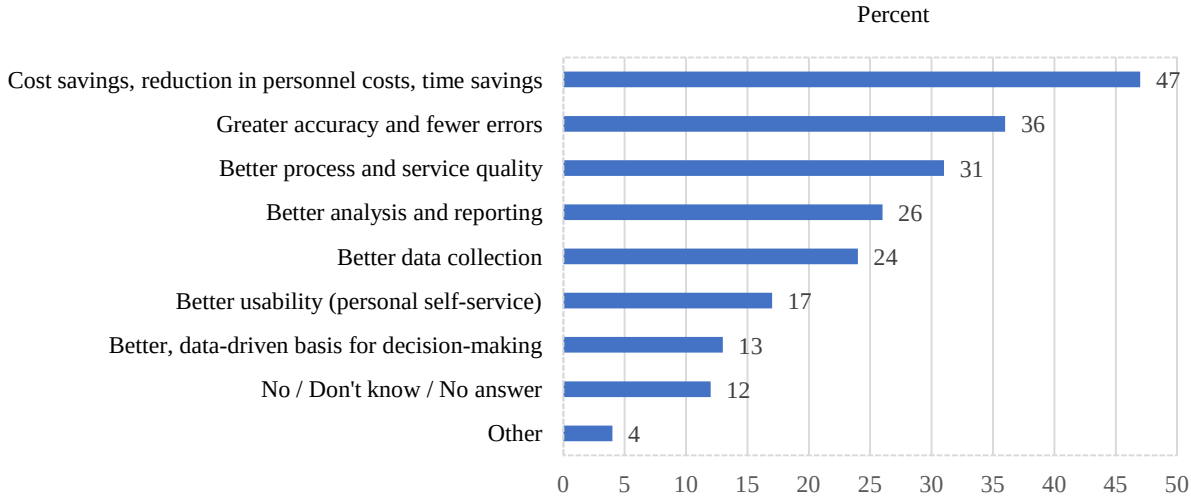

Figure 2. Reasons for using AI in a business
Source: own processing according to www.rtr.at (2025)

The following Figure 3 points out the possible barriers identify in the use of AI in HR. Based on the survey conducted, the following were identified:concerns about violation of data protection or privacy, lack of specialised knowledge or expertise in the company, too many legal requirements or unclear legal consequences, ethical concerns, poor traceability of results, concerns about inadequate or incorrect

outputs or decisions, difficulties with the availability or quality of required data, complex integration of existing data, devices, systems or software, reservations on the part of the workforce, employee representatives or management, potential discrimination, e.g. with regard to gender, age or disability and others. In addition, data protection remains a critical issue as HR systems often handle sensitive employee information. Organizations must implement robust security protocols to mitigate these risks.

Figure 3. Barriers identify in the use of AI in HR
Source: own processing according to www.rtr.at (2025)

Another survey focused on the use of AI in HRM in 2024 to understand the views and knowledge of AI held by HR professionals in Australia, as well as how AI and other related technologies are being used in the practice of HRM in organisations in Australia. This resulted in 236 valid responses from HR professionals across Australia, representing all industries, public, private, not-for-profit and academic institutions, and a diverse spread of organisation size. The results of the survey point to the following facts:

- Most HR professionals feel they have only a basic or average understanding of AI. Approximately 20% of HR professionals in academic institutions and the private and not-for-profit sectors reported having a good understanding of AI. The public sector was the least knowledgeable, with 22.9% saying they knew little or nothing about AI, compared to 14.9% in the private sector.
- The majority of HR professionals (83.9%) felt that the use of AI 'makes the HR function more efficient', although most (42.6%) agreed with this statement only to some extent (31.5% agreed, 9.8% strongly agreed), suggesting that there may be reservations about when and how efficiencies could be achieved. Consistent with this response, 88.9% also responded positively that the use of AI allows the HR department to focus on more strategic or 'higher value' activities - 16.2% strongly agreed, 37.4% agreed and 35.3% somewhat agreed.
- HR practitioners were asked to identify the issues that concern them most when using AI in HRM. Participants cited data security and privacy as the most pressing concerns (65.8%). Subsequently, drawing AI from poor quality data or evidence when used in HRM was a significant concern for 49.3%, as were bugs in AI systems (45.2%) (The State of AI in Australian Human Resources, 2024).

4. Discussion

By leveraging AI, HR teams can streamline recruitment processes, provide personalized learning and development opportunities, and improve employee engagement and retention rates. Simply put, the future of AI in human resource management is promising. HR practitioners should be able to solve current problems and adapt to future solutions that artificial intelligence offers to improve organizational development programs for a skilled and motivated workforce. Future research on the implementation of AI in HRM should aim to reduce barriers and develop the topic through further theoretical and empirical

contributions. By combining quantitative information from surveys and qualitative insights from case studies and interviews in research, it is possible to provide a comprehensive picture of the dynamics of AI adoption in different business areas. It would be interesting to conduct such studies in different organisational contexts, including public sector institutions, not-for-profit organisations as well as SMEs.

Based on the analysed studies and papers, we point out several facts. Artificial intelligence will make recruitment and selection processes of human resources management more efficient in the coming years, which will make it easier and faster for HR managers to identify the most suitable or talented candidates for a given job position. Personalised training and development programmes, which are part of employee training in companies, will become more common as AI algorithms will be used in the process of analysing employee data and, not least, in the process of introducing tailored training programmes and plans for each team member. AI chatbots will provide employees with constant support day, night, throughout the week, helping them to solve even unexpected problems quickly and efficiently. Predictive analytics will be used to forecast employee turnover and identify at-risk employees, so HR managers will have no problem retaining talented employees. Performance management feedback will become more objective as AI-based solutions automate the collection of performance data and provide real-time feedback.

Conclusion

By leveraging AI, HR teams can streamline recruitment processes, provide personalized learning and development opportunities, and improve employee engagement and retention rates. The benefits of AI in HR are immense, and it's time for companies to invest in these technologies to improve their workforce and stay competitive in today's rapidly changing business environment. The growing use of AI in HRM is driven by its impressive track record and is expected to become standard across all businesses in the coming years. Artificial intelligence enables HR managers to minimize administrative tasks, make more informed decisions about hiring and recruiting, training, employee compensation, and generate valuable employee data in the cloud through human-machine learning collaboration. Of course, it's important to point out how individual AI applications that focus on human resources enhance favorable outcomes while mitigating adverse effects. The impact of the socio-technological environment, including effective training, dealing with anxiety, managing change and improving employee skills, can lead to positive outcomes. At the same time, it is equally important to consider individual employee factors such as his or her personality, emanation and emotional intelligence as they have the potential to influence business results.

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Growth and Survival Strategies of Small and Medium-sized Enterprises in Slovakia

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Abstract

Research background: Small and medium-sized enterprises (SMEs) remain the backbone of the Slovak economy; by 2025 they will account for more than 99% of all businesses and provide two to three jobs in the private sector in the EU and Slovakia. After the pandemic, SME investment activity has recovered and is currently 10% higher than before 2020, while financing constraints have fallen to historically low levels (<0.1% of firms according to EIBIS). Nevertheless, high interest rates, increased regulation and a volatile global environment still limit access to traditional sources of financing.
Purpose of the article: The aim of the study is to analyze the growth and survival strategies of Slovak SMEs, with particular attention to the potential of alternative forms of financing and the development of the capital market in conditions of economic uncertainty.
Methods: A qualitative analysis of secondary data from the Web of Science, OECD and EIB databases was used - including the latest SME financing score and official reports from the ministries of the Slovak Republic. The comparative analysis covers a comparison of the Slovak environment with developments in the Czech Republic, Hungary and Poland. The research is analytical, without primary data collection.
Findings & Value added: Slovak SMEs are still mainly dependent on bank loans in 2025, but only ~5% use the capital market. The main barriers remain high transaction costs, complex legislation and low financial literacy of entrepreneurs. Digitalization and climate resilience are growing rapidly - over 76% of companies have applied advanced technologies and 25% have taken steps in the field of climate adaptation. International examples show that targeted government programs (IPO funds, tax breaks, education) significantly improve SMEs' access to alternative capital. The research brings specific recommendations for policymakers: establishing a pre-IPO fund, introducing legislation for REITs/SICAVs, expanding investment literacy, and developing digital capabilities. The implementation of these measures will increase the competitiveness of SMEs and support the long-term diversification of growth sources in Slovakia.

Keywords: Small and medium-sized enterprises, alternative financing, capital market, business growth, IPO

JEL classification: G24, G32, G38, L25

1. Introduction

Small and medium-sized enterprises (SMEs) are the backbone of nearly every modern economy. In the European Union, they account for over 99% of all businesses and provide approximately two-thirds of all private-sector jobs, contributing critically to stability, innovation, and social cohesion (Eurostat, 2024). In Slovakia, SMEs constitute an even larger share, representing 99.9% of active enterprises, generating over half of the nation's added value, and employing about 74.5% of the business workforce (European Commission, 2021). Recent data confirms that post-pandemic SME activity is recovering, with projected employment growth of 0.9% and real value-added growth of 1.7% for Slovak SMEs this year. Micro-

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enterprises are leading this rebound, outperforming larger categories in both employment and value added (Slovak Business Agency, 2021). Their growth and survival have a direct impact on the competitiveness and innovative capacity of the country.

Despite their economic importance, Slovak SMEs face persistent challenges. Nearly 75% of new small businesses fail within five years, with failure rates peaking in the critical third year (Kalemli-Ozcan et al., 2020). Key risk factors are low profitability, poor liquidity, and high debt levels. Traditionally, Slovak SMEs have relied almost exclusively on bank loans, with only about 5% accessing capital markets. This reliance has been further strained by rising interest rates, inflation, and tightening credit standards (Slovak Business Agency, 2021; von Imhof, 2021). These financial constraints are compounded by systemic issues such as high tax and social security contributions, complex administrative procedures, and slow permitting and registration processes that hinder sustainable business development.

Research Question: How do Slovak small and medium-sized enterprises (SMEs) adopt growth and survival strategies, with a focus on the potential of alternative forms of financing and the development of the capital market in conditions of economic uncertainty?

The aim of this article is to analyze how Slovak SMEs manage growth and survival, focusing on evolving capital market conditions, best practices from neighboring countries, and pragmatic steps for integrating SMEs into alternative financing channels to boost their competitiveness and resilience (von Imhof, 2021).

1.1 New Trends and Challenges for SMEs

In 2025, Slovak small and medium-sized enterprises (SMEs) face significant strategic challenges due to new regulations and the need for rapid adaptation. A key development is the extension of obligatory ESG (Environmental, Social, and Governance) reporting to smaller businesses, which now requires them to document sustainability performance, energy consumption, carbon footprint, and social responsibility metrics. While these new compliance obligations present substantial managerial demands, they also offer an opportunity for organizational transformation (PwC Slovakia, 2021). To improve their survival prospects, Slovak SMEs need to focus on several critical areas. One of the most important is strengthening strategic management and accelerating digitalization. According to recent OECD assessments, only 13% of Slovak businesses are considered highly digitalized, which is well below the EU average of 18% (OECD, 2021). On the other side, in recent years, we have noticed an increase in the importance of the shared economy, which has seen significant growth with the development of online platforms and which, with its disruptive approach, is becoming a new economic phenomenon (Viglaský, & Tóthová, 2024). This lag in digitalization represents a critical vulnerability in their competitiveness and highlights a need for a concentrated effort to adopt modern digital tools and processes. The continued growth and sustainability of these businesses will depend on their ability to adapt quickly, embrace these tools, and comply with evolving regulatory frameworks (SDA Bocconi, 2025; Eutech, 2025; Bianchini, & Sancho, 2025). Support initiatives are being introduced to help SMEs navigate this complex environment. For example, the national "Green for Businesses" program, launched in May 2025, provides financial and technical assistance to SMEs for investing in renewable energy systems. This not only helps them reduce operating costs but also lowers their environmental impact (Slovak Business Agency, 2025; Stavebný magazín, 2025). By taking advantage of such programs and integrating ESG policies into their daily operations, SMEs can improve their long-term viability and contribute to a more sustainable economy.

2. Methods

This research employs a strictly qualitative and analytical approach, structured around three key pillars to provide a comprehensive analysis of the Slovak small and medium-sized enterprise (SME) sector. The qualitative methodology is grounded in established research designs that emphasize depth of understanding through secondary data interpretation and systematic synthesis (Klein & Todesco, 2021).

2.1 Secondary Data Analysis

The investigation relies on the most current secondary data from leading international organizations, including the OECD, the European Commission, the World Bank, and Eurostat, as well as official Slovak policy documents, such as the SME Fact Sheet 2025. These sources offer a comprehensive macroeconomic, policy, and business environment context for the Slovak SME sector. The analysis covers critical areas such as SME performance, access to finance, innovation, and the regulatory and

administrative landscape. Secondary data analysis provides a robust, evidence-based foundation for understanding the current state and challenges facing Slovak SMEs (OECD, 2021).

2.2 Comparative Analysis

To contextualize the findings, this study includes a comparative analysis of SME development and capital market trends in the Czech Republic, Hungary, and Poland. These countries were chosen because of their geographical proximity, shared historical and policy backgrounds, and similar economic structures. The benchmarking process focuses on comparing policy reforms, the evolution of alternative financing channels, and best practices in SME support frameworks. Comparative case analysis is recognized as a powerful method to derive transferable insights across similar economic contexts (Saunders, Lewis & Thornhill, 2019)

2.3 Literature Synthesis

A systematic review and synthesis of peer-reviewed literature were conducted with explicit focus on Q1 and Q2 journal articles indexed in the Web of Science Core Collection. This analytical approach enabled targeted selection of high-quality, rigorously reviewed studies with direct relevance to the strategic growth of SMEs in Slovakia. Concentrating on publications between 2020 and 2025 captures contemporary empirical insights reflecting post-pandemic turbulence and simultaneous emergence of technological, regulatory, and sustainability-driven demands. The literature synthesis further validates the multidimensional pressures faced by SMEs and the centrality of dynamic adaptation strategies (Klein & Todesco, 2021) The methodology underlying this synthesis is strictly analytical, with no reliance on primary data collection such as surveys, interviews, or experiments. This ensures that the perspective remains objective, evidence-driven, and verifiable against established secondary sources. (Creswell & Poth, 2018)

3. Results

3.1 The Dominance of Bank Financing

Slovak small and medium-sized enterprises (SMEs) remain heavily dependent on bank financing. Approximately 76% of their financial resources came from bank loans as of 2025. This reliance mirrors a broader Eurozone trend, where bank lending is the dominant financing method for roughly 82% of businesses, according to surveys by the European Commission and the European Central Bank (ECB). However, a significant shift has occurred since the pandemic. Post-pandemic tightening of bank lending standards, increased risk-aversion, and rising interest rates have made it more difficult for SMEs to secure loans. The loan application rejection rate for SMEs rose sharply from around 5% in the first quarter of 2022 to 16% in the second quarter of 2023, signaling a growing financing gap. As a result, an increasing number of Slovak SMEs are being forced to explore alternative financing mechanisms beyond traditional bank credit. This pie chart displays the breakdown of funding sources. The largest segment, Bank loans, is shown in blue and makes up 76.0% of the total. Other sources, represented in green, account for 19.0%, while the smallest portion, Capital market, is shown in orange at 5.0%. The chart clearly demonstrates that bank loans are the dominant source of funding.

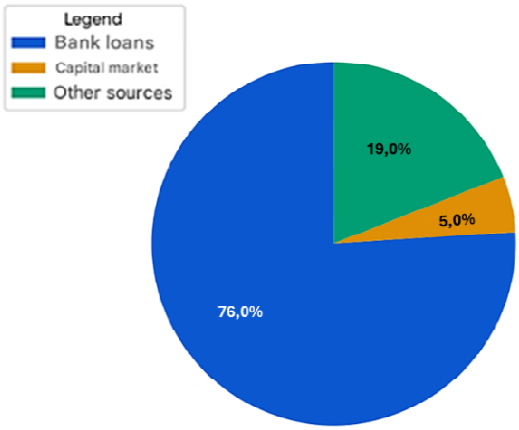

Figure 1. Sources of financing for small and medium-sized enterprises (SMEs) in Slovakia, 2025
Source: Slovak Business Agency (2025).

3.2 Barriers to Capital Market Entry

Despite the recognized benefits of capital market financing, such as access to long-term growth capital and risk diversification, Slovak SMEs face multiple, interconnected barriers to participation:

- **High Costs:** The initial and ongoing costs tied to initial public offering (IPO) processes, compliance, and maintaining public company status can be prohibitively high, especially for smaller firms.
- **Complex Regulations:** European regulations like the Market Abuse Regulation (MAR) and the Prospectus Directive require significant administrative compliance. This often demands costly legal and financial expertise that is often beyond the capacity of many SMEs.
- **Lack of Specialized Advisory Services:** SMEs frequently struggle to afford or access the specialized legal, accounting, and advisory firms that are essential for a public listing, which increases the complexity and risk of market entry.
- **Low Financial Literacy and Trust:** A pervasive lack of sophisticated financial knowledge among SME owners, coupled with limited trust in capital markets and institutional investors, further hinders active participation.
- **Emerging ESG Requirements:** New environmental, social, and governance (ESG) reporting obligations add another layer of compliance. While they increase operational burdens, they also offer pathways to ‘green’ financing, which few SMEs have yet been able to utilize.

3.3 Examples from Neighboring Countries

Several policy initiatives from Central and Eastern European neighbors illustrate actionable measures Slovakia could adopt:

- **Czech Republic:** The National Development Bank has established an IPO fund that provides capital support and helps cover SMEs’ upfront IPO costs. They also created an accessible online "Capital Guide" portal that educates SMEs about alternative financing and compliance steps, which boosts financial literacy.
- **Hungary:** Hungary's robust SME strategy includes a mentoring program designed to prepare SMEs for public offerings and a dedicated National Stock Exchange Development Fund, which co-invests in prospective IPO companies to mitigate risks and boost confidence.
- **Poland:** The government has implemented a dedicated SME Capital Market Development Strategy, which includes tax incentives for investors supporting small and medium-sized enterprises and simplified regulatory procedures for firms entering alternative trading platforms like NewConnect. Additionally, Poland’s state-backed financial institutions actively promote venture capital and mezzanine financing schemes, ensuring that innovative SMEs can access growth capital without excessive administrative burdens.

These regional best practices demonstrate that combining financial incentives, education, and public-private co-investments can effectively lower barriers and stimulate SME integration into capital markets.

Table 1. Overview of companies in the V4 countries

Enterprise size	Czech republic		Hungary		Poland		Slovakia	
	Number of enterprises	% share	Number of enterprises	% share	Number of enterprises	% share	Number of enterprises	% share
Micro enterprises	1 080 000	97.4%	924 000	88.4%	1 350 000	61%	220 000	77%
Small enterprises	34 000	3.1%	67 000	6.4%	650 000	29%	40 000	14%
Medium enterprises	6 825	0.6%	54 000	5.2%	210 000	10%	26 500	9%
SMEs total	1 120 825	1	1 045 000	1	2 210 000	1	286 500	1

Source: Eurostat. (2024)

Table 1 shows the structure of enterprises in the V4 countries based on enterprise size. This is most pronounced in the Czech Republic (97.4%) and Hungary (88.4%), which highlights their dependence on very small enterprises. In contrast, Poland has a more balanced structure, with micro-enterprises representing a smaller share (61%) and a larger share of small (29%) and medium-sized (10%) enterprises. Slovakia is located between these extremes, with micro-enterprises accounting for 77% of the total.

Table 2. Comparative analysis of access to financing and support for SMEs in the V4 countries

Country	Dominant source of financing	Barriers to entering the capital market	Examples of good practices
Slovakia	Bank loans (~76%)	High transaction costs	Use of R&D tax incentives
		Comprehensive legislation	Focus on public support through EU structural funds
		Low financial literacy	
Czech Republic	Bank loans, leasing, factoring, alternative sources (venture capital, crowdfunding)	Lack of capital for start-ups	IPO fund to cover initial costs
		Low knowledge of new financial instruments (IPOs, debt securities)	Online portal "Capital Guide" increasing financial literacy
Hungary	Bank loans, state subsidies and guarantee programs	Lack of capital for SME development	National Stock Exchange Development Fund (including investments in IPOs)
		The need to support green and innovative investments	Mentoring program for preparation for public offerings
Poland	Bank loans, leasing, grants, alternative sources (venture capital, factoring)	High taxes and levies Legal uncertainty and regulatory complexity High labor costs	SME Liquidity Support Programs Growing Investment in Technology Startups and Green Projects

Source: Eurostat. (2024)

Table 2 describes the financial environment for businesses in the V4. It highlights that bank loans are the main source of financing in all four countries, with Slovakia showing the highest dependence (76%). Key barriers to capital market entry include a lack of capital for startups, high transaction costs and low financial literacy. The table also identifies country-specific challenges, such as Poland's high taxes and regulatory complexity and Slovakia's problems with complex legislation.

4. Discussion

The findings of this study confirm that the high dependence of Slovak SMEs on bank loans significantly restricts their resilience and growth potential in the face of contemporary economic shocks such as inflationary pressures, rising interest rates, and post-pandemic market volatility. Empirical evidence highlights that firms which actively diversify their sources of capital—including engaging with the capital markets and alternative funding instruments—tend to experience higher sustainable growth, improved financial stability, and greater adaptability.

International case studies and policy analyses demonstrate that transformative improvements are attainable through a multi-faceted approach combining legislative reform, public-private partnerships, and financial literacy initiatives. These elements can collectively dismantle the key obstacles of high costs, regulatory complexity, and information asymmetry that continue to limit SME participation in capital markets. Leading international institutions emphasize several priority actions:

- The World Bank advocates for a national capital market development strategy that facilitates cooperation between public authorities, private investors, and business stakeholders to create an SME-friendly financing ecosystem.
- The European Union's Technical Expert Stakeholder Group (TESG) for SMEs recommends measures such as regulatory simplification, enhanced pre-IPO support programs, and the introduction of fiscal incentives to stimulate SME access to capital market financing.

Specific examples from Central Europe illustrate successful policy frameworks:

- In Hungary, the National Stock Exchange Development Fund plays a pivotal role by providing co-investments in SMEs preparing for IPOs, effectively reducing financial barriers and sharing risks. This is complemented by a mentoring and refinancing scheme which offers professional advisory services and reimburses up to 50% of IPO-related costs, alleviating both financial and knowledge constraints.

Countries should learn from examples of best practice, identify successful strategies that can be adapted or replicated in their own conditions. (Kučera et al, 2023). Adopting these international best practices in Slovakia could substantially enhance SME financing dynamics by:

- Removing financial and administrative barriers through tailored funding instruments such as pre-IPO funds, co-investment vehicles, and tax-advantaged financial products like REITs and SICAVs.
- Establishing comprehensive educational and advisory platforms to improve financial literacy, ESG integration, and investor relations skills among SMEs.
- Fostering greater collaboration between public entities and private investors to design scalable, sustainable support systems that align with the Slovak economic context.

Implementing such policies would not only empower Slovak SMEs to better access alternative capital but also contribute to building a more diverse, innovative, and resilient national economy capable of withstanding future global shocks and enhancing long-term competitiveness.

Conclusion

To secure sustainable long-term growth and economic stability, Slovak small and medium-sized enterprises (SMEs) must transition from an overwhelming dependence on bank financing toward a diversified financing ecosystem that includes capital markets, alternative financial instruments, and domestic capital mobilization. The findings of this study show that Slovak SMEs remain predominantly reliant on traditional bank financing in 2025, with approximately 76% of their financial resources coming from bank loans, while only about 5% use the capital market. This dependence limits their resilience and growth potential, especially in a volatile economic environment.

Slovakia should develop and adopt a comprehensive national capital market development strategy in close collaboration with the European Union to ensure alignment with EU fiscal and regulatory frameworks. This strategy is fundamental to establishing a stable macroeconomic environment and robust legal infrastructure, prerequisites for an effective and SME-friendly capital market. Through this, SMEs would gain access to diverse and long-term funding options, crucial for supporting innovative, growth-oriented ventures that often lack traditional collateral.

To implement this strategy, Slovakia needs targeted legislative reforms introducing and modernizing financial instruments such as Real Estate Investment Trusts (REITs) and updated Sociétés d’Investissement à Capital Variable (SICAV) funds. Additionally, the creation of a state-backed pre-IPO fund is imperative to offset the high initial costs associated with public listings for promising SMEs. Such a fund would reduce investor risk, improve market confidence, and encourage private capital deployment at scale.

Mobilizing domestic capital is essential for strengthening the SME financing landscape. Slovakia should explore mechanisms to engage its pension funds and expand offerings of retail government bonds aimed at directing local savings toward domestic enterprises and infrastructure investment. Recent government proposals envisage allowing voluntary pension contributions into national growth projects (including housing, transport, and energy infrastructure), capped initially at around 5%, thus bridging long-term financing gaps and supporting economic resilience.

Concomitant to financial reforms, significant resource allocation should be invested in entrepreneurship and investor education. The importance of education at every age, and especially in seniors, is also confirmed by research by Bursová et al (2024). As the authors Kondrla et al. (2023) claim, The starting point is a reflection on the philosophical background of education as a repetition and production of the same. Dedicated online portals, regional workshops, and analytical reporting platforms can significantly raise financial literacy, ESG competence, and investor transparency—key prerequisites for vibrant capital markets. Enhanced visibility for SME entrants through analytical reports would empower investors with better decision-making tools and augment market liquidity.

The coordinated implementation of these recommendations will not only reinforce the financial foundation and growth capacity of Slovak SMEs but will also contribute materially to the overall competitiveness and economic dynamism of Slovakia. By broadening financing sources and fostering a supportive ecosystem, Slovakia can better enable its SMEs to innovate, scale sustainably, and withstand future economic disruptions.

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Benefits of Using Key Performance Indicators in Management Process in Industrial Enterprises

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Abstract

Research background: The exceptional usefulness of key performance indicators lies in the fact that they help each area of the business to develop at a rapid pace and implement the strategy chosen by the management for the prosperity of the organization. The key performance indicators are a quantifiable measure of effectiveness, defined and limited in time and tied to the achievement and implementation of a specific goal. They represent specific and real goals that management and work teams should strive for, stages for measuring progress and observations, insights and conclusions that help employees in the organization make optimal decisions. The application of key performance indicators is wide-ranging and covers almost all areas of company management - finance, human resources, marketing and sales, innovation and investment, production and process improvement.
Purpose of the article: The aim of this article is to present the real practical effectiveness of the application of key performance indicators as a well-planned and prepared roadmap, leading any organization, regardless of the subject of activity, to dynamic development and prosperity through strategic orientation and measurement of work results and progress in each area.
Methods: To achieve the goal, a combination of mixed methods was applied, combining qualitative and quantitative research techniques.
Findings & Value added: At the end of the article, observations and conclusions regarding the application of key performance indicators as a tool for forming good management decisions and correct choices for strategic growth in a number of industrial enterprises are summarized. These results were obtained from an empirical study using the survey method of 24 industrial enterprises from the central northern region of the Republic of Bulgaria.

Keywords: Efficiency, Industrial enterprise, Key performance indicators, Process improvement

JEL classification: L0, M21

1. Introduction

The use of key performance indicators (KPIs) offers numerous advantages for the rational management of organizations. As performance measurement tools, KPIs help allocate and direct resources effectively in the areas of their consumption, leading to improvements in processes, performance, and overall productivity (Deliu & Frasineanu, 2013; Bititci, Garengo, Ates, & Nudurupati, 2011). Over the past two decades, the concept of KPIs has evolved significantly, becoming a central element in performance management systems across various sectors (Parmenter, 2015; Marr, 2012).

KPIs are widely recognized as essential tools for aligning operational activities with strategic objectives (Kaplan & Norton, 1996). Their application spans not only private enterprises but also public sector organizations, where transparency, accountability, and resource efficiency are paramount (Micheli & Kennerley, 2005). A well-designed KPI system provides organizations with the ability to evaluate and monitor performance, but also to promote continuous improvement and innovation (Neely, Gregory, & Platts, 2005).

Recent studies emphasize the need for KPIs to be dynamic and adaptable, particularly in rapidly changing business environments characterized by digital transformation, stakeholder pressure, and

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sustainability goals (Bititci, Garengo, Ates, & Nudurupati, 2012; Searcy, 2012). This requires integrating qualitative and quantitative indicators, including leading and lagging measures, to support both short-term operations and long-term strategic planning.

As already mentioned, the main use of KPIs is to measure and evaluate the effectiveness of work performance and to contribute to the coordination of goals and objectives across different departments. However, additional benefits can be achieved through the application of KPIs, such as:

- Real-time monitoring. KPIs enable tracking of project activities in real time and identifying critical issues early, which supports timely interventions (Benková, Gallo, & Nemec, 2020).
- Optimal distribution of activities and deadlines. KPIs help verify whether tasks are completed within the predefined time frame and detect potential delays or bottlenecks (Dominanta, 2015).
- Fairness and clarity in team operations. Transparent use of KPIs enhances collaboration, motivation, and accountability among team members (Rosová & Balog, 2012).
- Informed decision-making. Management benefits from specific, reliable, and timely information that enables strategic planning and risk mitigation (Folan & Browne, 2005; Gosselin, 2005).
- Resource allocation and optimization. KPIs support rational use of limited resources by identifying priority areas (De Toni & Tonchia, 2001).
- Continuous process improvement. Monitoring KPIs over time allows identification of trends and areas requiring corrective actions or optimization.
- Customer satisfaction insights. Customer-oriented KPIs provide valuable data on behavior and expectations, facilitating tactical changes to improve user experience and service quality (Zlateva-Petkova, 2024).

KPIs are more than numerical benchmarks – they are strategic tools embedded in performance culture. Their successful implementation depends on the clarity of objectives, data quality, and the organizational capacity to interpret and act upon KPI results.

2. Methods

This study investigates the application of key performance indicators (KPIs) as tools for enhancing efficiency and supporting management practices in technological enterprises located in the central-northern region of the Republic of Bulgaria.

A mixed-methods research design was employed, combining both quantitative and qualitative approaches to data collection and analysis. This design was chosen in view of the multifaceted operational contexts of the participating enterprises, which are involved in a variety of technological, industrial, and consultancy activities related to both engineering and management.

Data Collection. The primary source of empirical data was a structured survey questionnaire, designed to assess the level of implementation, perceived effectiveness, and challenges associated with KPIs in the surveyed organizations. The questionnaire included closed-ended questions using Likert scales, multiple-choice items, and dichotomous (yes/no) responses. The respondents were mid-level and senior-level employees, selected by enterprise management based on their engagement in operational and strategic decision-making.

Due to space constraints, the full version of the questionnaire is not included in this publication. Furthermore, a number of items in the instrument refer to broader organizational aspects that exceed the specific focus of this study and are therefore not discussed in detail.

Research Limitations. Several methodological limitations were encountered during the research process, primarily linked to data access and organizational constraints:

- The sample was limited to manufacturing and industrial enterprises, although KPIs are relevant across diverse organizational types.
- Survey participants were pre-selected by enterprise management, which introduces the risk of sampling bias and may affect the generalizability of the results.
- The fixed-response format of the questionnaire restricted the ability of respondents to elaborate on their views or provide additional insights, even when they expressed willingness to do so.

Enterprise Characterization. For the brief profiling of the surveyed enterprises, the following parameters were used:

(1) size of the enterprise, based on working capital and number of employees;
(2) participation in European-funded projects; and
(3) level of innovation activity, assessed by the scale of investments in production capacity renewal and technology acquisition or development.

3. Results

The high investment activity of the surveyed technology companies makes a good impression, given the stagnation of the markets, inflation and the crisis resulting from the Covid, the difficulties and the consequences of military activities on the territory of Ukraine. This is explained by the increased participation in European projects and other ways of financing business activities.

Twenty-four manufacturing enterprises from the industrial sector were asked to participate in the study on the implementation and effectiveness of the implementation of the key performance indicators. The enterprises vary in size, origin of capital, some of the enterprises are with mixed participation, and some of the enterprises are owned by foreign investors.

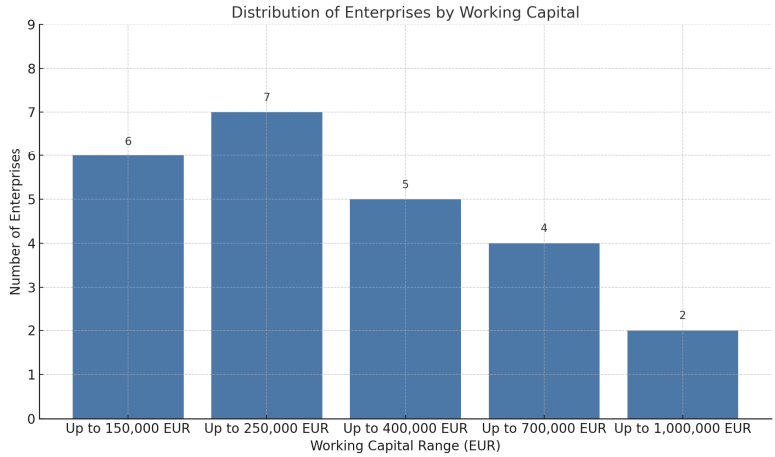

Figure 1. Number of enterprises according to working capital
Source: author (2025)

According to the amount of working capital (Fig. 1), the enterprises are divided into the following categories: up to 150,000 euros - 6 enterprises; up to 250,000 euros - 7 enterprises; up to 400,000 euros - 5 enterprises; up to 700,000 euros - 4 enterprises; up to 1,000,000 euros - 2 enterprises.

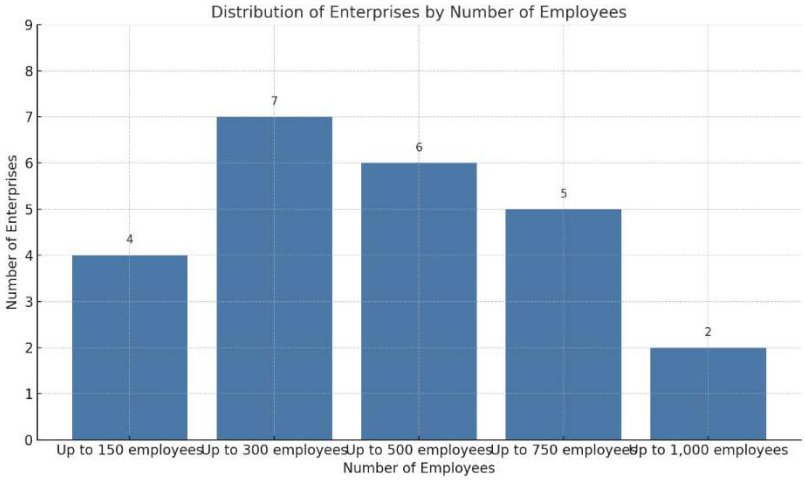

Figure 2. Sizes of enterprises by number of staff
Source: author (2025)

According to the number of personnel (Fig. 2), the enterprises are divided into five groups: up to 150 workers and employees - 4 enterprises; up to 300 - 7 enterprises; up to 500 - 6 enterprises; up to 750 - 5 enterprises; up to 1,000 - 2 enterprises.

The surveyed enterprises were also asked about their participation in European projects, as this implies that they meet specific requirements, as well as having the opportunity to apply modern methods, approaches and technologies in the exercise of their production activities. In their responses, some enterprises shared that they had not participated in European projects – 6 enterprises; 8 enterprises participated in up to 3 projects; 7 enterprises participated in up to 5 projects and only 3 enterprises participated in 6 or more projects (Fig. 3).

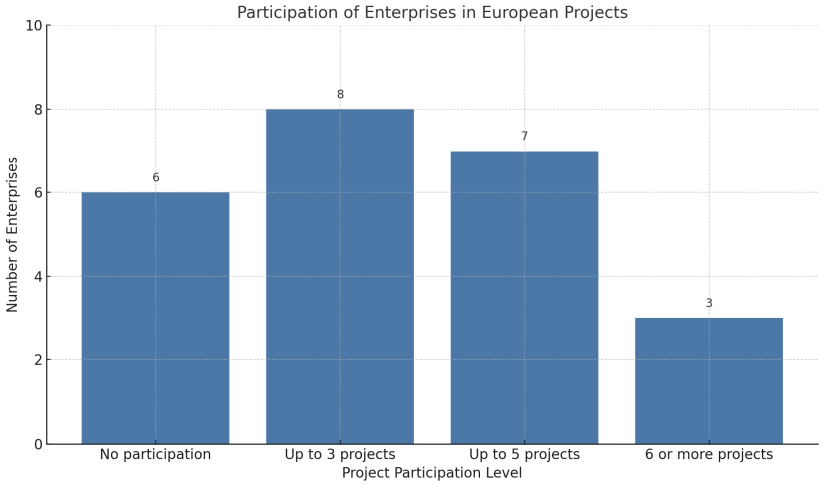

Figure 3. Distribution of enterprises in their participation in EU projects
Source: author (2025)

The research is interested in the innovation and investment activities of enterprises, as it provides some idea of the economic power of companies, as well as the understanding of the management teams that manage the processes and activities in enterprises. It is an indisputable fact that the use of modern technologies, materials and high-tech equipment leads to high quality of the products, as well as to higher final financial and production results

The following graphs present the responses to the survey on the funds invested in the renovation of production facilities. The results are presented in two versions - in value in euros and as a percentage of working capital.

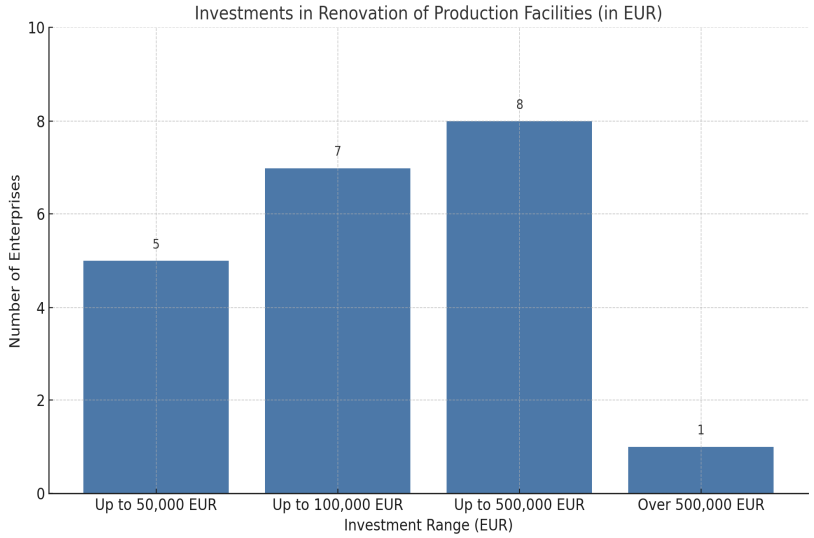

Figure 4. Investment in the renovation of production facilities in value
Source: author (2025)

The study shows that only five enterprises invest up to 50,000 euros to restore their technological equipment. Seven enterprises invest up to 100,000 euros, and eight enterprises allocate up to 500,000

euros. Unfortunately, the enterprises that can invest up to 500,000 euros in renovation are three, and only one enterprise could invest over 500,000 euros in its fixed assets (Fig. 4).

The distribution of the funds invested for the restoration and renovation of production facilities expressed as a percentage of working capital is as follows: up to 20% - 7 enterprises; up to 40% - 6 enterprises; up to 50% - 5 enterprises; up to 60% - 4 enterprises; and over 60% - 2 enterprises (Fig. 5).

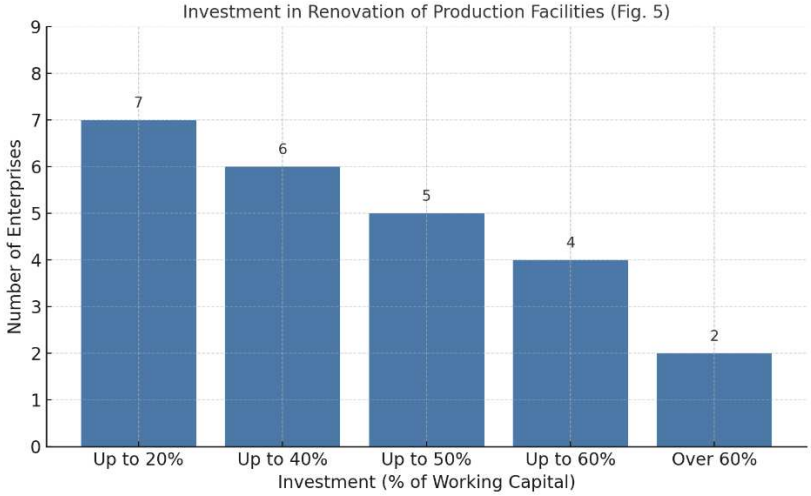

Figure 5. Investments in the renovation of production facilities expressed as a percentage of working capital
Source: author (2025)

The purchase and development of new technologies is an essential part of the investment and innovation practice in modern manufacturing enterprises. The current state of the surveyed enterprises is shown in the following two graphs using two approaches - in value in euros and as a percentage of working capital. Three of the enterprises have allocated up to 50,000 euros in the last reporting period for the development of new technologies, as this is an activity assigned to the technical specialists of the enterprises. Nine of the enterprises have invested up to 100,000 euros, and eight enterprises – 200,000 euros. Only four enterprises have purchased and developed new technologies for up to 500,000 € (Fig. 6).

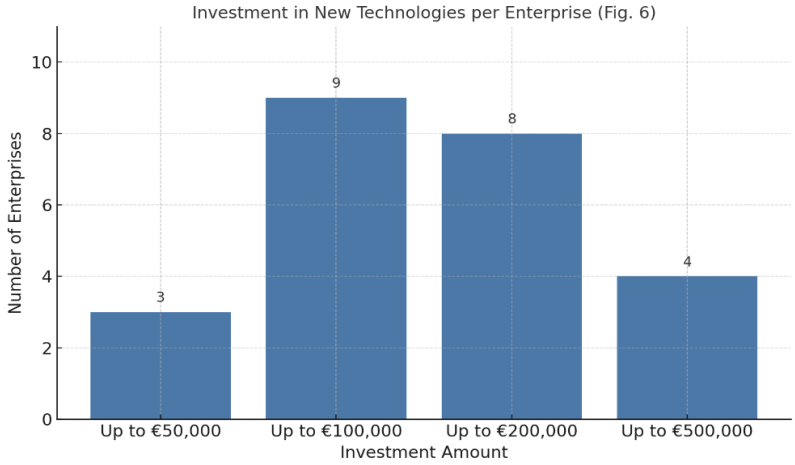

Figure 6. Purchase and development of new technologies in value in euros
Source: author (2025)

The distribution of funds for the purchase and development of new technologies expressed as a percentage of working capital is as follows: up to 20% - 5 enterprises; up to 40% - 8 enterprises; up to 50% - 7 enterprises; up to 60% - 4 enterprises (Fig. 7).

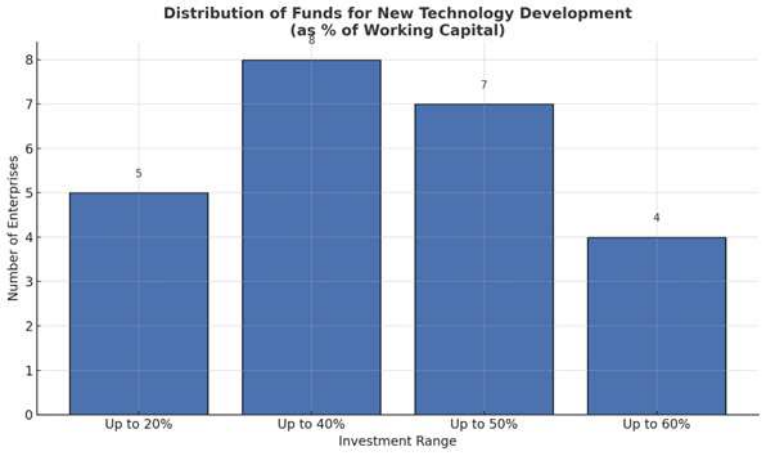

Figure 7. Purchase and development of new technologies as a percentage of working capital
Source: author (2025)

Key performance indicators are available in all possible combinations and their diversity stems from the different goals and needs of both the organization itself and the endless needs and demands of the customers that the organization is trying to satisfy. Key performance indicators are also distinguished by their complexity and size, since each of them serves to monitor a specific and specific goal in assessing the different aspects of the organization's activities. (Zlateva-Petkova, Ts., 2024)

This enables enterprises to define and rank key indicators themselves, which will lead to process improvement and increased efficiency. Since enterprises vary in size and economic power, it cannot be expected that the application of key indicators will be equivalent. The general conclusion is that all enterprises that have confirmed the use and application of key indicators have declared that this has led to increased performance and an increase in parameters such as market share, customer satisfaction, developing new products. In the field of work performance and human resources, enterprises have identified an increase in initiative and creativity, a desire for development and growth, and an increase in personal motivation.

Twenty-one of the companies confirmed that they use and apply key performance indicators in their management practice. It is worrying that four of these companies use such indicators only to manage their marketing activities. The remaining seventeen companies use key indicators in different areas of their management processes (Fig. 8).

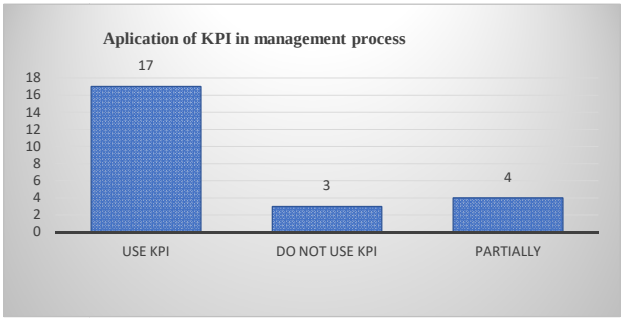

Figure 8. Application of KPI in the management process
Source: author (2025)

The following explanations and graphs will clearly and categorically demonstrate the relationship between KPIs and improved productivity of enterprises in several areas of their management process. Each graph and its comments describe the specific percentages by which the results in the studied areas have increased.

In the conditions of the difficult economic situation after the Covid crisis and the ongoing military operations on the territory of Ukraine, increasing the market share is a real success for any organization.

The studied industrial enterprises that use and apply KPI /21/ have reported an increase in their market share as follows: up to 20% - 6 enterprises; up to 35% - 7 enterprises; up to 50% - 5 enterprises and over 50% - 3 enterprises (Fig. 9).

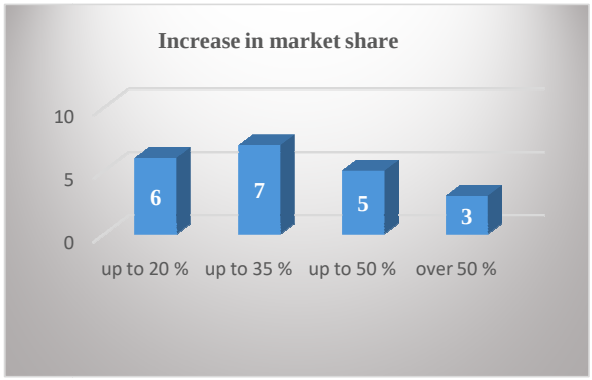

Figure 9. Increase in market share, in percentages
Source: author (2025)

An important indicator that testifies to the good condition and development trends is the development of new products for the last year of the reporting period. The surveyed enterprises confirm that they have worked on creating new products at the request of their customers. Because the capabilities of the surveyed enterprises are different, as are their products in terms of technical and production complexity, the number of new products developed is also different. Five of the enterprises have developed two new products. Seven enterprises have developed 4 products and also seven enterprises have developed 6 new products. Only two enterprises have developed more than 6 new products (Fig. 10).

Figure 10. New product development
Source: author (2025)

Due to the limitations of the scope of this publication it is not possible to present the key performance indicators explored in all areas. Therefore, we will indicate those key performance indicators that have led to increased competitiveness and increased market share of the industrial enterprises that were included in the survey.

1. Market Share Growth
2. Competitive Sales Growth Rate
3. Benchmarked Profit Margins
4. Customer Satisfaction Benchmark
5. Return on Investment (ROI) Benchmarking
6. Customer Retention Rate
7. Brand Equity Index
8. Earnings Before Interest and Taxes (EBIT) Margin Comparison
9. Capital Expenditure (CapEx) Efficiency
10. Market Position Rank

Customer retention is a key advantage in the conditions of increased competition and a wide range of high-tech products and increasing customer satisfaction in a difficult economic situation is a definite success. The companies participating in the study state that thanks to the definition of customer satisfaction as a key objective and the implementation of KPIs to track its implementation, they have established a significant increase in customer satisfaction: up to 20% - 4 companies; up to 35% - 6 companies; up to 50% - 6 companies; over 50% - 5 companies (Fig. 11).

Figure 11. Increase in customer satisfaction, in percentages
Source: author (2025)

Respondents in this study share their experiences with using and implementing KPIs in their management process and practices. As they explain when you start integrating KPIs into your business and production's operations, you gain a clear picture of the effectiveness of each individual indicator. This process allows you to determine which KPIs are delivering value and which indicators may require adjustments. And if a specific KPI does not provide sufficient or relevant information, it is a signal to consider replacing it with a more appropriate approach.

In a very short period of time, they reported serious improvement in several key areas of company management:

- marketing activities.
- innovations and investment policy.
- improved financial results and
- a positive impact on employees, regarding their motivation to achieve results, for development and career growth, as well as showing initiative and creativity in their work performance.

The benefits achieved as a result of implementing key performance indicators in the field of human resources are presented in the following graphs. Figure 12 shows the reported increase in personal motivation of employees when they were involved and committed to the current and operational goals of their enterprises and the linking of performance results to the achievement of these objectives.

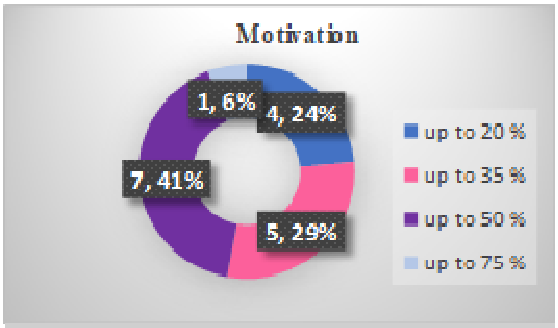

Figure 12. KPIs to increase motivation
Source: author (2025)

According to the results of the survey, an increase in personal motivation of up to 20% was observed in four enterprises; an increase of up to 35% was observed in five enterprises; an increase of up to 50% was reported by seven enterprises, and a more serious increase of up to 75% was found in only one enterprise (Fig. 12).

This positive effect is also observed when measuring employee initiative when they feel freer to present their ideas and views on improving processes, avoiding critical points, and making suggestions for improving the quality and products they produce. An increase in personal initiative of up to 20 % was reported by five enterprises; an increase of up to 35 % was observed in another 5 enterprises; an increase of up to 50 % was established by six enterprises; and only one enterprise reported an increase of over 75 % (Fig. 13).

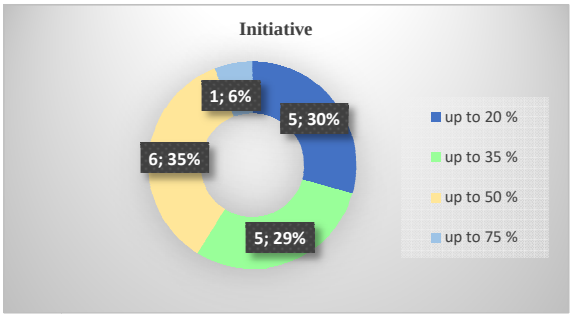

Figure 13. KPIs to increase initiative
Source: author (2025)

After the severe consequences of the Covid crisis and the serious loss of qualified workers and employees (according to some companies, around and over 50%), these companies are now reporting and enjoying an extremely positive trend among their staff. The opportunity to work in a high-tech and professional environment, producing quality and market-demanded products, encourages them to personal improvement, a desire to acquire new knowledge and skills, including a desire for development and career growth. Two companies reported up to 20% progress on this indicator. Six companies have established an increase of up to 35%. Up to 50% increase was registered in another six companies. And the result of three companies is remarkable, which declare up to 75% increase in the desire for development and growth of their workers and employees (Fig. 14).

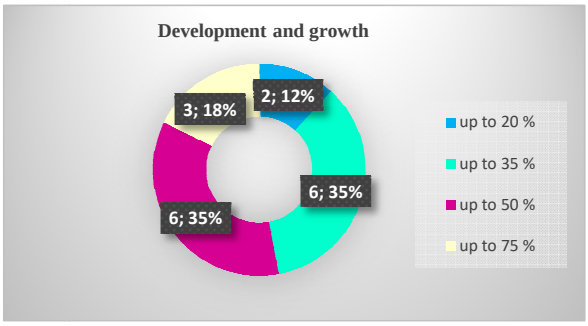

Figure 14. KPIs for development and growth
Source: author (2025)

By encouraging initiative and the desire for development in employees, the creative attitudes of the staff to find new solutions and approaches to fulfilling their work commitments are also unlocked. The staff willingly joins various work teams and initiatives to improve processes, brainstorming groups and other similar approaches in search of innovative and effective solutions to overcome emerging critical situations.

The results of the registered progress are shown in Figure 15 and are distributed as follows: progress of up to 20 % in promoting creative attitudes was reported by two enterprises; progress of up to 35 % was observed in six enterprises; an increase of up to 50 % was reported by seven enterprises; and progress of up to 75 % was reported by the remaining two enterprises participating in the study (Fig. 15).

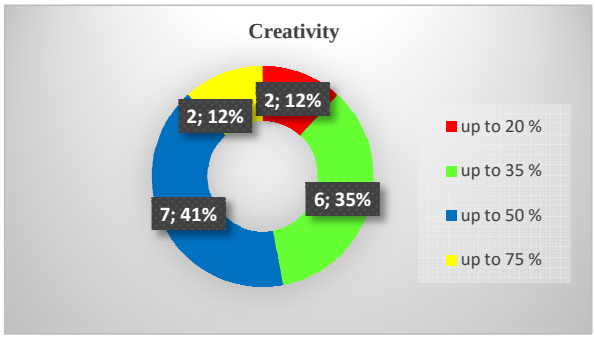

Figure 15. KPIs to increase creativity
Source: author (2025)

4. Discussion

As we have already mentioned many times key performance indicators are available in all possible combinations and their diversity stems from the different goals and needs of both the industrial enterprise itself and the endless needs and demands of the customers that the organization is trying to satisfy. Key performance indicators are also distinguished by their complexity and size, since each of them serves to monitor a specific and specific goal in assessing the different aspects of the business and production's activities.

Thanks to the support of enterprises and their willingness to participate in this study, we had the opportunity to verify the usefulness and effectiveness of the use of key performance indicators through the application of various scientific methods and approaches to receive verification, evidences and practical results. As a result of this survey, we can make the following conclusions.

Conclusion

This study confirms the strategic importance of key performance indicators (KPIs) as a fundamental tool for enhancing organizational performance, aligning operational efforts with strategic goals, and supporting data-driven decision-making in industrial enterprises.

1. KPIs as a strategic management instrument:

The findings reinforce that KPIs are essential for measuring and tracking an organization’s progress toward its strategic objectives. They provide a multidimensional view of performance across departments and timeframes, allowing enterprises to benchmark their development against industry standards and peers. Particularly noteworthy is the relevance of the KPI “Market Share Growth”, which reflects a company’s competitive positioning. The empirical data show that eight of the surveyed enterprises achieved a market share increase of up to or above 50%, while thirteen reported growth between 20% and 35%. These results are especially significant in the context of recent macroeconomic disruptions, including the COVID-19 pandemic, global recession, and the geopolitical instability caused by the war in Ukraine.

2. Versatility and impact of KPIs across domains:

KPIs prove to be a highly adaptable instrument, applicable in various areas such as sales performance, customer satisfaction, employee productivity, and organizational innovation. Beyond monitoring, KPIs also promote motivation and accountability when properly communicated and integrated into the organizational culture.

3. Role of regular performance reporting:

Consistent and analytically grounded reporting transforms raw data into actionable insights. Through KPI monitoring, organizations can identify performance trends, anticipate operational bottlenecks, and uncover areas requiring immediate attention or long-term improvement strategies.

4. Facilitating transparency and stakeholder alignment:

Well-structured KPI reports, presented in clear and accessible formats, enhance communication across managerial levels. They support shared understanding of performance, foster cross-functional collaboration, and empower stakeholders to make timely and informed decisions.

Recommendations

Based on the findings of the study, the following practical recommendations are proposed:

- Expand the scope of KPI systems to include both lagging and leading indicators, integrating financial, operational, and behavioral metrics for a holistic view of performance.
- Enhance digitalization of KPI reporting by introducing automated dashboards and real-time analytics tools, particularly in medium-sized enterprises that lack advanced data infrastructure.
- Involve employees actively in the KPI design and evaluation process to foster ownership, motivation, and alignment with individual and team-level goals.
- Establish training programs focused on performance interpretation and data literacy, ensuring that decision-makers and operational staff can fully utilize KPI insights.

In conclusion, key performance indicators represent not only a measurement tool but also a strategic resource for building adaptive, resilient, and high-performing industrial organizations in today's complex and competitive environment.

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Why And How Should Business Models in Industrial Organizations Be Transformed?

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Abstract

Research background: In the presented article, the author has made a theoretical study of issues related to business model management and the practical impact of digitalization on processes in manufacturing and industrial organizations. This significant impact in certain situations requires serious changes in the development and adaptation of appropriate business models to respond to the constantly changing business environment and to meet the growing needs of customers and consumers.
Purpose of the article: The purpose of this article is to prove the significant impact of digital transformation on the development of business models and to offer a practical model for transformation of business models in periods of crisis. Because the rapid development of digital technologies creates economic opportunities for innovation, growth and intellectual products. To ensure their success, organizations need to implement innovative business models and technologies.
Methods: To achieve the goal, the comparative analysis method was used, comparing the types and varieties of possible business models, on the basis of which the author developed own business model proposed in the article. The limitations in the study are reduced to the fact that the author himself sets the boundaries of his research and chooses only engineering and manufacturing organizations since business management is a vast scientific territory, and the volume of a scientific article is too short.
Findings & Value added: For every industrial organization, the choice of business model is of strategic importance, because in practice this is the way it does its business and generates added value. This means that every organization must implement solutions that support the development, testing and offering of new products and services based on digital technologies, including artificial intelligence. The implementation of digital technologies in modern industries are solutions that can provide competitive and sustainable advantages to any business organization. The author offers its own definition of the term "business model" and a model for transformation of business models in industrial organizations in periods of crisis.

Keywords: Business model, Digitalization, Impact of digital transformation, Industrial organization, Transformation of business model

JEL classification: M10, O20, O21

1. Introduction

Digital transformation of economy after Covid-19 crisis. The high-speed development in the digital field creates economic opportunities for innovation, growth, jobs and makes people's lives easier. The digital transformation is at the heart of the current industrial revolution and secures the future of business organizations. The digital transformation of the economy is a source of competitive advantage and creates conditions for prosperity in all areas. Business organizations must prioritize upgrading their strengths in advanced digital technologies and their strong presence in traditional sectors to take advantage of the opportunities offered by technologies such as 5G networks, robotics and artificial intelligence, 3D printing, and more. They could enable business organizations to gain a share of emerging markets for the products and services of the future. To ensure their success, organizations need to implement innovative business models and technologies. In practice, this means that every organization must implement

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solutions that support the development, testing and experimentation of new products and services based on digital technologies, including artificial intelligence.

But almost five years ago, the Covid-19 crisis came suddenly, unexpected and changed the World. Nothing was the same - people and their believing, communications and partnerships, business models and economy. The rise in technologies that ushered in the new millennium and the prevailing principles of Industry 4.0, along with the digital transformation, seem to have given way to fear and paramount concern for the protection of human life. This situation has changed everything from the globalized heavy industrial markets to the smallest units in national economies - small businesses and private entrepreneurs. In addition to economic indicators, this crisis has hit industrial organizations hard in their most valuable and costly resource, human resources. This necessitated a change in the business models, strategies and policies of the manufacturing organizations. The development of flexible models and forms for dealing with the difficult situation and overcoming the crisis came to the fore. „To improve company's performance, it is essential to monitor and respond correctly to current trends that affect its business. Only then, the company can make a profit and meet the expectations of the owners and other interest groups." (Benkova et al., 2020)

The digital transformation is influencing business models by requiring the implementation of elements of Industry 4.0 related to technology transfer, construction of research and development centers of a new type such as science and technology parks and the creation of electronic networks for cooperation, trade and training. To achieve this, it is necessary to apply information and communication technologies in related cyber-physical systems and create integrated business models.

The positive impact of the digital transformation on industrial production and modern manufacturing organizations can be expressed in the creation of new products and services with built-in intelligence that would fully meet customer requirements and develop innovative business models; digitalization and flexible organization of production processes, development of digital prototypes and virtual production (figure 1).

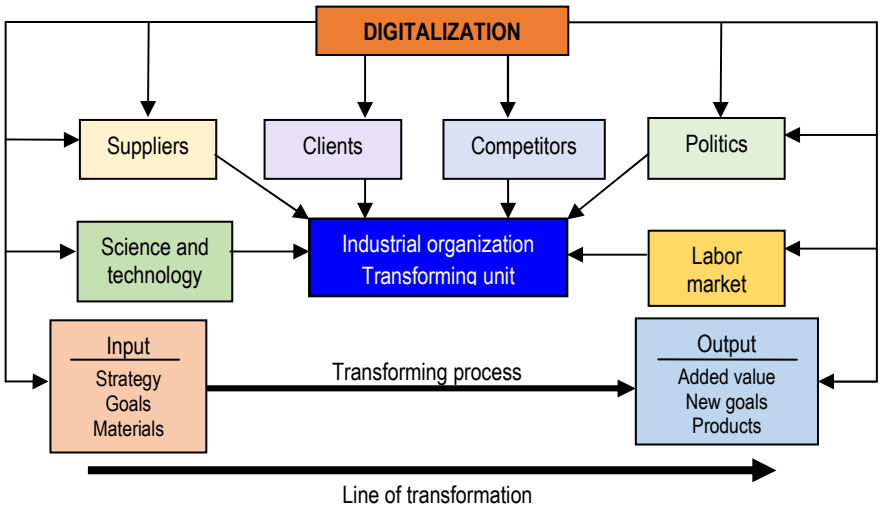

Figure 1. Influence of digital transformation on industrial organizations and business environment
Source: Author (2025)

Literature review

1.1 The impact of digitalization on business model's transformation.

In recent years, there has been a lot of talk about the digital transformation and the penetration of digital technologies in all spheres of public and economic life. These topics are the subject of many scientific studies and are worked on by both famous scientists and practitioners. Governments develop strategies and concepts for business digitalization, measures and programs for innovation, jobs, growth, and improving societal standards. So, let's take a brief look at the work of some scientists and how they define the digital transformation of business.

Digital transformation is the reorganization of business by changing the business strategy or digital strategy, models, operations, products, marketing approaches, goals and more. through the acquisition of digital technologies. This accelerates sales and overall business growth. (Stolterman et al., 2004)

Digital business transformation is a process of rediscovering business to digitize operations and formulate expanded supply chain links. The challenge for digital business transformation management is about reengineering the business, which can now successfully capture the full potential of information technology throughout the supply chain. (Bowersox et al., 2005)

Digital transformation is a conscious and ongoing digital evolution of a company, business model, conceptual process or methodology, both strategically and tactically. (Mazzone, 2014)

Digital business transformation - significant changes in organizational processes, structures and systems applied to improve the productivity of organizations through the use of more and more digital media and technology platforms. (Chaffey, 2015)

Digital Business Transformation is Organizational Change through the use of Digital Technologies and Business Models to Improve Performance. (Wade, 2015)

The rapid penetration of digital technologies in business imposes the need for digital transformation of modern organizations. It includes all activities related to the application of digital technologies. Digital transformation facilitates business processes, decision-making and interaction with value chain partners and end customers. (Slavova, 2015)

The digital transformation of business is an objective process that corresponds to the changing business environment. Its implementation requires a clear strategy and prioritization, supported by financial resources, leadership and active participation of all employees in the organization. The speed of its flow depends on the specifics of the sector. (Slavova, 2016)

The digital transformation includes in its framework the building of contacts between business representatives and consumers through all segments of the value chain and the application of new technologies. In itself, digital transformation requires skills such as retrieving and exchanging data, as well as analyzing and converting that data into information for future action. This information should be used to calculate and assess probabilities to enable decision-making and/or initiation of activities. To increase company productivity and impact, digital transformation includes organizations, business models, processes, relationships, products, and more. (Schallmo et al., 2017)

Generally speaking, digital transformation is the integration of new digital technologies in all areas of business, leading to a fundamental change in the way the organization works. (Shopov, 2017)

Digital business transformation is a process that takes place in enterprises to meet changing needs through the implementation and use of innovative and integrated technologies, creating the need for new management approaches, processes and skills, both managers and contractors. (Boneva, 2018)

Digital transformation marks a rethinking of how an organization uses technology, people, and processes in pursuit of new business models and new revenue streams, driven by changes in customer expectations around products and services. (Boulton, 2021)

1.2 What is a business model?

Business models are a management tool that describes recurring problems for a group of organizations and provides a solution to these problems based on good practices in other organizations and companies.

Let us briefly recall what the business model is in order to look for opportunities for its transformation in the conditions of crisis and accelerated digitalization of technologies. There are too many definitions of different authors in scientific literature. This is because scientists have studied different types of companies and organizations and have been guided by different criteria in their research.

At a general level, the business model has been referred to as a statement (Stewart&Zhao, 2000), a representation (Morris, Schindehutte &Allen, 2005; Shafer, Smith&Linder, 2005), an architecture (Timmers, 1998), a structural template (Amit&Zott, 2001), and a set (Seelos&Mair, 2007). Surprisingly, however, the business model is often studied without an explicit definition of the concept.

"… a successful business model represents a better way than the existing alternatives. It may offer more value to a discrete group of customers. Or it may completely replace the old way of doing things and become the standard for the next generation of entrepreneurs to beat. Creating a business model is, then, a lot like writing a new story. At some level, all new stories are variations on old ones, reworkings of the universal themes underlying all human experience. Similarly, all new business models are variations on the generic value chain underlying all businesses. Business modeling is the managerial

equivalent of the scientific method—you start with a hypothesis, which you then test in action and revise when necessary." (Magretta, 2002)

"the functions of a business model are to: articulate the value proposition, identify a market segment, define the structure of the value chain, estimate the cost structure and profit potential, describe the position of the firm within the value network, and formulate the competitive strategy." (Chesbrough and Rosenbloon, 2002)

"The logic of the firm, the way it operates and how it creates value for its stakeholders." (Lecocq et al., 2006):

Johnson and Kagermann determined the four elements of business models: a customer value proposition, a profit formula, key resources, and key processes. (Johnson and Kagermann, 2008)

Business model design involves assessments with respect to determining: (1) the identity of market segments to be targeted; (2) the benefit the enterprise will deliver to the customer; (3) the technologies and features that are to be embedded in the product and service; (4) how the revenue and cost structure of a business is to be 'designed' (and, if necessary, 'redesigned') to meet customer needs; (5) the way in which technologies are to be assembled and offered to the customer; and (6) the mechanisms and manner by which value is to be captured, and competitive advantage sustained. These issues are all interrelated. They lie at the core of the fundamental question asked by business strategists – which is how does one build a sustainable competitive advantage. (Teece, 2009)

Based on this existing theoretical basis, the Author offers his own definition of a business model, which focuses mainly on the functional side of business models and brings to the fore the practical benefits of implementing business processes. This definition refers to industrial business models with a real production process, which the Author presents as a transformational process (Figure 1).

Author`s definition for the term "business model" (Figure 2): The way of organizing and managing business processes and resources (material, financial and human) in order to meet customers demand, create added value and profit to ensure the future development of the industrial organization and its prosperity.

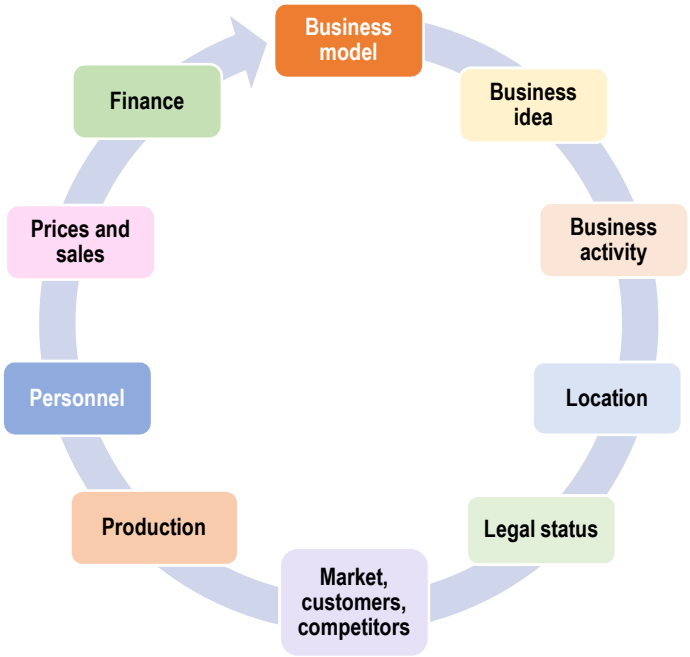

Figure 2. Process for generating and operating a business model
Source: Author (2025)

2. Methods

The purpose of this article is to prove the significant impact of digital transformation on the development of business models. For any organization, the choice of business model is of strategic importance, because in practice this is the way it does its business and generates added value.

To achieve the goal, the comparative analysis method was used, comparing the types and varieties of possible business models, on the basis of which the author developed and proposed in this article his own definition of the term "business model".

Also, the methodology of system-structural analysis was used, which creates the opportunity to consider related processes and phenomena as a structured system that functions at the level of the manufacturing enterprise and allows the Author to create and propose in this article his own business model for industrial organizations.

The limitations in the study are reduced to the fact that the author himself sets the boundaries of his research and chooses only engineering and manufacturing organizations since business management is a vast scientific territory, and the volume of a scientific article is too short.

The topic is well known and still relevant because business processes and their management is a daily activity for management specialists, but unfortunately there is still much to add and improve in the knowledge, skills and competencies of managers. Overall, the author believes that this is a topic that would help to achieve higher goals and results, and to improve the existing management practice.

3. Results

What and why should it be transformed in business models? Today, digitalization is seen as a megatrend to achieve new levels of productivity. Virtual and real worlds are getting closer than ever and lead to "Industry 4.0". Production operations are combined with the latest information and communication technologies, and the driving force behind this development is the rapid digitalization of the business world and society as a whole.

The implementation of the digital transformation of business models implies an organizational change that can be realized through the use of digital technologies and models to improve the final financial and production results, as well as labor productivity.

In the context of digital transformation, consumers are the engine of change. The process of digital transformation must be carried out jointly with customers and for their benefit through targeted introduction of new models, solutions and applications for inclusion and development of human potential based on building a digital culture and thinking to achieve concrete results and enrich the life of citizens [30]. Technology is a tool, not a goal in digital transformation. The implementation of modern technologies with simple solutions is the ideal combination that will make economy intelligent, competitive and sustainable.

The consulting company Gartner applies a detailed list of actions in the presence of threats (Gartner, 2020):

1. Reassessment of the business model, paying priority attention to several main parts of the business model:
   - Consumer segments and how they are affected by the crisis.
   - What changes occur in the value supplied to consumers, do they already have other needs.
   - Whether the organization can offer the required value.
   - What the organization needs to do it herself.
2. Identification of unknown quantities and determination of probable scenarios for occurrence. As difficult as this may be, at least the main variables can be outlined in an optimistic and pessimistic version.
3. Business impact analysis, forecasting the consequences of the crisis and developing recovery strategies.

How can we change the business model? The change in business models requires a serious process of transformation, which begins with a rethinking of the existing situation and leads to a reorganization of the practices that the organization applies.

The Author proposes a possible model in eleven main steps for the transformation of a business model caused by a crisis in the industrial business environment (figure 3).

Step 1. Defining and, if necessary, redefining the goals – identifying the core values and mission of the business.
Step 2. Identifying the risks and the most significant trends of change in the business environment.
Step 3. Assessing the damage and losses caused by the crisis.
Step 4. Analyzing the activities and processes within the organization.
Step 5. Analyzing the necessary resources and possibilities for their provision.

Step 6. Identifying potential business partners.
Step 7. Creating additional opportunities.
Step 8. Searching for approaches, methods, and tools for change; developing possible options.
Step 9. Developing an example model that focuses on the most important or critical points.
Step 10. Maintaining a high level of motivation - inspiration through innovative models that ensure long-term competitiveness and sustainability.
Step 11. Evaluating the achieved result.

Figure 3. Model for transformation of a business model
Source: Author (2025)

4. Discussion

For any organization, the business model is of strategic importance because it reflects the way the organization carries out its business processes. Regardless of the scale of the business or industry in which the organization operates, the business model illustrates how the organization designs and manufactures products or how it provides services to its customers. Business models describe and manage specific business processes; build and provide appropriate infrastructure; develop competitive strategies for expanding market presence and entering new markets.

The rapid development of digital technologies and the difficult epidemiological situation around the world have necessitated the rapid penetration of digitalization in the ways of doing business. The inevitable closure of many businesses and markets due to lockdowns has increased Internet influence in all areas - trade, banks, education, administrative services and much more. This imposed certain business models as more successful and up-to-date. The models for direct sales, franchising, freemium, subscription and crowdsourcing became such models.

Direct sales. Business models that rely on direct sales prefer to stay in touch with their customers. To this end, they develop a distribution network or center where individual retailers contact the parent company to offer their products or services at retail. In this way, these traders become entrepreneurs and make a direct connection with the consumers of the good or service. This gives them the opportunity to receive first-hand information about the evaluation and customer satisfaction of the product or service, as well as to get ideas for their improvement or updating. Customers could also share information about their experience using a similar product offered by the organization's key competitors.

Direct sales can be made through presentations or demonstrations of the product or service in several different situations, such as organizing a presentation of a new product, organizing a party at home and presenting the products to guests or presenting the business to potential customers and investors.

In direct sales, traders profit by receiving part of the sales revenue or a certain percentage, and the parent company generates the sales revenue.

Some of our best known companies that follow the business model of direct sales are Avon, Arbonne and Herbalife.

Franchising. Franchising is, in fact, a strategic alliance between organizations, one of which has an established image and offers a prestigious brand under certain conditions and for a fee to another organization that wants to develop the same activity and gets the right to use a developed and successful business model in a certain kind of business. The following types of Franchising are known: production - for the production of goods, using the provided production experience, know-how, brands and others; placement - for distribution of goods or services; and franchising services.

This cooperation is successful and beneficial for both parties, because the franchisee does not have to invest capital in developing their own products and brands, and the franchisor gets access to a large number of users without having to incur costs to enter new markets or expand its distribution network.

Freemium model. The freemium model is typical when private or business services are offered mainly from the Internet. This model enables organizations to connect with their future customers and lay the foundation for a good collaboration. Initially, organizations provide free basic services. After building trust with their customers, they offer to expand the services, add applications or use the same services, but without including ads, thus improving the user experience for a fee.

This model works successfully for Internet organizations that do not want to make serious investments to acquire new customers, but at the same time offer high value to their users.

Examples of well-known companies working on the freemium business model are Spotify and Skype.

Subscription model. When organizations are forced to pay high costs for expanding markets and gaining new customers, they need to secure a circle of secure customers to ensure periodic sales revenue. This can be achieved through the subscription model, which provides a set of customers under a long-term contract and multiple consumption of the product or service, which allows to form a relatively stable sales revenue.

This model is used by business organizations that provide utilities, telephone companies, Internet providers, mobile and electronic services.

Crowdsourcing. This practice is about getting the services, ideas, or products you need by attracting a large group of people. In most cases, these users are organized online. Projects are usually announced publicly and anyone can volunteer.

Crowdsourcing is indeed the process of combining the efforts of a large, diverse group of people to achieve a common goal, where each individual contributes their unique skills, knowledge, or resources. It's essentially outsourcing a task, idea, or content generation to a broad, often online, community. This collaborative approach allows for the gathering of diverse perspectives, potentially leading to innovative solutions and efficient outcomes. The contracting company usually announces a prize that is linked to the outcome of the project. Sometimes it is a monetary payment, and in other cases the group of people may work due to moral motives (personal satisfaction, honor, fame).

The practice is often applied on the Internet, when a solution to a problem is sought by the users of a certain site, product or service.

There are an infinite number of examples and good practices for transforming business models as a result of the increased digitalization of business processes in industrial enterprises. It is extremely positive and encouraging that this trend is happening all over the world, and not only in developed regions or advanced economic countries. Due to the limitations of the scope of this article, the author has selected only a few different and diverse examples and good practices to demonstrate the true diversity of business model transformations:

- "Recently, Briones Peñalver and Prokopchuk (2023) analyzed the adaptation of drinking water business models to the blue economy in Ukraine."
- "A new approach to installing rubber mats in dairy farms was proposed by Chanthes et al. (2024) and demonstrated significant productivity gains."
- "Chemerys et al. (2019) show how business model development in rural Ukraine can stimulate sustainable growth."
- "Dyadyuk (2016) proposes improving methodological principles for managing competitiveness in crises."
- "Sumets (2018) examines business management strategies, and later (2020) proposes a methodological approach for assessing production systems."
- "A study by Widadie et al. (2024) demonstrates models for integrating smallholder farmers into high-value vegetable markets."
- "Zott, Amit and Massa (2011) summarize recent developments in business models research and outline key directions for future research."
- "Bogdanova (2020) analyzes university business models in times of crisis."

Conclusion

If it is possible to find anything positive in the emergency and pandemic situation and the Covid-19 crisis, it is to accelerate the process of digital transformation. In isolation, many companies had to close offices, production facilities and work remotely, in an electronic environment. Business organizations orientated themselves quickly and flexibly and began to make the most of the opportunities and potential of digital technologies in all sectors of the economy, social activities and politics, education, medicine and others. This proved once again the key importance of the digital transformation and confirmed the fact that it is not just a necessity, but a prerequisite for competitiveness and sustainability of business models and processes in a crisis. Thanks to digital technologies, many companies have survived the crisis, kept their markets, their associates and continue to grow. Others, who were more enterprising, created new business models, new jobs, and new revenue opportunities for e-services.

The rapid development of digital technologies creates economic opportunities for innovation, growth and intellectual products. To ensure their success, manufacturing organizations need to implement innovative business models and technologies. In practice, this means that every organization must implement solutions that support the development, testing and offering of new products and services based on digital technologies, including artificial intelligence. The implementation of digital technologies in modern industries are solutions that can provide competitive and sustainable advantages to any business organization. The impact of digital transformation on business models is so significant because it replaces a huge range of physical offerings with digital tools and services. In their desire to reach more customers and consumers, organizations offer and introduce digital products and require the use of technologies to provide global shared services. Thanks to the digital transformation, industrial organizations adapt more easily than ever to the ever-changing conditions of the business environment and are eager to improve and refine their performance in order to achieve higher efficiency, meet the requirements for products/services and improve of the end-user experience.

Business models are available in a variety of forms. The article is intended for managers in practice who need to adapt their business models to the ever-changing environment and the growing needs of consumers. For business administration specialists, this article can be an additional look at the current situation and expand their knowledge of business models. The process of organizational change through the use of digital technologies and new business models to improve economic performance in response to changing consumer behavior is inevitable for industrial organizations in the current digital economy and the so-called fourth industrial revolution.

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3. Business and Marketing

A Gender Perspective on Selected Neuromarketing Attributes to Enhance Sales

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Abstract

Research background: Neuromarketing, as an intersection of psychology, neurology, and marketing, is concerned with the study of how neuromotor and emotional responses influence consumer decision-making. Gender differences in these responses can have a significant impact on the creation of marketing strategies, and recognizing these differences can help marketers create more effective and precisely targeted campaigns.
Purpose of the article: The main objective of this study is to examine cognitive, emotional, and behavioral factors in sales neuromarketing and, subsequently, gender differences in the assessment of these factors or attributes that influence consumer decision-making. Part of this objective is to present how findings from neuromarketing research can contribute to optimizing consumer behavior to enhance sales success.
Methods: The initial survey and subsequent research were conducted on a sample of 122 respondents who evaluated individual attributes through the NMCEB methodology. Furthermore, a hypothesis that neuromarketing approaches integrating these attributes lead to more effective influence on consumer behavior and subsequently to increased sales compared to traditional approaches was tested.
Findings & Value added: The results showed that women are more affected by emotional stimuli than men, with statistically significant differences in emotional reactions during purchasing decisions. These findings emphasize the need to customize marketing strategies according to gender differences to enhance their effectiveness and efficiency.

Keywords: Neuromarketing, Gender differences, NMCEB methodology, Sales

JEL classification: M31, D91, J16

1. Introduction to Neuromarketing

Neuromarketing is an interdisciplinary field that combines knowledge from neuroscience, psychology and marketing to better understand how consumers perceive and respond to various marketing stimuli, such as advertisements, products or brands. Morin (2011) presents neuromarketing as a new science of consumer behavior. He emphasizes how neuromarketing techniques can reveal hidden motivations and reactions of consumers to marketing stimuli and incentives. Kenning, Linzmajer (2011), Balconi and Sansone (2021) provide an overview of the development of consumer neuroscience and discuss its benefits and potential risks, including consumer protection. In recent years, neuromarketing has established itself as an important tool for obtaining deeper and more accurate knowledge about how consumers respond to various marketing stimuli (Lee, Broderick & Chamberlain, 2007).

Neuromarketing focuses on investigating consumers' neural responses to marketing stimuli using techniques such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and eye-tracking (Alsharif et al., 2023). These techniques allow researchers to analyze how various stimuli, such as advertisements, product packaging, or pricing policies affect consumers' brain activity and emotional responses (Plassmann, Ramsøy & Milosavljevic, 2012). Neuromarketing techniques such as

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fMRI, EEG, and biometric methods allow scientists to track consumers' brain responses and physiological responses to marketing stimuli. These techniques provide deeper insight into cognitive and emotional processes that traditional marketing methods cannot effectively map. Ariely (2008) examines how irrational behavior influences consumer decision-making. The author shows how small changes in product presentation can significantly influence consumer decisions, which has direct implications for neuromarketing. Ariely, Berns (2010), Ismajli, Ziberi, and Metushi (2022) provide an overview of the possibilities and limitations of neuromarketing, including a discussion of how neuroimaging can help understand consumer preferences.

One of the main applications of neuromarketing is the optimization of marketing campaigns. Analysis of neuromarketing data can reveal which aspects of marketing materials, such as visual elements, sound effects, or text, most influence consumers' attention and emotional responses (Gerdes et al., 2021). For example, studies have shown that emotionally resonant advertisements tend to create stronger memory traces and higher levels of engagement (Rigby & Lee, 2024). Neuromarketing also provides valuable information about how consumers evaluate products and brands. Techniques such as eye-tracking can reveal which parts of packaging or advertising attract the most attention and which elements may influence purchase decisions (Wedel & Pieters, 2007). In addition, EEG analysis can provide insight into consumers' emotional responses to various marketing stimuli, allowing marketers to tailor their strategies to better resonate with their target audience (Alsharif & Isa, 2025).

Neuromarketing is an invaluable tool in the study of consumer behavior because it provides objective data on how consumers respond to various marketing stimuli at the neurobiological level (Alsharif & Isa, 2025). This knowledge can be used to create more effective marketing strategies and improve the overall consumer experience (Panksepp, 1998). With the advent of new technologies and analytical methods, the importance of neuromarketing in consumer behavior research is expected to continue to grow, allowing for even more precise tailoring of marketing activities to consumers' needs and preferences.

Therefore, the main objective of the presented study is to examine cognitive, emotional, and behavioral factors in sales neuromarketing, as well as gender differences in the assessment of these factors as they influence consumer decision-making, and present how findings from neuromarketing research can contribute to optimizing consumer behavior to enhance sales success.

2. Cognitive, Emotional, and Behavioral Factors in Sales Neuromarketing

One of the key aspects of neuromarketing is the study of cognitive and emotional factors that influence consumer decision-making. Kahneman (2011) discusses two systems of human thought – fast, intuitive thinking and slow, rational thinking. He provides a deep insight into the cognitive processes that influence consumer behavior and decision-making. Emotions play a fundamental role in shaping consumer preferences and decisions. Neuromarketing findings show that the emotional resonance of an advertisement or product can significantly influence not only short-term purchase decisions, but also long-term brand loyalty. Behavioral economics and neuromarketing together examine how various stimuli and environments influence consumer behavior (Cenizo, 2025). Factors such as product design, store shelf layout, and visual and audio cues can have a significant impact on purchasing decisions. Studies show that changing the presentation of a product can increase the likelihood of purchase. Neuromarketing techniques help uncover these subtle differences and enable marketers to create more effective campaigns and strategies. Lindstrom (2010) examines the subconscious factors that influence purchasing decisions and offers practical examples of how marketers can use neuromarketing insights to improve marketing campaigns.

One example is the "nudge theory" popularized by Thaler and Sunstein (2008). This theory suggests that subtle changes in the environment in which a consumer finds themselves can significantly influence their behavior. Neuromarketing techniques provide a better understanding of how these subtle changes can improve the effectiveness of marketing campaigns and increase sales. These techniques also help to reveal consumers' subconscious responses to various stimuli and provide marketers with valuable information for optimizing their strategies, which is especially effective in optimizing marketing campaigns. Kahneman (2011) describes in detail concepts such as "anchoring" and the "availability heuristic", which are part of the cognitive biases that influence consumer decision-making. Behavioral factors also include the concept of "behavioral biases", i.e. cognitive biases that can influence consumer decision-making. These biases can lead consumers to make unanticipated decisions that traditional marketing approaches often fail to take into account.

Neuromarketing research shows that understanding these biases and implementing them into marketing strategies can lead to increased sales and more effective influence on consumer behavior (Cenizo, 2025). Integrating neuromarketing insights into marketing strategies presents a great opportunity for marketers. Neuromarketing provides specific recommendations for optimizing ad content, website design, and product placement to better resonate with target customers. The key is to consider cognitive, emotional, and behavioral factors that can lead to increased sales. Marketers who can apply this insight can better target their campaigns and achieve higher returns on investment. Plassmann, Ramsøy and Milosavljevic (2012) provide a critical overview of neuromarketing, describing the current state of neuromarketing research and its applications in the areas of branding and consumer decision-making. They discuss how neuromarketing methods help to better understand how brands influence consumer behavior.

3. Gender Differences in Responses to Neuromarketing Stimuli for Marketing Strategies

As mentioned above, neuromarketing, as an intersection of psychology, neurology, and marketing, is concerned with the study of how neuromotor and emotional responses influence consumer decision-making. Gender differences in these responses can have a major impact on the creation of marketing strategies, as different genders may respond differently to the same marketing stimuli (Suh, Wilson & On, 2023). Recognizing these differences can help marketers create more effective and precisely targeted campaigns. Gender differences in responses to marketing stimuli can be analyzed through various neuromarketing techniques (Stefko et al., 2021). Functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) allow researchers to examine how male and female brains respond to different types of stimuli, such as visual advertisements, audio cues, or text messages (Alsharif & Isa, 2025). These techniques provide data on which brain areas are activated in response to marketing stimuli and how these responses influence the final purchase decision (Plassmann, Ramsøy & Milosavljevic, 2012).

3.1 Gender Differences in Cognitive Responses

Cognitive responses to marketing stimuli can vary considerably in the context of gender. For example, women may be more sensitive to the visual and emotional elements of advertisements, while men may be more responsive to the rational and functional aspects of products (Putrevu, Tan & Lord, 2004). This distinction may influence how marketers tailor their campaigns to suit different preferences and values, which may lead to more effective marketing strategies.

3.2 Gender Differences in Emotional Responses

Emotional responses to marketing stimuli may also exhibit gender differences. Women often show stronger emotional responses to advertisements that contain emotional content or social elements such as family and friendship (Majeed, Lu & Usman, 2017). Conversely, men may be more influenced by advertisements that emphasize performance or technical features of products (Sheehan, 2013). These differences in emotional responses can be used to design marketing campaigns that are more gender-specific.

3.3 Gender Differences in Behavioral Responses

Behavioral responses to marketing stimuli may also differ between men and women. Men and women may respond differently to interactive stimuli, such as product tastings or physical contact with the product (Lidón et al., 2018). Women may be more likely to seek out and respond to the opportunity to physically explore products, while men may place greater emphasis on practical aspects and product performance (Wedel & Pieters, 2007).

4. Methodology

In terms of methodology, the paper contains two studies. The first one is a preliminary survey carried out in two stages – secondary data analysis and questionnaire analysis – to assess how the implementation of neuromarketing improves consumer behavior and increases sales. The second study consists of research the aim of which is to determine whether there are statistically significant gender differences in the assessment of the selected neuromarketing attributes.

For the purposes of the research, the NMCEB methodology (Birknerová, Miško & Ondrijová, 2022) was used to assess the cognitive, emotional and behavioral aspects of neuromarketing. The questionnaire contains 15 statements that respondents assess on a Likert scale of agreement from 1 – "definitely no" to 6 – "definitely yes".

The three NMCEB factors may be specified as follows:

Cognition: Cognitive attributes focus on perception, cognition and information processing. Items in this category examine how customers acquire and process information about products through various sensory stimuli: Music can improve cognitive information processing by improving attention and memory. Tactile perception (touch) increases customer trust and perception of quality, which affects decision-making. Olfactory perception contributes to product evaluation, especially for items such as food or cosmetics. Taste as a cognitive factor provides direct information about the quality and method of use of the product. Reading the composition and description of a product allows customers to make informed decisions.

Emotions: Emotional attributes focus on how sensory stimuli evoke positive or negative emotions in the customer: Music in a store can create an atmosphere that promotes positive feelings and increases satisfaction. Touch can lead to an emotional attachment to a product, which increases the chances of a purchase. Smell can evoke pleasant memories and improve mood, which positively affects purchasing behavior. Tasting a product can lead to emotional satisfaction, which supports the decision to purchase. The visuals and design of the packaging can directly affect the emotional response and attractiveness of a product.

Behavior: Behavioral attributes examine how these stimuli influence real-world purchasing decisions and behavior: Identification with music can subconsciously influence movement in a store and purchasing decisions. Touch affects not only cognitive perception, but also decision-making and final purchasing behavior. Olfactory sensations can lead to increased time spent in the store and a greater likelihood of purchase. Tasting a product can directly lead to impulse purchase. Packaging design and presentation can have a major impact on a customer's final decision.

The research sample consisted of a total of 122 respondents, of which 46 were male (37.7%) and 76 were female (62.3%). In terms of completed education, we addressed 35 (28.7%) respondents with secondary education, 38 (31.1%) with a first-level university education, 47 (38.5%) with a second-level university education and 2 (1.6%) with a third-level university education.

5. Preliminary Survey

The aim of the initial survey is to verify how the implementation of neuromarketing improves consumer behavior and increases sales. It focuses on identifying specific neuromarketing techniques that have the greatest impact on the cognitive, emotional and behavioral aspects of consumer decision-making, and their potential for optimizing marketing strategies in various industries. The survey was based on a combination of a systematic literature review and a questionnaire survey among experts in the field of neuromarketing and marketing. The systematic literature review was carried out by analyzing academic databases such as Google Scholar, PubMed and ScienceDirect. The studies were categorized according to the neuromarketing techniques used and the results analyzed, focusing on identifying the main trends and applications within these studies.

5.1 First stage of the survey: Secondary data analysis

The first phase of the research involved a thorough analysis of existing academic studies and professional articles in the field of neuromarketing. This analysis focused on identifying the most commonly used neuromarketing techniques, such as eye-tracking, EEG and fMRI, and on examining case studies that document the successful use of neuromarketing in practice and its benefits for increasing sales. The results of this analysis provided a basis for understanding current trends and identifying areas where neuromarketing brings the greatest added value. To complement the systematic review of the literature and case studies, a quantitative analysis of secondary data was conducted. This analysis focused on statistical data on sales, the success of marketing campaigns and consumer behavior before and after the implementation of neuromarketing techniques.

Secondary data was obtained from publicly available databases, company annual reports and market surveys. The analysis of this data allowed for a quantitative comparison of the impact of neuromarketing approaches on sales and consumer behavior compared to traditional methods. The statistical methods used

included correlation analysis, regression analysis, and other methods to measure the effectiveness of marketing strategies. Although the systematic literature review and case study analysis provide valuable insights, the study faced several limitations. The main challenges included the limited availability of some empirical data and differences in the methodologies used in the analyzed studies. In addition, the quantitative analysis was limited by the availability of secondary data that could provide a more comprehensive picture of the long-term impact of neuromarketing.

5.2 Second stage of the survey: Questionnaire analysis

The second stage of the survey was conducted by means of a questionnaire survey among experts in the fields of marketing, neuromarketing and business. The questionnaire included questions focused on the perception of the effectiveness of neuromarketing techniques in optimizing marketing campaigns and consumer behavior, experiences with the use of these techniques and their impact on campaign results, identification of the most effective techniques that contributed to improving consumer behavior and increasing sales, and suggestions for better use of neuromarketing knowledge in marketing strategies. The data obtained were analyzed using frequency statistical methods to determine the extent to which neuromarketing techniques translate into improved marketing results.

Based on the analysis of selected studies, several key areas were identified where neuromarketing techniques have demonstrated a significant impact on consumer behavior and sales success. The most prominent techniques include eye tracking, which allows us to understand which parts of an advertisement or product consumers are most focused on, and electroencephalography (EEG), which measures consumers' emotional and cognitive responses to various marketing stimuli. The research confirmed that neuromarketing approaches that integrate cognitive, emotional, and behavioral factors lead to more effective influence on consumer behavior and, consequently, to increased sales. Experts who participated in the questionnaire survey agreed that neuromarketing techniques that focus on emotional resonance and understanding consumers' subconscious responses are the most effective in optimizing marketing campaigns and increasing sales.

6. Research

Following the outcomes of the preliminary survey, the aim of the research was to determine whether there are statistically significant gender differences in the assessment of neuromarketing attributes according to the NMCEB methodology (NeuroMarketing – Cognition, Emotion, Behavior). For this purpose, the following hypothesis was formulated:

"There are statistically significant gender-based differences in the assessment of selected neuromarketing attributes (cognitive, emotional, behavioral reactions)."

6.1 Analysis of gender differences in the assessment of neuromarketing attributes

The research focused on the analysis of gender differences in the assessment of neuromarketing attributes. Based on the results of the data distribution normality testing (Table 1) it is possible to consider the use of parametric statistics.

Table 1. Data distribution of NMCEB methodology attributes

	Cognition	**Emotions**	**Behavior**
N	122	122	122
Skewness	-.191	-.335	-.256
Curtosis	-.279	.116	-.195

Source: own processing

The results of the normality test show negative skewness values within the neuromarketing attributes of Cognition, Emotion and Behavior, which indicates that respondents indicated more larger values than smaller ones in their answers. The hypothesis: "There are statistically significant gender-based differences in the assessment of selected neuromarketing attributes (cognitive, emotional, behavioral reactions)" was analyzed using a t-test for two independent samples in the statistical program IBM SPSS Statistics 26. Table 2 describes the gender differences recorded.

Table 2. Statistically significant gender-based differences in the selected neuromarketing attributes assessment

Attribute	Gender	M	t	Sig.
Cognition	male	4.4125	1.113	.270
	female	4.6207		
Emotions	male	4.2000	2.969	**.004**
	female	**4.7655**		
Behavior	male	4.5375	1.104	0.274
	female	4.7655		

Source: own processing

The results of the t-test confirmed the existence of statistically significant differences in emotional reactions between the male and female respondents. Females show higher scores in emotional reactions when evaluating neuromarketing stimuli (mean 4.7655, $t = 2.969$; $p < 0.004$) compared to males. This result indicates that females are more influenced by emotional stimuli in purchasing decisions than males, who tend to make decisions based on practical and rational factors. Based on these results, it is possible to regard the ***hypothesis*** that there are statistically significant gender-based differences in the assessment of selected neuromarketing attributes as ***supported***.

7. Discussion

The results of a preliminary study in the form of a systematic literature review suggest that neuromarketing techniques have significant potential to optimize consumer behavior and increase sales. The findings show that the integration of cognitive, emotional, and behavioral factors allows for a better understanding of how consumers perceive and respond to various marketing stimuli. These techniques allow marketers to create campaigns that are not only more effective, but also better targeted at specific market segments. One of the key findings is that emotionally charged advertisements and products tend to resonate more deeply with consumers, leading to higher levels of recall and brand loyalty. Emotions have been shown to be a key factor in purchasing decisions, often outweighing rational considerations. This aspect is extremely important for marketers who are trying to create a strong emotional bond between the brand and the consumer. Another important factor is the behavioral optimization of the sales environment. Research shows that even small changes in packaging design, product layout, or store atmosphere can lead to significant changes in consumer behavior. For example, studies that investigated the impact of music, lighting, and scent on purchasing decisions have shown that these elements can subconsciously influence customers and increase the likelihood of purchasing.

According to the results of the research study, the NMCEB methodology provides a comprehensive view of how various sensory stimuli and factors influence consumer behavior from a cognitive, emotional, and behavioral perspective. The results of this research show that consumers' cognitive, emotional, and behavioral responses to neuromarketing stimuli vary not only individually but also by gender. The findings indicate that females tend to be more sensitive to emotional stimuli, which can affect their purchasing behavior more significantly than males.

These gender differences are of fundamental importance to marketing practice, as they allow marketers to create campaigns that are tailored to the specific needs and preferences of different gender groups. Personalizing marketing strategies based on these differences can significantly increase the effectiveness of campaigns while improving consumer experience. In addition, understanding the interactions between cognitive, emotional, and behavioral factors can help design more comprehensive and effective marketing strategies (Alsharif & Isa, 2025; Plassmann, Ramsøy & Milosavljevic, 2012). Implementing neuromarketing findings into practice also brings new challenges, such as using these techniques ethically and ensuring that consumers are not being manipulated unconsciously. This aspect is particularly important because neuromarketing taps into subconscious processes that are beyond the conscious control of consumers. Therefore, it is essential that marketers use these techniques responsibly and transparently.

The survey results provide a strong argument for the wider use of neuromarketing techniques in marketing campaigns. The findings confirm that neuromarketing can provide valuable insights into consumer behavior that can lead to more effective targeting of marketing activities and increased sales. However, implementing these findings in practice requires not only technical expertise but also ethical considerations to avoid consumer manipulation. Future studies should focus on the long-term effects of

neuromarketing campaigns and their impact on brand loyalty and consumer decision-making. It would also be useful to examine how neuromarketing approaches can be adapted to different cultures and demographic groups.

Conclusion

Neuromarketing represents a revolutionary approach to understanding and optimizing consumer behavior. It has become an invaluable tool in the field of marketing research, providing a deeper understanding of how cognitive and emotional attributes influence consumer behavior and decision-making. This knowledge allows marketers to create more targeted and effective campaigns that are better tailored to the needs of consumers. Integrating cognitive, emotional, and behavioral factors into marketing strategies offers marketers new tools to improve the effectiveness of their campaigns and increase sales. A systematic review of the literature confirms that these techniques can lead to significant results if properly implemented. Neuromarketing findings have the potential to significantly contribute to optimizing consumer behavior and increasing sales. The key to successfully implementing these findings is understanding and integrating cognitive, emotional, and behavioral factors into marketing strategies. The results of the preliminary survey provide a strong foundation for further research and applications of neuromarketing in practice, while emphasizing the need for an ethical approach to the use of these techniques.

Gender differences in responses to neuromarketing cues represent an important aspect in the development of marketing strategies. Recognizing and exploiting these differences allows marketers to create campaigns that are not only more effective, but also better able to reach different genders. Future research should focus on examining these gender differences in more detail and their practical applications in marketing strategies, which could lead to even more sophisticated use of neuromarketing techniques in practice. The future of neuromarketing also lies in further deepening knowledge about how the human brain responds to various stimuli and in finding new ways to use these findings in practice. Marketers, who can apply these techniques ethically and effectively, can also gain a significant competitive advantage in the marketplace. Further research should continue to explore the ethical aspects of neuromarketing and its long-term impacts on consumer behavior, focusing on creating transparent and responsible marketing strategies that respect consumers and support their choice. The ethical use of neuromarketing techniques is key to maintaining consumer trust and responsible marketing.

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Revealing the Neuromarketing Potential of NLP Subconscious Mechanisms in Entrepreneurial Practice

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Abstract

Research background: In the context of a rapidly changing global environment, the ability of entrepreneurs to adapt and sustain their potential is increasingly important. Neuromarketing and neuro-linguistic programming (NLP) offer new insights into the subconscious mechanisms that influence personal development and decision-making processes. These tools can serve as a valuable asset in the pursuit of sustainable business and entrepreneurial practices.
Purpose of the article: The main objective of the paper is to identify and specify personal indicators of sustainable development in entrepreneurs through NLP. The research investigates how NLP training affects key characteristics related to entrepreneurs' adaptability and resilience in uncertain socio-economic conditions.
Methods: A sample of 208 entrepreneurs (96 women and 112 men), with an average age of 40.2 years, participated in the research. Of these, 112 participants had received NLP training, while the remaining 96 had not. The methodologies of Sustainable Human Capital (SHC) and NLP techniques (NLP-T), validated tools for assessing sustainable human capital indicators, were used to collect data. Statistical analysis aimed to identify significant differences between the two groups in terms of their experience with NLP training.
Findings and value added: The results revealed significant differences in personality indicators of sustainable human capital development between entrepreneurs who received NLP training and those who did not. The findings point to the potential of NLP as a tool to increase the adaptability and resilience of entrepreneurs. Integrating NLP with neuromarketing principles provides a new perspective on strategic human capital development.

Keywords: Neuromarketing, Neurolinguistic programming, Entrepreneurship, Sustainability, Human capital

JEL classification: M13, O15, M31

1. Introduction

In an era characterised by dynamic and unpredictable global developments, the ability of entrepreneurs to adapt and maintain their personal and professional potential is becoming an increasingly important factor for long-term organisation success. The success of an organisation depends also on to the quality of decisions and judgements made by both individuals and work teams (Fasolo et al., 2024). Rapid technological advances, changing market demands and socio-economic uncertainty are creating an environment in which traditional business strategies are no longer sufficient. Instead, there is a growing need to explore innovative approaches that increase both cognitive flexibility and emotional resilience.

In this context, emerging interdisciplinary fields such as neuromarketing and neuro-linguistic programming (NLP) offer valuable tools for understanding the unconscious mechanisms that influence human behaviour, decision-making and personal development. These approaches not only enable entrepreneurs to better understand their own communication and leadership styles, but also foster stronger connections with stakeholders, clients and teams. Integrating NLP with neuromarketing principles provides a new perspective on strategic human capital development (Plassmann et al., 2012).

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In this article, we approach neuromarketing as a multidisciplinary approach that combines insights from neuroscience, psychology, and marketing to better understand and influence customer behaviour, particularly by measuring subconscious responses. Neuromarketing instrumentation includes not only technologies such as eye-tracking or EEG, but also psychological tools and techniques (e.g. NLP) that can target the subconscious mechanisms that influence decision-making. From this perspective, NLP techniques have the potential to function as a neuromarketing tool, as they work with symbols, language patterns and non-verbal communication at a level that the recipient is not always consciously aware of.

1.1 Neuromarketing, NLP and unconscious mechanisms: common backgrounds

NLP shares many similarities with neuromarketing, especially when it comes to understanding the human mind and behaviour. Neuromarketing focuses on the study of the human brain's responses to various stimuli, including advertising. Studies suggest that both disciplines, neuromarketing and neurolinguistic programming, are effective tools in evaluating customer decisions and behaviour (Anazco et al., 2019).

While neuromarketing works with research on the brain's subconscious responses to stimuli that influence individuals' behaviour, often without their knowledge, neuro-linguistic programming (NLP) focuses mainly on conscious communication and personal development skills. However, both disciplines share an emphasis on information processing, emotional experience and decision-making processes that are not always consciously controlled (Plassmann et al., 2015).

Research in neuromarketing shows that up to 90-95% of decisions are made based on the subconscious (Zaltman, 2003). This means that the way we communicate, ask questions or use body language can have a neural impact, even if the recipient is not aware of it. Thus, NLP principles such as rapport, representational systems, or leading can influence not only cognitive understanding but also emotional and physiological response, which is the basis of neuromarketing.

For example, body language in neuromarketing is directly linked to the activation of mirror neurons - these are activated when observing other people's movements or expressions (Rizzolatti & Craighero, 2004). Thus, NLP, through the conscious use of body language, not only affect the ‘impression’, but can reach the neurobiological level of interaction. These areas are crucial for building trust, which is also a basic premise for forming successful business relationships.

NLP also works with linguistic patterns that can purposefully influence information processing at a subconscious level. In neuromarketing, the use of specific language or stories (narratives) has been shown to activate areas of the brain associated with self-experience (e.g., hippocampus, medial prefrontal cortex), thereby increasing emotional engagement and memorability of content (Zak, 2013). From this perspective, NLP can be seen not only as a communication tool but also as a method of subliminal influence, which is an essential element of modern customer experience-oriented marketing.

Properly applied, NLP techniques can, for example, increase the conversion rate of sales conversations in the same way that neuromarketing techniques increase the effect of advertising (Hult et al., 2017).

1.2 Neuro-Linguistic Programming (NLP)

Knight (2020) sees NLP as an attitude of learning, curiosity and respect for the unique way of being in the world, with its essence being the study of perfection. Hamill and Kerr (2013) add that many of our seemingly automatic responses are the result of learned sequences of thought and behaviour that run so fast that we perceive them as a whole. NLP analyses these behavioural structures and offers tools to consciously change and optimise them (Birknerová et al., 2022b).

Bandler et al. (2013) argue that NLP provides people with tools to change the way they think. It is a process of reprogramming thoughts that allows ideas to adapt to changes.

NLP is based on the premise that the point of communication is the response it elicits (Sandu, 2022). Effective communicators modify their language and communication style until they achieve the desired outcome. According to Knight (2020), the ability to create trust and understanding through language is one of the fundamental pillars of NLP. In this context, our research compared respondents who had received NLP training with those who had not, looking at differences in aspects of sustainable human potential development. El-Ashry (2021) states that neuro-linguistic programming greatly improves external communication with others in the workplace, using all the different communication mechanisms such as: understanding the other person's way of thinking, the hidden meaning of their words and their

actions, and also achieving common goals in the workplace. Finally, he adds that companies that use neuro-linguistic programming skills when communicating with customers achieve greater profits and superior customer service.

1.3 Aspects of sustainable human capital development

Sustainable human capital development is a strategic approach to shaping entrepreneurial decisions and developing people in both organisations and business environments that takes into account long-term needs, adaptability and the balance between performance, health and growth of the individual (Stajkovic & Stajkovic, 2025). Human capital sustainability includes not only traditional skill development, but also an emphasis on soft skills such as communication, collaboration, stress management, and the ability to learn, which enhance individuals' ability to respond to the challenges of the work environment and support their long-term psychological and occupational health (Wheeler, 2013).

From a business practice perspective, sustainable human capital development is closely linked to ethical leadership, self-reflection, knowledge sharing and continuous learning. Tools such as neuro-linguistic programming (NLP), which support the development of interpersonal and intrapersonal competencies, can contribute significantly to the sustainable strengthening of entrepreneurs' human capital. Sustainable development in this sense is not just about temporarily improving performance, but about building resilience, adaptability and long-term growth for the individual and the business environment as a whole.

2. Methods

Based on the theoretical knowledge and the results of the research (Frankovský et al., 2018), the aim of the presented research project was defined. The research aimed to identify and specify indicators of sustainable human capital development and to verify the existence of statistically significant differences in the level of aspects of sustainable human capital development between respondents who have received NLP training and those who have not. Based on the above objectives, the following hypotheses were formulated:

H1: We assume that it is possible to identify and statistically extract relevant factors of sustainable human capital development (SHC) indicators.

H2: We assume that there are statistically significant differences in the identified factors of sustainable human capital development between respondents who have received NLP training and those who have not received NLP training.

H3: We assume that there are statistically significant differences in the application of NLP techniques (NLP-T) between respondents who have received NLP training and those who have not.

We tested the hypotheses using two methodologies: Neuro-Linguistic Programming Techniques (NLP-T) and Sustainable Human Capital Development Indicators (SHC):

NLP-T: Neuro-Linguistic Programming Techniques (Frankovsky et al., 2018) – it explores neuro-linguistic programming techniques. The methodology includes 15 items that are assessed on a 5-point Likert-type scale (0-definitely no, 1-no, 2-rather no than yes, 3-rather yes than no, 4-yes, 5-definitely yes). Three factors were defined by factor analysis:

Representational systems - the belief that every human being views the world around them preferentially through one of the five sensory systems. Each person has his or her own, so-called, preferred sensory system, which one uses most advantageously and in which one feels best.

Rapport - creates an ideal state of communication based on trust and understanding that business people can use to influence behavior, initiate change, and persuade people.

Leading - guiding, accompanying or directing. Adapting to and creating harmony with a partner for a period of time should lead to the creation of a sufficient relationship that will then allow us to lead the partner to where we want to go.

SHC: Sustainable Human Capital Development Indicators (Frankovsky et al., 2019) - the methodology consists of 11 statements related to sustainable human capital development that underpin NLP. Each statement contains 6 possible ways of responding to the level of agreement with it (0-decidedly no, 1-no, 2-rather no than yes, 3-rather yes than no, 4-yes, 5-definitely yes). As an example, we give the statement ‘There is no failure, there is only feedback.’ ‘I have all the resources I need to make a change.’.

In the research presented here, data were collected from a pool of 208 entrepreneurs, of which 96 were women (46.2%) and 112 were men (53.8%). The average age of the respondents in the research sample was 40.2 years (standard deviation 10.187 years) ranging from 26 to 64 years. The average number of years of service of the respondents was 17.83 years (standard deviation 10.564 years) ranging from 1 to 40 years. Training in Neuro-Linguistic Programming (NLP) was completed by 112 respondents (53.8%), of whom 51 were male (45.5%) and 61 were female (54.5%) with a mean age of 41.5 years. 96 respondents (46.2%) did not undergo NLP training, of which 42 were male (43.8%) and 54 were female (56.2%) with an average age of 39.7 years.

3. Results

The data obtained allowed to perform factor analysis (Principal Component Analysis with Varimax rotation) and difference analysis (Student's t-test) using the statistical program IBM SPSS Statistics 26. The normality of the data distribution was tested using Skewness and Kurtosis.

Identification and specification of indicators of sustainable human capital development

Factor analysis, based on KMO test (.814) and Bartlett's test (585.2, sig. .000), Principal Component Analysis with Varimax rotation was used. Two factors were extracted (Table 1):

1. Uniqueness is assessed in terms of effective communication even without words. Unique individuals have their body and mind in harmony and perceive the world in a unique way. They are not afraid of change because they believe they have all the resources they need.
2. Positivity is perceived in terms of success, positive direction and intention. Positive individuals work to the best of their ability in a given situation. They always have the choice to change lives when other individuals have been able to do so.

The data obtained enabled factor analysis (Principal Component Analysis with Varimax rotation) and difference analysis (Student's t-test) to be carried out using the IBM SPSS Statistics 26 statistical program. The normality of the distribution of the data was tested using Skewness and Kurtosis.

Table 1. Factor structure of the SHC methodology

	Component		
	F1 Uniqueness	**F2 Positivity**	
I communicate even when I say nothing.	.638		
The meaning of communication is the response it evokes.	.799		
Every behaviour has a positive intention.		.785	
There is no failure, there is only feedback.		.764	
One works as best one can in a given situation.		.893	
The mind and the body are part of the same system.	.853		
All of us perceive the world in a unique way.	.891		
The possibility of choice is life-changing.		.673	
The same procedure equals the same results.	.741		
If someone has done it, others can do it, too.		.614	
I have all the resources I need to make a change.	.697		
Component	**Initial Eigenvalues**		
	Total	**% of Variance**	**Cumulative %**
F1 Uniqueness	5.187	47.143	47.143
F2 Positivity	1.382	12.557	59.699

Rotation Sums of Squared Loadings		
Total	% of Variance	Cumulative %
3.798	34.532	34.532
2.768	25.169	59.699

Source: own processing (2025)

The extracted factors explain 59.699% of the variance. This percentage of variance explained by the extracted factors is acceptable; the factors could be content-specific. The internal consistency of the factors was ascertained by calculating the Cronbach's alpha coefficient (Tables 2, 3).

Table 2. Internal consistency of the Uniqueness factor

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
I communicate even when I say nothing.	20.72	16.199	.549	.863
The meaning of communication is the response it evokes.	20.43	16.598	.695	.829
The mind and the body are part of the same system.	20.25	17.277	.729	.832
All of us perceive the world in a unique way	20.27	16.685	.709	.826
The same procedure equals the same results.	20.26	17.662	.619	.844
I have all the resources I need to make a change.	20.56	16.018	.656	.836

Cronbach’s alpha F1 Uniqueness = .867
Source: own processing (2025)

Table 3. Internal consistency of the Positivity factor

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
Every behaviour has a positive intention.	15.14	13.037	.589	.759
There is no failure, there is only feedback.	15.29	11.469	.664	.736
One works as best one can in a given situation.	15.52	11.594	.672	.735
The possibility of choice is life-changing	14.63	15.656	.479	.796
If someone has done it, others can do it, too.	14.78	13.944	.536	.778

Cronbach’s alpha F2 Positivity = .799
Source: own processing (2025)

The above Cronbach's alpha values indicate a satisfactory level of internal consistency of the extracted factors of sustainable human capital development. Based on the above results, hypothesis 1, 'We assume that it is possible to identify and specify indicators of sustainable human capital development,' can be considered as verified.

Identification of differences in the factors of sustainable human capital development

Mathematical and statistical analysis of the data was carried out using Student's t-test in the statistical program SPSS 26. The results found are presented in Table 4.

Table 4. Differences in the assessment of sustainable human capital development factors

	NLP training	Average	Standard deviation	T-test	Significance
F1 Uniqueness	not received	3,32	,798	3,492	**,002**
	received	**3,98**	,748		
F2 Positivity	not received	3,15	,727	4,458	**,000**
	received	**4,23**	,533		

Source: own processing (2025)

We found that respondents who had received NLP training judged the SHC factors more positively than did respondents who had not received NLP training.

The first indicator of sustainable human capital development that proved to be statistically significant is the trait of Uniqueness. This characteristic reflects individual uniqueness and the ability to develop one's potential, with development also possible at a subconscious level. The second significant factor was the Positivity indicator, which refers to the ability of individuals to orient themselves towards constructive and goal-directed behaviour

Identification of differences in the application of NLP techniques

The mathematical and statistical analysis of the data was carried out using Student's t-test in the statistical program SPSS 26. The responses of the respondents who had or had not undergone NLP training were compared. The findings are presented in terms of the 3 extracted factors of the degree of application of NLP techniques (NLP-T methodology): Representational Systems, Rapport and Leading (Table 5).

Table 5. Differences in the assessment of the degree of applying NLP techniques

	NLP training	Average	Standard deviation	T-test	Significance
F1 Representational systems	not received	3,27	,788	3,143	**,005**
	received	**3,99**	,756		
F2 Rapport	not received	3,46	,728	4,637	**,000**
	received	**4,73**	,517		
F3 Leading	not received	3,13	,746	2,356	**,004**
	received	**3,91**	,562		

Source: own processing (2025)

The results presented in Table 5 show statistically significant differences ($p < 0.05$) in all three factors between the group of respondents who had received NLP training and those who had not. Respondents who had received NLP training showed a higher rate of application of NLP techniques across all the domains studied. Specifically, in the area of representational systems, NLP training participants demonstrated higher levels of awareness and use of preferred sensory modalities in communication. Under the rapport factor, respondents confirmed that they were able to purposefully build trust and harmonious relationships through adapting to their partner's communication after the training. In the third factor, leading, respondents who had received training reported a greater ability to guide

communication towards the desired outcome through establishing a connection and then guiding the partner according to NLP principles.

4. Discussion

Statistically significant differences were found in the identified factors of sustainable human capital development. Respondents who received NLP training showed higher scores, especially in areas such as conscious perception of communication, flexibility and openness in expression, ability to work with the meaning of information, as well as self-reflection. These factors are considered important aspects of human capital development, especially in the context of working with people and in environments where quality interaction is vital. There were also statistically significant differences in the application of NLP techniques (NLP-T). Respondents who had received NLP training were more likely to rapport actively using techniques such as working with representational systems, rapport generation and communication (leading).

The results are also consistent with existing findings from the literature. For example, research conducted in India (Singh, 2008) confirms that NLP techniques can be useful for managers and employees in increasing work effectiveness and building a better understanding in teams. Similarly, Tripathi (2012) highlights the importance of NLP in recognising one's own emotional and behavioural patterns, which can help individuals develop both interpersonal and intrapersonal skills. Research results suggest that NLP training not only increases the conscious level of communication skills, but can also influence the subconscious (unconscious) processes that underlie emotional response, trust formation and decision-making.

These aspects are the subject of neuromarketing research. These processes refer to psychophysiological reactions and mental operations that take place below the threshold of conscious perception, yet fundamentally influence an individual's emotional experience, decision-making and behaviour. Key NLP techniques such as rapport, leading or working with representational systems can lead to the activation of brain structures (Birknerová et al., 2022a). These processes often take place outside the conscious control of the communicators, which means that NLP can also function as a tool for subconsciously optimising interaction (Budiman et al., 2018).

The present study primarily draws on data collected through questionnaire methodologies, which are based on the subjective assessment of the respondents and do not fully capture the real subconscious reactions that often take place outside of conscious awareness. Future research may combine self-assessment and behavioural data with biological indicators of unconscious responses. We also plan to validate our findings with tools such as eye-tracking, which allow us to objectively monitor respondents' unconscious reactions in real time.

Conclusion

These findings open up a new research area - investigating the effects of NLP techniques not only through questionnaire methods, but also using neuroscientific and psychophysiological tools that allow monitoring of immediate and unconscious reactions. Such an approach could provide new insights into the effectiveness of NLP and its potential use in the fields of neuromarketing, coaching and managerial communication.

From a business practice perspective, it is important to recognise that the application of NLP in business goes beyond conventional verbal strategies and involves shaping the customer experience, building credibility and influencing decision-making behaviour over the long term - often at a level that the recipient is not even aware of. This ability to reach the “subconscious” is why NLP is also relevant in the context of modern neuromarketing.

In the context of marketing practice, NLP techniques can be used effectively in creating advertising messages, building customer trust and increasing conversion rates through targeted communications that reflect customers' preferred sensory modalities.

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Advertising Literacy and Implicit Reactions to Brand Benefits: A Case Study of Research on Implicit Reactions as a Complement to Verbal Feedback

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Abstract

Research background: advertising literacy is traditionally understood as the ability to recognize an advertisement, understand its intent and critically evaluate its content. In practice, however, consumers often react affectively rather than rationally - and their bodily reactions may signal rejection before they are consciously aware of it. Neuromarketing methods thus represent a valuable tool for exploring those layers of perception that remain outside verbal articulation, but may be key to understanding advertising literacy as a complex set of cognitive and emotional processes.
Purpose of the article: The aim of the study is to investigate how implicit bodily reactions can serve as an indicator of the level of advertising literacy of the audience. Using the example of the Digital University brand campaign, we analyze the reactions to the terms "MBA" and "online learning", which were declared as benefits. We focus on cases where the audience did not verbally express disagreement, but biometric data (GSR and facial coding) revealed a hidden affective aversion.
Methods: An exploratory case study used a combination of facial coding (Affectiva SDK), GSR (Shimmer) and eye-tracking (Smart Eye Aurora) on a sample of 19 respondents. An advertising spot with repetitive expressions was analyzed.
Findings & Value added: The results show that some concepts, while not causing conscious rejection, do cause affective mistrust. These reactions can be seen as a bodily expression of advertising literacyliteracy - as a prior stage of critical processing. The study proposes to integrate neuromarketing methods into both research and branding practice, especially with target audiences that are sensitive to authenticity.

Keywords: Advertising literacy, Affective trust, Biometric response, Brand communication, Emotion measurement, Implicit reactions, Neuromarketing.

JEL classification: M31, D91, M37

1. Introduction

Advertising literacy has traditionally been defined as the ability to recognize advertising, understand its intentions, and critically evaluate its content (Rozendaal et al., 2011). This view is further supported by Čábyová, Krajčovič and Hudáková (2023), who emphasise that advertising literacy in the current media environment includes the ability to detect misleading environmental claims and to evaluate the credibility of advertising content in the context of greenwashing practices. However, this concept is difficult to measure in practice solely through stated responses - especially if we also want to understand the emotional impact of advertising (Hobbs, 2017). Researchers have long recognised that advertising also operates non-verbally, emotionally and implicitly - which raises the question of how consumers actually process it (Gordon, 2006). The difference between what consumers think and what they feel can be substantial (Krajčovič & Darázs 2021).

As a research approach, neuromarketing also allows us to investigate responses to advertising that are not verbalized. Biometric measurements such as galvanic skin response or facial coding have the potential to add to our understanding of how humans process advertising content (Čábyová et al.,2024).

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This case study is intended to show what can be learned by observing not only what people say, but also how they react to advertising outside of their conscious minds. By analyzing biometric responses to specific expressions in the Digital University brand campaign, we reveal situations in which respondents' bodies express disapproval or disbelief - even though verbal reactions remain neutral or positive.

We show that implicit responses can be an important part of ad content processing, and that tracking these responses can expand the way we think about ad literacy, brand trust, and overall ad perception.

In this sense, advertising literacy is not limited to the ability to verbally identify advertising, but also includes affective competence - i.e. the ability to respond physically and emotionally to the non-verbal aspects of communication. The concept of "affective advertising literacy" is not yet settled in the literature, but this research shows that emotional processing of advertising can reveal important patterns of implicit judgment and credibility that remain hidden in rational evaluation. The results of this type of research can be seen as a manifestation of an expanded understanding of advertising literacy - not only in what audiences are aware of, but also in how their bodies react to the way an advertising message is framed. In the context of biometric data, we thus observe implicit signs of 'understanding' advertising that may express tacit disapproval, scepticism or emotional dissonance.

This article analyses the case of the Digital University brand, which built its video campaign on two main benefits: the MBA degree and the online form of study. From a traditional marketing perspective, these are strong benefits - declared as modern, flexible, practical. Conscious evaluations by respondents did not reject these statements: no significant questioning emerged in questionnaires or interviews.

But neuromarketing data showed something else: the body reacted with contempt, a decrease in bias, or even anger - at the very moments when these "benefits" appeared in the video.

What does it mean when an audience consciously agrees but their implicit responses tell a different story? And what does this say about branding as a discipline that today increasingly works with data but doesn't always understand its meaning? And what do consumers understand of it?

The understanding of marketing communication and brand message does not originate in the office environment, but in the experiences of the people who come into contact with it. In modern marketing communications, it is not enough for a brand or communication to 'make sense'. It has to be emotionally grounded, credible, and affectively experienced (Bilotti, 2011). The emotional connection between the communication and the audience is a critical factor in loyalty - rational benefits are just a ticket, but not a reason to stay (Joshi & Nema, 2015).

Brands and their communications that ignore the emotional register seem to risk 'affective failure' - a situation in which audiences may understand the words, but do not believe them with their bodies (Rostomyan, 2014). This is especially true for audiences that are vulnerable to inauthenticity and marketing machinery - for example, Generation Z, whose relationship with brands is fragmented, cautious, and often tested by emotional resonance, not argumentative force (Feng et al., 2024)

Statements that are meant as benefits thus run up against cultural and bodily filters. Neuromarketing in this case does not reveal "what people think". It reveals tacit bodily disagreements that don't appear in rational discourse - but which determine whether we trust a brand and how we perceive it.

Also, theoretical frameworks point out, a communication or brand that is not lived - even if it were technically correct - remains alien (Rosenbaum-Elliott et al., 2018; Ho, 2020; Powers & Pattwell, 2015).

The aim of this study is to show how tracking biometric responses can enrich the understanding of advertising literacy, especially in cases where verbal expressions do not capture the full range of brand perception. However, to better understand how advertising literacy works, we must also pay attention to those layers of perception that take place below the level of consciousness - in the subtle, often hidden bodily responses that precede rational judgments of advertising. In this sense, advertising literacy manifests itself not only in the ability to identify advertising, but also in the ability to respond bodily to its (inauthenticity. If the audience perceives a difference between the declared and the actually experienced meaning, their emotional reaction may be the first indicator of advertising literacy or a refusal to trust the message.

2. Methods

This article presents a case study with an exploratory nature, which aims to analyse the implicit affective responses of the audience to specific value elements of the Digital University brand - in particular, to the notion of *MBA* and *online learning*, *revealing* differences in stated and lived perceptions. Digital University is a Slovak educational platform that offers online MBA and other professional

programmes focused on practical skills and flexibility. The brand operates in the Czech and Slovak markets and focuses on students who want to study alongside work or remotely. Teaching is fully online, with an emphasis on *up-to-date content, practitioner tutors and professional branding*.

This study focuses exclusively on one particular video under test - referred to as V1. It was a short video review filmed in the streets of Bratislava, linking the testimony of the main lecturer with the testimony of the graduates. The opening part of the video features the lecturer - a well-known motivational speaker and coach working in the Central European area - who introduces the benefits of studying and presents the brand values. This is followed by personal testimonies from the graduates, ending with a return to the brand challenge. The video has a professional format and is typically representative of branded content designed for social media.

It was in this video that the most affective reactions were observed in relation to the statements about "MBA" and "online learning". Therefore, V1 is the main focus of analysis in this study.

The study is based on a research collection that was conducted as part of a broader pre-test of the Digital University's advertising materials. The impetus for the research was an internal initiative of one of the employees of this educational institution, who, as part of her master's studies at the Faculty of Mass Media Communication at UCM, conducted a master's thesis focused on the evaluation of the campaign's video formats.

Although the research did not originate as a formal commercial assignment, its design, implementation and interpretation were conducted with the intention of providing actionable insights to optimise the brand's communication strategy. The research was conducted under expert supervision and using professional equipment in the NEUROLAB neuromarketing laboratory at the FMK UCM in Trnava.

However, the aim of this study is fundamentally different from the aim of the thesis. While the thesis compared the effectiveness of different video formats and looked for the 'best' way to communicate the campaign as a whole, this paper purposefully focuses on one of the most contextually interesting phenomena that repeatedly emerged across the different formats - namely, affective responses to the words 'MBA' and 'online study'.

Thus, this research does not seek to compare video formats, but to conceptually analyse what happens when a brand communicates values that, while appearing to be rationally advantageous, are physically experienced as problematic.

The research question addressed in the text is: *What implicit affective reactions are elicited by the communication of the value of "MBA degree" and "online learning" in the context of the Digital University brand - and what do these reactions say about its affective credibility?*

The nature of the study is qualitative-interpretive. We do not work with hypotheses or statistical inference. The aim is to identify and interpret specific affective patterns that are not articulated consciously by the respondent, but are detectable through biometric indicators and visual attention tracking.

Data collection took place on 27 February 2024. The study population consisted of 19 respondents aged between 20 and 50 years, who were purposively selected based on their assumed similarity to the Digital University target group. The sample consisted of working students, self-employed people, marketing professionals, entrepreneurs and people interested in external or flexible learning.

Five promotional videos were shown to the respondents. The videos were played in random order to avoid the influence of attention and order. They all contained elements that communicated the benefits of studying - and among these, two key ones were recurring: *the MBA degree* and the *online form of study*.

Technically, the research was carried out using three basic biosensory methods:

- eye-tracking (Smart Eye Aurora) - tracking the distribution of visual attention and AOI,
- facial coding (Affectiva SDK) - capturing basic emotions by facial expressions,
- GSR (Shimmer sensor) - recording electrodermal activity as an indicator of emotional arousal.

After playing the videos, each participant completed a questionnaire designed to compare conscious ratings with implicit responses. It is noteworthy, however, that it was the occurrence of "MBA" and "online learning" that showed no complaints or negative comments in the questionnaires, whereas the biometric data showed the opposite - disdain, decreased attention, micro-expressions of disgust or disinterest.

In this study, we exclusively analyze these recurring moments - not entire videos or their composition, although there were also some fluctuations (e.g., in illogical editing or foreign names of performers).

Ethical aspects of the research were observed. Informed consent was provided by the respondents, the research was anonymous and focused solely on non-invasive observation of behavioural and physiological responses.

The limitations of the research lie in the small sample size and the specific composition of the participants. However, the intention was not to make generally valid recommendations, but to highlight a conceptually important phenomenon that would have gone unnoticed in classical research: that a brand can communicate values that, although not consciously questioned by the audience, are affectively rejected by them.

3. Results

In this part of the study, we focus exclusively on one of the tested videos - video V1, whose structure and format we have described in detail in the methodology section. The reason for the selection is not only based on the strength of the biometric response, but also on its fundamental role within the brand campaign. Of all the formats tested, it was the most classic promotional output in which the brand directly declares its main benefits - namely *the MBA degree* and *online study*. The other videos in the tested series varied in nature: they were either authentic accounts of life, personal stories or slightly ironic, humorous spots without strong brand statements.

That is why the analytical focus of this study is on video V1 - not only as a carrier of expression, but as a representative of the overall communication rhetoric of the brand. Indeed, the expressions used in this video are *brand-speak in its pure form* - they are formulations that have been created 'at the table', not in the field.

This raises an important question: What happens when a brand declares an advantage, but the body of the audience doesn't experience it as an advantage? Can we talk about a loss of trust? Or more precisely: a loss of affective trust - the type of trust that is not based on argument, but on bodily resonance.

Emotional response to advertising is key to creating lasting memory and subsequent consumer behaviour. Emotions activate the limbic system, which plays a crucial role in decision making and the formation of trust in a brand (Kaushik et al., 2024). Emotional reactions influence a consumer's attitude towards a brand and their subsequent decisions - positive emotions can reinforce trust, while negative emotions can undermine it (Bungatang et al., 2023).

Another specific aspect of this analysis is the target group that the video clearly aims at: young adults - mostly from a Generation Z background - who combine study and work and naturally expect flexibility, digital environments and authenticity. At the same time, however, this is a group that is highly sensitive to inauthenticity, unnatural forms of presentation or a 'marketing tone' that is not emotionally anchored.

The affective response of a brand - especially in the case of Generation Z - is thus not only determined by vocabulary, but also by whether a given term "fits into the world" they already know and live. If an utterance isn't emotionally rooted, it won't pass through the body. And if it doesn't pass through the body, it is ineffective from a trust perspective - regardless of rational correctness.

In the context of this study, therefore, we are looking at elements of affective mismatch - situations where a brand says something that the audience does not verbally reject, but their body responds with resistance, a decrease in engagement, or an absence of trust. These moments are tacit but measurable - and can be just as important as verbal caveats or changes in attitudes.

So we are not analysing the performance of the campaign as a whole. We do not examine which video had the best impression. We are looking at a more subtle phenomenon: specific moments in which the audience affectively rejects what the brand declares as an advantage.

The following three subsections are devoted to three such moments captured in video V1:

- first response to the term *"MBA"* in the introduction of the video,
- second response to *"MBA"* in the mouth of a graduate,
- and in response to a statement about *online learning* that was intended as a benefit but caused emotional distance.

3.1 First reaction to "MBA" - the lecturer as the voice of the brand

The first critical point in the V1 video is the lecturer's statement at the ninth second:

"The opportunity to earn an international MBA."

In terms of marketing rhetoric, this is a classic example of a claimed benefit. The statement is clear, positive, embedded in the language of career progression. Within the structure of the video, it is also the

first peak of meaning - the audience is just entering the narrative and the brand is signalling here what it wants to be: modern, prestigious and trustworthy.

However, the data show that it is at this point that the affective break occurs. In the ninth second of the video it occurs:

- a decrease in electrodermal activity (GSR) of approximately 29% within four seconds,
- and at the same time, expressions of contempt - nonverbal expressions that indicate rejection, feelings of superiority, or emotional distance - appear in facial coding data.

This fluctuation cannot be interpreted as the result of general inattention - up to this point, the audience's physiological engagement was stable and slightly elevated, indicative of underlying emotional engagement. Thus, the video was building trust at the outset. However, the statement about the MBA disrupted this rhythm. It was as if there was a note in the harmonic flow that didn't fit.

We can speak of a distortion of the affective trajectory - a statement that was meant to strengthen confidence instead weakens it. The body does not respond with assent, but with silent rejection.

There are several possible causes for this reaction:

- Ignorance of the acronym MBA - some respondents may not have understood it or associated the term with something irrelevant (e.g. professional sport),
- The perception of the term as elitist - an MBA degree can convey a sense of distance, superiority, or even the idea of a "bought education",
- Low credibility of the utterance - the utterance comes across as a learned brand, not a natural utterance. The lecturer as the voice of the brand does come across as professional, but perhaps that is why he is perceived as a marketing spokesperson, not as an authentic source.

As Romero Olucha et al. (2015) point out, the emotional response to an utterance depends not only on its meaning, but mainly on how it corresponds to the recipient's physical and cultural frame. The body does not evaluate grammar or logic - it evaluates confidence.

Particularly noteworthy is that this is the video's opening semantic highlight. At this stage, the brand hasn't yet built trust capital - on the contrary, it's in the process of building it. If the first affective disruption has already appeared at this point, the entire subsequent course of communication can take place in the shadow of this disruption.

This single utterance thus becomes the point of an affective turning point. Not because it is factually incorrect. But because it failed to pass through the body. And it is these micro-frames that we focus on in this study - the seemingly insignificant seconds that decide whether or not we believe a brand.

However, it is also worth mentioning the cultural context - the research was conducted in Slovakia, where the MBA degree is not socially established. Its value is not generally perceived as unambiguous. Some consider it a prestigious degree, others a formal label. In this environment, it is not impossible that the expression of contempt captured in the biometric data was not just a bodily response to an unfamiliar concept, but an authentic expression of value disapproval.

In this short snippet of video, this may be mirroring a strategic problem that the brand is unaware of: it is communicating an advantage that not only doesn't work, but can be actively denied. And more seriously - it's doing it without knowing it.

Such a finding goes beyond campaign optimization. It may be a significant reputational issue that requires careful reflection, perhaps even a stand-alone educational or trust-building campaign that aims not only to name the benefit but also to embed it in the experience and values of the target group.

3.2 The second reaction to the "MBA" - authentic testimony without trust

The second significant moment, when the *MBA* degree appears within the V1 video, comes later in the sequence of Digital University alumni testimonials. This time it is not the statement of a professional lecturer, but the personal experience of one of the graduates, which is intended to strengthen the credibility of the brand through the so-called "social proof" - that is, through people who have used the product and believe in it.

Here, the brand changes its communicative role: it moves from a representative (lecturer) to a witness (graduate). This would be expected to gain authenticity. But paradoxically, it is at this point that the affective response occurs again, suggesting that the mere rephrasing of the expression is not enough.

By the time a graduate mentions the MBA, it appears repeatedly in the data:

- expression of contempt,
- decrease in emotional engagement,
- and in some cases an increase in sentimentality, which may suggest a mixture of confusion, irony or subliminal disapproval.

Compared to the first situation, a strange paradox arises here: the audience no longer hears the statement from the mouth of a "brand announcer", but from the mouth of an "ordinary person" - and yet (or perhaps precisely because of this) the reaction is just as affectively negative.

This phenomenon may be related to several factors:

- Low persuasiveness of the utterance - if the utterance is not delivered persuasively (body language, intonation, word choice), the audience may perceive "readiness", thus weakening authenticity,
- Appearance-statement discrepancy - if the respondent's appearance, language, or emotional tone clashes with the MBA concept, cognitive tension arises, which the body may respond with resistance,
- Unintelligibility of purpose - if a statement acts as an "add-on" to a statement without context, the audience may interpret it as meaningless or even imposed.

It seems that if a statement feels like a mechanical component or is emotionally out of tone with the rest of the scene, it can be dismissed as inauthentic.

In this particular situation, it turns out that even "live testimony" is not enough if it is not experienced as credible. Just because a statement comes from the mouth of 'one of us' does not guarantee that it will be accepted by 'us'. On the contrary - it can reinforce the effect of inauthenticity if the audience perceives that it is just 'another announcer' with another actor's lines. The affective reaction thus paradoxically shows that the problem may not only be the form of communication, but the content of the utterance itself. That is, not *who* says it, but *what is* said - and *how* it resonates in context.

Here again, the importance of the cultural framework becomes apparent. As we indicated in the previous chapter, the MBA is not firmly embedded in the cultural discourse in Slovakia. While in some countries it is seen as a clear symbol of prestige, in our country it can mean many things - or nothing. This context also influences the perception of graduates' statements - not as evidence of confidence, but as repetition of a word that is not yet emotionally embedded in the target group's map of values.

In the end, even the strengthening of authenticity (through the form of the utterance) does not compensate for the lack of affective anchoring (content). The utterance "MBA" may have sounded different, but it was not received differently. And this is an important signal for the brand.

If the benefit is not accepted even by those who have supposedly already gone through it, it may mean that it is not just a problem of communication, but a problem of perceived value itself.

This finding reinforces a previous hypothesis - that the MBA degree is not just unfamiliar or formal, but that there is some form of affective distance associated with it. And it is perhaps for this reason that it requires not just a "better campaign" but a new embeddedness in the cultural and emotional fabric of the audience.

3.3 Online learning as a word marked by crisis

The third critical moment in the V1 video is the lecturer's statement about the possibility of studying from home - i.e. about the online form of studying. This statement appears at about the 31st second of the video.

Like the *MBA* concept, "online learning" is also presented as an advantage in the communication strategy of the Digital University. The brand thus communicates flexibility, convenience, independence - all elements that are often associated on a conscious level with a positive evaluation of education in the digital space.

However, the data shows that the body reacted differently:

- at the time of this statement there was a decrease in joy,
- the emotion of contempt reappeared,
- and the GSR curve showed a decrease in activation, indicating a decrease in emotional involvement.

From the perspective of the classical logic of benefits, this is a surprising reaction. After all, online learning is flexible, convenient, accessible - and generally seen as one of the major trends in modern education. Why, then, would this particular statement elicit such an affective response?

The affective history of the word "online" offers one possible explanation.In the cultural memory of young adults - and especially Generation Z - the notion of *online learning* is closely associated with the pandemic period. A time of isolation, of technical chaos, of absent contact, of frustration with learning that was limited to "screen survival."

This effect can be referred to as the affective inheritance of the expression. Terms such as *online learning* may be technically neutral, but they are emotionally steeped in the audience's prior experience. This is particularly important if a brand is working with a young target audience that has experienced pandemic studying as a pivotal life experience.

Words like *online*, therefore, cannot be communicated without considering the emotional layers that resonate within them. From an identity-based branding perspective, there is again a tension between brand intent and audience perception. The brand wants to be modern and practical. However, audiences may experience this statement as a reminder of insecurity, isolation and emotional exhaustion.

Of particular importance is that this is the second occurrence of a semantic distortion within the same video - again in the mouth of the lecturer. This reinforces the hypothesis that the problem is not with the individual, but with the dictionary. The brand uses terms that it considers to be benefits, but which the audience - physically, emotionally - does not read as benefits. This type of contradiction may not appear at all on a conscious level. Questionnaires and interviews can remain 'clean'. All the more important is the use of neuromarketing methods that can capture the discrepancy that the conscious mind does not express - but the body experiences. The affective response to *online learning* is thus not a rejection of the concept per se, but a mismatch between the brand intent and the emotional context in which the concept takes place.

In the end, the brand says nothing wrong. But it speaks it in the wrong language of experience. So if the Digital University brand wants to communicate benefits like flexibility or accessibility, perhaps using the word "online" isn't enough. Perhaps it needs to reframe the term, examine its affective traces, and find a way to disentangle it from pandemic memory. Otherwise, it will continue to function as a silent confidence blocker.

3.4 Summary of affective patterns

The three situations analysed - the lecturer's statement about the MBA, the graduate's statement about the MBA and the mention of online learning - represent clear points of value communication from a brand perspective. They were meant to signal credibility, flexibility, career growth. However, biometric data shows the opposite: a decline in GSR, the appearance of contempt, a decrease in emotional engagement. The common denominator in all three cases is the affective mismatch between what the brand declares and how the audience - bodily - experiences it. These reactions could be interpreted as isolated if they did not occur repeatedly. And more importantly - they were not consciously noticed. After watching the videos, respondents completed questionnaires in which they indicated reservations about formal and compositional elements (e.g., choice of actors, editing illogicalities, or foreign names). Terms such as *MBA* or *online study* did not appear in the questionnaires - their 'problematic' nature only became apparent in the later analysis of the biometric traces. These findings underline the importance of what (Brenninkmeijer et al., 2020) refer to as *silent data* - data that the body records without consciousness naming it. Neuromarketing methods (GSR, facial coding) thus provide insight not only into audience reactions, but especially into reactions that would remain hidden by classical research methods. The emotional response is not determined by the meaning of the utterance, but by the context in which it takes place - both cultural and bodily (Bagozzi et al. 1999). The body does not evaluate grammar or logic - it evaluates confidence. And it is the latter that has been eroded in moments when the brand has communicated values that, while not consciously rejected, have not been affectively embraced by the audience.

The term *MBA* was heard in the introduction from the mouth of the lecturer - a representative of the brand - and later also from the mouth of the graduate, i.e. the person who was supposed to legitimise it through personal experience. In both cases, however, there was a marked decrease in GSR activity and the appearance of the emotion of contempt. This type of reaction is not usual in misunderstanding - on the contrary, contempt is a sign of rejection, disrespect or the perception of the expression as "inflated" and

untrustworthy. Thus, the look of contempt on faces that appeared repeatedly may not just be a random micro-revelation - it may be symptomatic of a brand communicating a concept that the audience either does not believe or finds empty. It is also problematic from a trust perspective that the brand first entrusted this statement to a lecturer - a person with authority, but also with a visible distance from the target audience - and then had it confirmed by the graduates. This repetitive narrative, if not emotionally compelling, only reinforces affective alienation. A statement that was intended to act as evidence of trust ultimately becomes evidence of misunderstanding. In terms of affective experience, then, it turns out that words like "MBA" may be rejected not because they are wrong-but because they do not carry support in the audience's bodily memory. Their problem is not meaning but emotional loneliness.

The same mechanism of trust failure shows up with the term *online learning*. In the cultural memory of young adults - and especially Generation Z - this term is closely associated with the pandemic period. A time of isolation, of technical chaos, of absent contact, of frustration with learning that was limited to screen-based survival. Words like *flexibility* or *flexible learning* can convey benefits - but when tied to negative affective experiences, communication fails without the brand noticing.

The affective failure of the brand here is not the result of a typo or a bad campaign. It is the result of the brand benefits not being embedded in the value maps of the audience. In this case, however, the concept of *the MBA* and *online learning* were not experienced as credible - and therefore remained emotionally alien. The brand therefore says nothing wrong. But it is saying it in a language that the audience doesn't believe. The communication may be formally correct - but without emotional rootedness, it communicates into the void.

In this context, it is important to recall that it is neuromarketing that has provided the opportunity to identify these "invisible" moments. Traditional questionnaires would not - and indeed did not - draw attention to them. The terms *MBA* and *online learning* did not appear as problematic in the questionnaire responses at all. And yet it was these words that elicited the most physiological reactions. Neuromarketing thus showed in this case not what people think - but what they unconsciously reject. As (Brenninkmeijer et al., 2020) aptly state, it is biometric tools such as GSR or facial coding that are nowadays crucial for capturing the *silent data* - the silent disagreements that do not pass into conscious language, but decide whether we trust a brand. Without a neuromarketing approach, these patterns would remain invisible. And the brand could continue to communicate benefits that the audience understands with the mind - but rejects with the body.

4. Discussion

This study did not address whether an MBA degree is an advantage. However, the findings resonate with a broader academic redefinition of advertising literacy. Čábyová et al. (2023) argue that true advertising literacy must also encompass the ability to critically interpret not only rational messages, but also affective framings and persuasive tactics aimed at unconscious processing.Nor whether online learning is flexible. It focused on something more subtle, but more fundamental: how these concepts "pass through the body." And she showed that sometimes they don't pass at all. We can interpret these differences between conscious consent and nonverbal refusal as evidence of the importance of tracking implicit responses in advertising literacy research. Neuromarketing methods thus allow us to reveal deeper layers of media understanding that conventional questionnaires cannot capture." The data suggests that brand communications may be formally correct but emotionally blind. Audience reactions were not consciously dismissive. No objections to these values emerged in the questionnaires or interviews. And yet - it was in the moments when the brand communicated *an MBA* or *online learning* that the body of respondents withdrew. It lost engagement. It showed disdain. This paradox - between word and trust, between content and body - deserves deeper discussion. For it opens up four key strands that have implications for both research and branding practice. A brand is not just a carrier of meanings. It is a mirror of the affective trust that audiences attribute to it. If a brand says a word that the audience understands but does not feel, the result is not understanding - but coldness. The term *MBA* carries weight in the world of management - but it may not be emotionally anchored for a Slovak audience. On the contrary, it can be perceived as a fashionable shorthand that inspires not respect but distance. In the same way, *online learning* - although formally associated with flexibility - can evoke lockdown, chaos, loneliness in the minds of respondents. Trust is thus not broken because the brand misleads. It is breached because it speaks words that the body does not welcome.

In marketing, it is often assumed that if something is profitable, it will also be perceived as profitable. But this is not true. Emotions don't listen to benefits - they listen to context. As this study shows, the Digital University brand repeatedly emphasized two benefits: title and form. But neither was emotionally resonant. And therein lies the blindness - that the strategy sees the words but doesn't see their emotional legacy. The statement "you study from home" can only be a benefit if home is not synonymous with isolation for the audience. The statement "you will get an MBA" only works if the degree is not seen as an empty symbol. A brand that doesn't know this context runs the risk of making its benefits seem like foreign words in a familiar language.

If we relied only on questionnaires, we would not see this affective blindness. The respondents did not realize it. They did not articulate it. It was only present in the body. As (Brenninkmeijer et al., 2020) state, tools such as GSR or facial coding reveal *silent data* - silent micro-reactions that do not pass into language, but determine confidence. These signals are not noise. They are predictors of behavior that classical research often overlooks. Neuromarketing is therefore not a fancy gadget for special projects. It is a diagnostic tool. Like an EEG in medicine - it doesn't say what the patient feels, but it shows what their body is doing. And sometimes that's where the truth that consciousness hides lies.

A brand is not a lecture. It is a conversation. And a good conversation is not created by saying what we want to say - but by the other person's perception shaping how we speak. Affective blindness is one of the most dangerous mistakes in brand communication. Not because it's dramatic - but because it's silent. It doesn't sound remorseful. A complaint isn't written. Trust is just lost. So this study is not just about one campaign. It's about the fact that brands need to test not just what they say, but how the body receives it. And sometimes they find that the word they thought was an advantage - is a *hint of foul play* in the audience's experience. So the new sensibility in branding doesn't start with strategy. It starts with the ability to listen quietly.

Conclusion

The results of this study contribute to the discussion of advertising literacy (Arbaiza et al., 2023) with the idea that advertising literacy is not only the ability to recognize advertising per se, but also the ability to respond intuitively to its emotional and nonverbal layers. It is for this reason that we consider neuromarketing tools to be a valuable contribution to research on media education and the development of critical thinking in young consumers. This aligns with the conclusions of Čábyová et al. (2023), who highlight that enhancing emotional and media competencies is essential for equipping consumers to resist manipulative practices like greenwashing, especially in environmentally themed advertising. This case study has shown that communication can fail in credibility even when it communicates formally correct benefits. When the Digital University promotional video was analysed, it was found that terms such as *MBA* and *online learning*, which were the backbone of the campaign, elicited negative affective reactions from respondents - in particular, disdain and a decrease in emotional engagement. At the same time, these reactions were not present in any conscious statements. Respondents did not cite them as problematic, which only confirms the importance of working with implicit data in brand research. It is neuromarketing tools that reveal these tacit bodily disagreements that determine whether a brand generates trust - or not.

The findings of this study offer two key recommendations for both practice and research on advertising literacy:

1. Brands should test not only the choice of communication terms, but also their emotional embeddedness in the target group. Terms that look like benefits on paper (e.g. 'flexibility', 'online learning') may in fact evoke negative associations - especially if they are not culturally or affectively experienced. Young people's advertising literacy also manifests itself in the fact that they intuitively recognise these meanings, even if they do not articulate them.
2. Biometric measurements should not be seen as an add-on, but as an integral part of advertising perception research. The ability to capture nonverbal, bodily reactions - such as tension, disdain, or rejection - provides deeper insight into how audiences actually process an advertising message. It is these reactions that allow us to better understand the level of implicit advertising literacy and its impact on brand trust.

The results of this study also offer an impetus to rethink traditional definitions of advertising literacy. They show that true understanding of advertising may take place at a level that respondents themselves are not aware of - and should therefore be complemented by the analysis of biometric and affective data.

For the Digital University itself, this means that the terms *MBA* and *online learning* require a new contextualising framework in which these benefits are emotionally legitimised. They may not be wrong - but they are communicated in a way that does not take into account the emotional map of the target audience.

This study was exploratory in nature, with a small research population (N = 19). Its aim was not to make statistical generalisations, but to highlight a conceptually important phenomenon - that the affective response of an audience can differ fundamentally from conscious evaluation. Future research could:

- validate the findings with a larger sample and more videos,
- To observe the long-term effects of affective mismatches in building brand loyalty,
- combine neuromarketing methods with deeper qualitative interviews to capture the full structure of affective-cognitive decision-making.

From an advertising literacy perspective, these findings remind us, despite the limitations of the study, that emotional response is also a form of evaluating advertising - and that the ability to perceive but not believe is increasingly common in the digital environment. Thus, we need to think of advertising literacy not only as a rational faculty, but also as a bodily filter that sorts between trust and distrust before conscious assent occurs.

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The Importance of E-Commerce in Global Enterprises

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Abstract

Research background: E-commerce has become an integral part of the business strategies of many global companies in recent years. The digitalisation of sales and marketing channels fundamentally changes how companies interact with customers, optimise their internal processes and expand into new markets. At the same time, e-commerce generates new challenges in logistics, legal regulation and customer behaviour that companies must face if they want to remain competitive in the global environment.
Purpose of the article: The article aims to analyse the importance of e-commerce in the context of global companies, focusing on its impact on business models, marketing strategies, customer behaviour and company performance. The article examines how digital transformation affects the functioning and success of multinational companies in different sectors of the economy.
Methods: The research is based on a qualitative comparative analysis of four case studies of successful multinational companies – Amazon, Zara (Inditex), IKEA and Nike. Thematic analysis of secondary data (scientific articles, annual reports, analytical studies) was chosen as the research method, which was coded and interpreted to identify common patterns and differences in implementing e-commerce.
Findings & Value added: The results confirm that e-commerce plays a strategic role in modern business models and contributes to increasing the performance of companies through better customer experience, efficient distribution and personalised marketing. Companies that have integrated e-commerce into their business achieve a higher rate of innovation, faster growth and better adaptation to global market changes. The article's added value is synthesising knowledge from different industries and formulating recommendations for companies that strive to digitise their operations in an international context successfully.

Keywords: E-Commerce, Global businesses, Business model, Marketing strategy, Customer behaviour

JEL classification: L81, M31, F23

1. Introduction

In the current digital era, electronic commerce (e-commerce) is becoming crucial for the functioning and development of global businesses. The development of information and communication technologies, especially the Internet, has fundamentally changed how companies interact with customers, suppliers and partners (Štefko, Nastišin, Nebeský & Fedorko, 2023). E-commerce has ceased to be just an additional sales channel and has become a strategic tool for competitiveness, expansion and innovation. The boundaries between the physical and digital worlds are increasingly blurred, and businesses that fail to adapt their models to digital reality risk losing relevance and market share (Chaffey, 2015; Vartiak, 2015). Global companies face a constantly changing environment that requires flexibility, efficiency and the ability to reach customers on different continents in real-time. E-commerce offers these advantages – it enables geographical expansion, personalisation of the offer, efficient logistics and data collection for strategic decision-making (Laudon & Traver, 2021). The importance of e-commerce has been further highlighted during the global COVID-19 pandemic, underscoring the vulnerability of traditional distribution channels and accelerating the digitalisation of many industries (UNCTAD, 2021).

E-commerce is business transactions over electronic networks, particularly the Internet (Kalakota & Whinston, 1997). It encompasses the purchase and sale of goods and services and marketing,

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distribution, service and customer processes carried out electronically. As Schneider (2020) states, e-commerce includes B2C (business-to-consumer), B2B (business-to-business), C2C (consumer-to-consumer) and increasingly mobile (m-commerce) or social commerce.

With the growth of digitalisation, e-commerce has become a significant part of global business ecosystems. As Turban et al. note (2018), the development of technologies such as cloud computing, big data, artificial intelligence, and blockchain fundamentally affects the structure and functioning of e-commerce. These technologies enable process automation and a higher level of personalisation, security and transparency.

Global businesses use e-commerce as a key tool for entering new markets and optimising supply chains. As Kshetri and Dholakia (2014) point out, electronic platforms enable rapid and efficient expansion without requiring extensive physical infrastructure. Amazon, Alibaba, eBay and other global brands prove that a well-set e-commerce strategy can significantly contribute to the profitability and growth of a company.

Studies also point to the synergistic effect of e-commerce and internationalisation. For example, Sinkovics, Sinkovics and Jean (2013) showed that small and medium-sized enterprises (SMEs) can effectively overcome traditional barriers to entry into foreign markets through e-commerce. Adapting to local conditions, legislation, language, and culture requires sophisticated IT solutions and localisation strategies (Strauss & Frost, 2014; Rentková & Vartiak, 2017, Genzorová, Corejova & Stalmašeková, 2018).

E-commerce is changing the paradigm of marketing communication. In the online environment, digital marketing, especially search engine optimisation (SEO), content marketing, PPC campaigns, email marketing and social media marketing, is gaining importance (Vartiak, 2016; Chaffey & Ellis-Chadwick, 2019). Personalisation, dynamic pricing and retargeting allow companies to target customers highly.

Customer behaviour in the digital environment fundamentally differs from traditional shopping. The role of online reviews, ratings and so-called user-generated content is growing significantly. Customers expect a convenient shopping process, fast delivery, easy returns, and quality customer support (Laudon & Traver, 2021). According to Bhatti (2020), flexibility, accessibility, and personalisation are the main reasons customers prefer online shopping over physical stores.

Despite the advantages, e-commerce also brings several challenges. These include cyber threats, risks related to personal data protection, the need for digital skills and logistical problems in cross-border sales (OECD, 2020). Another critical aspect is regulation – global businesses have to face different legal frameworks and tax regulations in individual countries, which complicates the standardisation and scaling of solutions (Grewal et al., 2017; Konvit, Jasečková & Vartiak, 2023).

At the same time, there is an emphasis on sustainability – customers and investors increasingly expect online commerce to be environmentally responsible. This includes, for example, eco-friendly packaging, carbon-neutral delivery and ethical shopping (UNCTAD, 2021). These factors are also key in shaping long-term brand reputation and customer loyalty.

2. Methods

This article aims to analyse the significance of e-commerce in the context of global enterprises, emphasising its impact on business models, marketing strategies, customer behaviour, and firm performance. The research is based on a comparative analysis of selected case studies of multinational companies that have successfully integrated e-commerce into their operations. Given the complexity and multidimensionality of the research issue, a qualitative comparative case study analysis was chosen as the primary research strategy (Yin, 2018).

2.1 Research design

The article is based on a multi-case design, with each case study representing one global enterprise that has integrated e-commerce into its business model. This approach allows for an in-depth analysis of real digitisation processes and enables the identification of standard features, patterns, and differences between companies operating in different industries.

2.2 Case study selection

Based on theoretical criteria and the availability of secondary data, four multinational companies with a significant e-commerce presence were selected:

- **Amazon** – a technology platform and global leader in online sales,
- **Zara (Inditex)** – a fashion brand with a strong omnichannel strategy,
- **IKEA** – a global furniture retailer with a hybrid online-offline model,
- **Nike** – a sports brand with an innovative approach to digital marketing and mobile sales.

These companies were selected to represent different industries (technology, fashion, furniture, sports), ensuring the findings' contextual variability and broader generalizability.

2.3 Data collection

Data collection was carried out through secondary research, i.e. analysis of existing data sources, which included:

- annual reports and official documents of companies,
- scientific and professional articles published in the Web of Science, Scopus and Google Scholar databases,
- case studies from renowned research institutions and universities (e.g. Harvard Business School),
- reports from international organisations (e.g. OECD, UNCTAD),
- media and analytical outputs from renowned portals (e.g. Statista, McKinsey, Deloitte).

These sources were chosen for their reliability, timeliness and analytical value, with emphasis on documents published after 2018 to reflect the latest developments in the field of e-commerce.

2.4 Analytical method

Thematic analysis (Braun & Clarke, 2006) was used to process the data, which allowed for the systematic identification, analysis and interpretation of key themes within the individual case studies. The analysis process proceeded in the following steps:

1. **Data coding** – identification of relevant passages in the texts that relate to the main research dimensions (business model, marketing strategy, customer behaviour, performance),
2. **Categorisation** – grouping codes into higher thematic units according to standard features,
3. **Comparison** – comparing findings across individual cases to identify patterns, differences and potential causal connections,
4. **Interpretation** – linking empirical findings with a theoretical framework and formulating conclusions.

The analysis results are presented as synthesised findings that connect individual cases into a common analytical core and answer the main research question: What is the significance of e-commerce in global enterprises, and how does it affect their business functioning?

2.5 Research limitations

Despite the emphasis on thoroughness and systematicity, there are certain limitations of the research that need to be mentioned:

- Due to the orientation towards qualitative analysis, the aim was not to quantify the exact impact of e-commerce on firm performance but rather to understand the mechanisms and processes that lead to this impact.
- The selection of firms was targeted and not random, which may limit the generalizability of the findings to all firms.
- Secondary data depends on the transparency and availability of published information, and not all firms publish detailed data on e-commerce activities.

Despite these limitations, the methodology allowed for deep insight into the practical integration of e-commerce in the global business environment and offered valuable insights for research and management practice.

3. Results

This article analysed four case studies of multinational companies – Amazon, Zara (Inditex), IKEA and Nike – that are implementing e-commerce as a strategic part of their business. The analysis focused

on identifying the impact of e-commerce on their business models, marketing strategies, customer behaviour and overall performance. Each case provided specific insights that can be generalised to a broader range of global businesses.

3.1 Business model transformation

The analysis results show that e-commerce has fundamentally transformed traditional business models into customer-centric and digital-centric models. Amazon represents a paradigmatic example of a platform business model, where e-commerce is the structure's central pillar. The company sells its products and provides space for other sellers, thereby creating network effects and a large-scale digital economy (Laudon & Traver, 2021).

Similarly, Zara has expanded its fast fashion model to include digital elements – customers can track product availability online, create personalised collections, and order goods with home or brick-and-mortar delivery. In this way, Zara has connected the brick-and-mortar and online worlds into an omnichannel model, thereby increasing efficiency and customer satisfaction (Fernie & Sparks, 2019).

The results show that companies that could connect physical and digital infrastructure saw increased revenues, shortened delivery times, and higher customer retention. However, this shift required significant technological, logistics, and data analytics investments.

3.2 Innovations in marketing strategies

Marketing in the e-commerce environment has proven to be a key factor in the success of the analysed companies. For example, Nike uses advanced personalised marketing built on data from mobile applications, websites, and social media. Customers receive individual recommendations, discounts, and content, which increases their engagement and loyalty (Chaffey & Ellis-Chadwick, 2019).

IKEA has also innovated in content marketing, investing heavily in augmented reality (AR) and visualisation tools. Customers can use a mobile app to see how furniture will look in their interior, which increases confidence in their purchasing decisions. IKEA has also optimised its e-commerce campaigns for different regions and cultures, effectively lowering barriers to entry into new markets.

The comparison showed that effective e-commerce marketing strategies must be built on data, localisation, automation and omnichannel integration. Companies focusing exclusively on pricing or mass communication without segmentation did not achieve such significant performance improvements.

3.3 Impact on customer behaviour

E-commerce has significantly influenced customer expectations and behaviour, with customers of the analysed companies demonstrating a higher level of digital literacy, demands for quality of service and the need for a personalised experience. In the case of Amazon, it turned out that the key factors of customer satisfaction are speed of delivery, ease of purchase and transparency of product information.

The results show that customers actively search for reviews, compare prices and expect quick communication with customer support, ideally via chatbots or live chats. These elements were effectively deployed within the e-commerce platforms of Nike and Zara, which led to a reduction in the number of complaints and an increase in the conversion rate.

An interesting result was provided by IKEA, showing that customers use e-commerce mainly as an information tool before visiting the store. This hybrid model, ROPO (research online, purchase offline), emphasises optimising online channels for offline sales. E-commerce is, therefore, not only a substitute for brick-and-mortar sales but also acts as a complement to brick-and-mortar sales.

3.4 Impact on business performance and growth

All companies analysed have seen a positive impact of e-commerce on their performance, which has been reflected in increased sales, reduced costs, and expanded customer base. As a purely digital platform, Amazon has achieved a dominant position in the global market thanks to e-commerce. At the same time, its innovative solutions (e.g. predictive logistics subscription services) ensure a high rate of repeat purchases (Laudon & Traver, 2021).

In 2022, Nike announced that more than 40% of its sales come from digital sales channels, with the SNKRS mobile application becoming the primary distribution tool for special editions and collectable models. Zara saw more than 75% year-on-year growth in e-commerce sales during the pandemic, with its

online-offline combination strategy giving the company an advantage over competitors that relied solely on brick-and-mortar stores.

IKEA has seen the most significant shift in distribution efficiency – optimising e-commerce warehouses and new pickup locations has reduced logistics costs by approximately 12% over two years. In addition, e-commerce has enabled the collection of valuable data on customer preferences, which is used in the design of new products and marketing campaigns.

3.5 Summary of findings

Based on the comparative analysis, it can be concluded that:

- E-commerce is an integral part of the business models of successful global companies and plays a decisive role in internationalisation.
- Implementing e-commerce requires advanced technological solutions, the ability to process data efficiently and a high degree of adaptability in marketing communication.
- Customers expect a simple, fast and personalised shopping experience, which places high demands on UX, logistics and customer support.
- All analysed companies have seen a positive impact on performance, mainly in sales growth, increased customer loyalty and expansion into new markets.

These results confirm the hypothesis that e-commerce represents a strategic tool for competitiveness in the global business environment.

4. Discussion

The results show that e-commerce has become essential to global companies' business strategies. This fact is consistent with previous findings by several authors who claim that digital transformation is one of the key drivers of growth and innovation in the global economic environment (Chaffey, 2015; Laudon & Traver, 2021). Studies of Amazon, Zara, Nike and IKEA show that e-commerce is not just an additional sales channel but the core of a comprehensive digital strategy that goes beyond individual departments' boundaries and affects all business components. The results confirm that successful companies apply an integrated approach to e-commerce, which is linked to the business model and marketing, thus reflecting the concept of omnichannel strategy (Verhoef et al., 2015). E-commerce is not an isolated activity but an intersection between technology, logistics, customer experience and strategic management. This corresponds to the model of the digital business ecosystem, in which companies act not only as sellers but also as intermediaries, innovators and service providers (Turban et al., 2018).

An interesting finding is that e-commerce is not always just a substitution for traditional channels. In the case of IKEA, the so-called ROPO effect (Research Online, Purchase Offline) was evident, confirming the need to synchronise online and offline elements of the sales process. This finding is in line with the research of Frasquet et al. (2015), who claim that customers often use digital tools to obtain information but purchase themselves physically.

The findings suggest several practical recommendations for businesses that want to expand their e-commerce activities in a global context:

1. **Invest in technology and data analytics:** In the case of studies, successful companies use advanced tools for data collection and analysis, which allows them to understand customer needs better, optimise marketing campaigns and increase operational efficiency. Businesses that ignore this ability risk losing their competitiveness.
2. **Localisation and cultural adaptation:** Successful global e-commerce strategies require adapting the product portfolio, website design, language mutations, and delivery and payment methods to specific markets. A one-size-fits-all approach proves ineffective in a global environment (Sinkovics et al., 2013).
3. **Flexible logistics:** Fast and reliable delivery is one of the main competitive advantages of e-commerce. Companies like Amazon or Zara invest in automated warehouses, predictive supply, and local distribution centres, thereby reducing costs while increasing customer satisfaction (Fernie & Sparks, 2019).
4. **Customer experience and UX design:** An e-commerce platform must be intuitive, responsive, and optimised for different devices. In addition, customers expect a high level of personalisation and

the possibility of immediate feedback. These aspects have a direct impact on conversion rates and repeat purchases.

Despite its many advantages, implementing e-commerce is not without risks. A significant challenge is cybersecurity, especially protecting personal data and financial transactions. Cyberattacks increasingly target global businesses, which requires a robust IT infrastructure and constant threat monitoring (OECD, 2020).

Another problem is the complexity of the legal and tax environment in different countries. Globally operating companies have to face several regulations related to consumer protection, electronic signatures, invoicing and VAT. This complicates the standardisation of processes and increases the administrative burden (Grewal et al., 2017).

Last but not least, the sustainability of e-commerce is also a challenge. Although electronic sales can reduce the need for physical stores, it also generates new environmental burdens – packaging, transport, and returns. Consumer pressure for environmentally responsible solutions is growing, and companies must reflect this trend in their strategies (UNCTAD, 2021).

This article contributes to expanding knowledge about e-commerce in the context of global business strategies. Unlike many previous studies that focused only on the technical side of e-commerce, this research highlights its holistic impact on business model, marketing and performance. It also emphasises the importance of the interaction between online and offline channels and the need to integrate them into a unified strategy.

The comparative analysis of real case studies provides valuable empirical knowledge that can serve as a reference framework for future research in digital transformation, customer behaviour in e-commerce or internationalisation of business through digital channels.

Conclusion

Electronic commerce has become one of the most critical factors shaping the global business environment in recent decades. The results of this article demonstrate that e-commerce is no longer just an additional sales tool but a key element of the strategic management of global companies, influencing business models, marketing strategies, customer behaviour and overall business performance.

Based on a comparative analysis of selected multinational companies (Amazon, Zara, IKEA, Nike), it can be concluded that successful e-commerce implementation requires a comprehensive, integrative approach that includes technological innovation, consistent customer orientation, supply chain optimisation and effective use of data. These companies have demonstrated the ability to adapt their business models to the dynamic digital environment, achieving significant competitive advantages.

The key success factors in e-commerce have been shown to be:

1. the ability to connect online and offline environments (omnichannel),
2. the use of personalised marketing and content tailored to specific market segments,
3. fast and flexible logistics as a tool for maintaining customer satisfaction,
4. and the emphasis on analysing customer behaviour through digital tools.

At the same time, the article also pointed out several challenges associated with implementing e-commerce, such as problems with cybersecurity, legal regulation in different countries, logistics capacities or the environmental impacts of digital sales. These factors require systematic risk management and a long-term strategic vision.

From a scientific point of view, this work contributes to expanding knowledge about the impacts of e-commerce on global businesses. It confirms the need for further research in this area. Future research could focus on:

1. the effect of e-commerce on sustainability and the environmental footprint of businesses,
2. comparing e-commerce approaches across sectors (e.g. manufacturing vs. services),
3. and studying e-commerce in the context of developing countries and their specific conditions.

In conclusion, e-commerce is no longer just a technological trend but a systemic element of the modern global economy, shaping how companies sell and think about innovation, customer relationships and the sustainability of their business. For businesses that want to succeed in the digital age, e-commerce is an option and a necessity.

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Visual and Psychographic Features of Advertising Creatives as Predictors of User Attention on the Meta Platform

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Abstract

Research background: In highly saturated digital environments like Meta platforms (Facebook and Instagram), user attention is a scarce resource. The effectiveness of video advertising increasingly depends on creative elements that can capture and retain viewer attention. Prior research has suggested that emotional tone and brand presentation may significantly influence user engagement, yet empirical validation using behavioral metrics remains limited.
Purpose of the article: This study aims to examine how selected visual and psychographic features—specifically emotional tone and brand visibility—affect user attention in video ads. Attention is operationalized through the *15s_views_rate* metric, which reflects the percentage of impressions in which users viewed at least 15 seconds of a video, commonly used as a proxy for brand awareness.
Methods: A multiple linear regression analysis was conducted on a manually coded dataset of 20 video ads from a luxury watch brand campaign on Meta platforms. Key creative variables were coded based on predefined criteria and tested as predictors of *15s_views_rate*. Variables were standardized, and diagnostic checks were performed to ensure model validity.
Findings & Value added: Although the hypotheses were not statistically confirmed, results showed a positive directional effect for emotionally framed ads and a negative effect of overt brand visibility on sustained user attention. These findings demonstrate that behavioral metrics like *15s_views_rate* can be effectively used to model user response, even with a small sample. The study contributes to the growing body of research on data-driven creative optimization and highlights practical considerations for ad design in attention-driven media environments.

Keywords: User attention, Visual features, Psychographic attributes, Advertising creatives, Social media

JEL classification: M37, D91

1. Introduction

In the context of digital advertising on platforms such as Meta, the ability to capture and sustain user attention is a critical determinant of success. The fast pace of content consumption and the highly visual nature of these platforms underscore the importance of creative elements in advertising. This chapter therefore examines how visual and psychographic features influence user attention and engagement.

1.1 Attention and Engagement on Social Media: The Role of Visual Elements in Online Advertising

In the social media environment, where users scroll through vast amounts of content within seconds, attention and engagement have become key indicators of advertising effectiveness. These two concepts are closely interconnected: while attention represents the initial cognitive step in processing an advertisement, engagement reflects a deeper emotional and behavioral involvement of the user.

As noted by Schivinski et al. (2022), engagement on social media is a multidimensional phenomenon—encompassing cognitive (attention, awareness), emotional (experience, affinity), and

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behavioral responses (interactions such as likes, comments, shares). Similarly, Voorveld et al. (2018) show that the type of social platform influences which of these dimensions dominates—for instance, Instagram tends to foster emotional engagement, while text-based platforms promote more cognitive responses. Engagement should therefore not be viewed as a single metric, but rather as a set of reactions whose intensity and form depend on the platform environment and the type of content.

Kadhim and Ozuem (2020) demonstrated that engagement—whether measured through interactions or attention tracking—is significantly influenced by the visual elements of an advertisement, such as color, typography, composition, and overall design. Their predictive analysis of Instagram campaigns showed that visually compelling ads generated higher levels of user engagement.

Other studies likewise suggest that the appearance of the creative is often a decisive factor in whether a user notices the advertisement at all. Müller and Christandl (2021) identified several design elements that increase an ad's ability to capture and hold attention, including contrast, clear visual hierarchy, a dominant central object, and subtle motion. Their research also highlights the risk of visual overload, which can overwhelm the user's senses and diminish the effectiveness of the communication.

From a psychological perspective, the social context of an advertisement is also crucial. Smitshuijzen et al. (2020) found that ads containing social cues—such as information that the product is liked by a friend—enhance message credibility and strengthen emotional connection with the brand. This effect may be particularly relevant in video advertising, where associations and subconscious perception can quickly influence a user's decision to pay attention.

Openness to experience has been identified as the most consistent personality predictor of artistic preferences, suggesting that similar psychographic traits may also influence which visual advertisements users are likely to notice (Chamorro-Premuzic et al., 2009). Individuals with a strong tendency toward sensation-seeking and higher psychoticism scores often prefer visually intense or "unpleasant" visuals—potentially explaining their different reactions to emotionally charged advertisements (Rawlings, 2003).

On the other hand, Masłowska, Ohme, and Segijn (2021), in an eye-tracking study, showed that visual attention is not always affected by recommendation content or device type (mobile vs. desktop). Their experiment conducted in a realistic newsfeed environment demonstrated that the primary determinant of user attention remains the visual design of the ad itself.

These findings suggest that in the context of digital advertising—particularly on visually driven platforms like Meta—the form and visual execution of the creative play a fundamental role in capturing and retaining user attention.

1.2 Psychographic Features, Emotional Tone, and Video Advertising on the Meta Platform

When creating video advertisements on the Meta platform (Facebook and Instagram), it is essential to consider not only the demographic profile of the target audience but especially psychographic attributes such as personality traits, values, preferred communication style, and users' emotional predispositions. These factors fundamentally influence attention, emotional engagement, and ultimately the memorability of the ad.

Advertising campaigns that account for the psychographic characteristics of the audience tend to achieve higher effectiveness. As early as Boote (1982–1983) pointed out, psychographic segmentation is particularly critical in multinational campaigns, as value-based preferences can vary significantly even among seemingly similar target groups. Ignoring these differences during data aggregation may lead to inaccurate or misleading conclusions. This principle remains relevant today—especially in the context of social media ad formats, where it is crucial to evoke user identification with the content through carefully selected emotional tone, music, storytelling, and visual style.

Recent advances in psychographic segmentation have introduced new possibilities for identifying these traits without relying on traditional surveys. Pitt, Bal, and Plangger (2020) demonstrated that the language consumers use when spontaneously describing their experiences can reveal personality traits such as extraversion, openness, or emotional stability. These insights—obtained, for example, from reviews or social media posts—enable advertisers to craft more targeted creatives, not only based on demographics but also on the "real" psychological disposition of the

audience. This opens new opportunities for platforms like Meta, where a personalized emotional tone in video ads can influence user response within the first few seconds of playback.

The language consumers use reflects not only their personality traits but also their degree of authenticity and emotional connection, which can serve as an important guide for crafting genuine advertising messages on social media (Pennebaker et al., 2003). The words people use in online comments or reviews can be analyzed to reveal personality traits such as extraversion or neuroticism—unlocking new opportunities for personalizing video advertisements without relying on traditional surveys (Fast & Funder, 2008; Hirsh & Peterson, 2009).

From the perspective of emotional impact, Poels and Dewitte (2019) emphasize the importance of emotional dimensions such as pleasure, arousal, and dominance. These dimensions affect how a creative is perceived—for instance, higher levels of arousal can increase viewer attention and enhance message recall. Therefore, in video content on Meta, it is not enough to simply choose a "positive" or "negative" emotion—what matters is the intensity and timing of the emotional experience within the ad.

Similarly, Teixeira, Wedel, and Pieters (2012) highlight the critical role of emotions like surprise and joy in sustaining attention in online video advertising. Their research shows that the degree of surprise effectively captures attention, while the speed at which joy builds is key to keeping viewers engaged. This implies that advertisers on Meta should deliberately design the emotional trajectory of their videos—how emotions evolve and intensify throughout the spot. Well-paced emotional structuring can increase not only the likelihood of surpassing the 15-second view threshold (often used as a proxy for brand awareness) but also the overall impact of the advertisement.

2. Conceptual Framework and Hypotheses Development

Attention is one of the key factors influencing advertising effectiveness, particularly in environments saturated with digital content, where users are constantly exposed to competing visual stimuli (Pieters & Wedel, 2004). On platforms such as Meta (Facebook and Instagram), where consumers scroll at high speed and make intuitive decisions within milliseconds, an advertisement's ability to retain attention is a critical prerequisite for building brand awareness.

One of the most widely used indicators in advertising analytics is the 15-second video view metric—that is, the percentage of impressions in which the user watched a video for at least 15 seconds. This standardized metric is available within the Meta Ads interface and is commonly used as a proxy for attention retention and potential user engagement. Oğuz et al. (2023) point out that viewing duration may be a more robust measure than raw impression counts, as it better reflects the level of user involvement and the creative's ability to stand out in a visually competitive environment.

Previous research suggests that attention in video advertising is shaped by a combination of psychographic and visual elements—including emotional tone, rhythm and pacing, music selection, color, and brand visibility (Rasheed, Sheikh, & Shah, 2005; Oğuz et al., 2023). These features have been shown to predict not only subjective engagement but also objectively measurable behaviors such as view duration and interaction rates. While some studies rely on automated extraction of low-level features, others employ manually annotated creative characteristics, which can more precisely capture the psychological and communicative context of the ad's execution.

Our study builds on these insights by testing the impact of manually coded visual and psychographic attributes of video advertisements on the 15s_views_rate metric. We use this measure as a quantitative proxy for user attention allocated to advertising content. Based on the theoretical framework and preliminary data exploration, we propose the following hypotheses:

H1: Video ads with an emotional tone will exhibit a statistically significantly higher 15s_views_rate compared to product-focused video ads.

H2: Ads in which the brand is visually present from the beginning of the video will achieve a higher 15s_views_rate compared to those where the brand appears only at the end or is entirely absent.

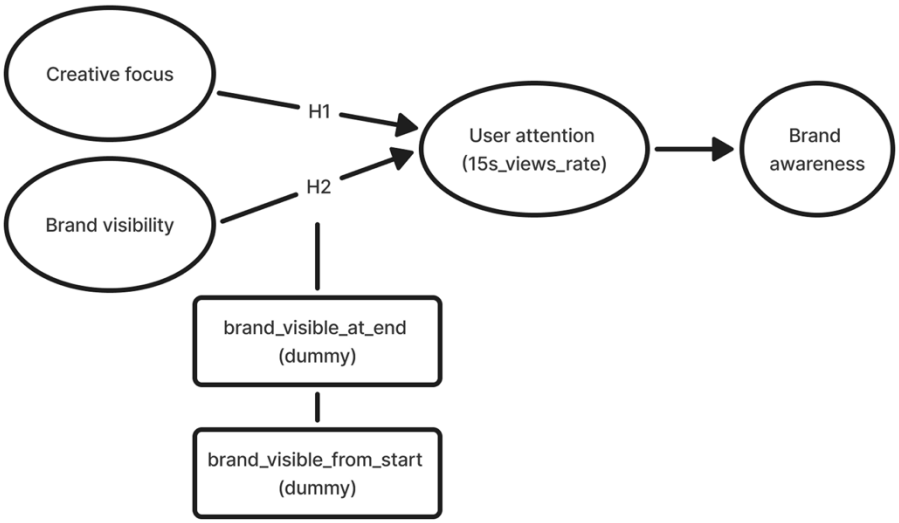

Figure 1. Conceptual model: Predictors of brand awareness via user attention (15s view rate)
Source: own processing (2025)

3. Methodology

3.1 Research Design

The study is designed as an exploratory analysis of a small sample of video advertisements, aiming to test the applicability of behavioral metrics (e.g., *15s_views_rate*) in predicting user attention based on creative features. The objective is also to assess whether a simple manual coding framework of visual and psychographic attributes can serve as a reliable foundation for quantitatively modeling user responses to video advertising in the real-world context of social media platforms.

3.2 Data Set

The analysis is based on performance data from 20 unique video advertisements created as part of brand awareness campaigns for a luxury watch brand. All videos were deployed via the Meta platform (Facebook and Instagram) and targeted a Slovak audience. The ads generated over 2.4 million impressions in total, reaching more than 1.3 million unique users. The sample includes videos of varying lengths and styles, ensuring variability within the dataset.

Additional statistics: Total number of 15-second video views: over 190,000; Total watch time beyond 15 seconds: approximately 791 hours; Average *15s_views_rate*: 7.5%; Range across videos: from 1.7% to 13.9%.

3.3 Variables and Coding

Each video was manually analyzed and coded based on predefined criteria. During the coding process, several practical dilemmas emerged, which were addressed by simplifying certain variables:

Ad focus (creative_focus): Originally, three categories were distinguished—product-focused, lifestyle-oriented, and status-driven videos. However, in practice, the distinction between lifestyle and status proved ambiguous, as both often employ similar visual elements and emotional framing. Therefore, a binary coding scheme was adopted: 0 = product-focused video (e.g., “hands-on” shots emphasizing functionality or detail), 1 = emotionally driven video (e.g., storytelling, metaphor, lifestyle scenes, or characters).

Brand visibility (brand_visibility): This variable captures when the brand is visually presented in the video: 0 = brand is absent, 1 = brand appears only at the end of the video, 2 = brand is visible from the beginning.

For the regression analysis, this three-level ordinal variable was transformed into two binary (dummy) variables: brand_end = 1 if the brand appears only at the end; brand_start = 1 if the brand is visible from the beginning. The reference category comprises videos in which the brand is entirely absent. This approach allows for more flexible hypothesis testing (H2) without assuming equidistant effects between all three levels of visibility.

3.4 Dependent Variable – *15s_views_rate*

As the primary dependent variable, we selected the 15s_views_rate metric, defined as the proportion of impressions in which a user watched the video advertisement for at least 15 seconds. This metric is calculated as follows: *15s_views_rate = (views_15s / impressions) × 100*. It represents a standard behavioral metric in Meta Ads analytics for campaigns aimed at building brand awareness.

The rationale for using this metric is as follows: Relevance to the research objective: Given that the campaign objective was to increase brand awareness, longer ad viewing duration (at least 15 seconds) is considered an indicator that the advertisement captured the user's attention sufficiently to retain their interest. The metric thus serves as a proxy for attention, which we consider a necessary intermediate step in the brand awareness formation process. Stability compared to other metrics: As highlighted by Aslan Oğuz et al. (2023), duration-based metrics are less susceptible to random fluctuations and often correlate more strongly with user engagement than impression counts or 3-second view thresholds. Availability and consistency: Unlike declarative indicators (e.g., post-test brand recall surveys), 15s_views_rate is readily available for every video, generated directly by the platform, and does not require additional research instrumentation. This makes it an ideal dependent variable for modeling the effect of creative features in large-scale datasets.

Methodological simplicity and comparability: The value is expressed as a percentage, allowing for direct interpretation and comparison across different creatives without the need to standardize by reach or frequency. For these reasons, we consider 15s_views_rate the most appropriate metric for this exploratory analysis of the relationship between visual and psychographic features of video ads and user attention.

Table 1. Operational Definitions of the Variables Used in the Model

Variable	Type	Definition
15s_views_rate	Continuous	Percentage of ad impressions that resulted in at least 15 seconds of continuous video view.
creative_focus	Binary (0/1)	Binary variable: 0 = product-focused ad (hands-on), 1 = emotionally driven ad (storytelling, lifestyle).
brand_visibility	Ordinal (0–2)	Ordinal variable: 0 = brand absent, 1 = brand visible only at the end, 2 = brand visible from the beginning.
brand_visible_at_end	Dummy (0/1)	Dummy variable: 1 if brand is only shown at the end of the video, 0 otherwise.
brand_visible_from_start	Dummy (0/1)	Dummy variable: 1 if brand is shown from the beginning of the video, 0 otherwise.

Source: Own coding and processing based on Meta Ads performance data (2024).

3.5 Analytical Procedure

The relationship between the selected independent variables and user attention was examined through a multiple linear regression analysis. The model was constructed to predict user attention, operationalized by the *15s_views_rate* metric, based on key visual and psychographic features of each ad. The regression equation was specified as follows:

$$\text{15s_views_rate}_i = \beta_0 + \beta_1 \cdot \text{creative_focus}_i + \beta_2 \cdot \text{brand_visible_at_end}_i + \beta_3 \cdot \text{brand_visible_from_start}_i + \varepsilon_i$$

The input variables were standardized and screened for the presence of extreme values. Multicollinearity among predictors was low, and the assumptions of linearity and normality of residuals were verified using diagnostic plots. Given the sample size (n = 20), the results are interpreted as preliminary and primarily serve to test the applicability of the methodology and the formulation of hypotheses for future research on a larger sample. All calculations were performed in Python 3.11 using the pandas, statsmodels, and matplotlib libraries.

4. Results

4.1 Descriptive Statistics

The average *15s_views_rate* across all video ads was 7.55% (SD = 2.90), with individual values ranging from 1.68% to 13.88%. Emotionally driven ads achieved a higher mean view rate (9.04%) compared to product-focused ads (6.95%), although this difference is not statistically significant at this stage. The sample included 12 product-focused and 8 emotionally driven ads. Regarding brand visibility, 4 ads did not display the brand at all, 5 showed the brand only at the end, and 11 featured the brand from the beginning of the video.

Table 2. Results of the Multiple Linear Regression Model Predicting 15s Video View Rate

Variable	Coefficient (β)	p-value	Interpretation
Intercept	10.16	0.000	Baseline view rate for a product-focused ad with no brand
creative_focus	+2.09	0.318	Emotional ads ↑ by 2.09% on average (not significant)
brand_visible_at_end	−5.49	0.068	Brand shown only at end ↓ by 5.49% (marginally significant)
brand_visible_from_start	−3.33	0.104	Brand shown from beginning ↓ by 3.33% (not significant)

Notes: The overall model explained 21.9% of the variance in 15s_views_rate ($R^2 = 0.219$).
Source: Author's calculations based on Meta Ads campaign performance data (2024).

4.2 Hypotheses testing

The coefficient for the variable creative_focus (coded as 0 = product-focused ad, 1 = emotionally driven ad) was positive (β = 2.09), aligning with Hypothesis H1, which predicted a higher attention retention rate for emotionally driven creatives. Although the difference between the groups was quantitatively noticeable (mean 15s_views_rate for emotional ads = 9.04%, for product-focused ads = 6.95%), this effect did not reach statistical significance (p = 0.318). Therefore, H1 cannot be statistically supported; however, the direction of the coefficient and the difference in means suggest a potential practical effect that merits further investigation with a larger sample.

The coefficients for the brand visibility variables—brand_visible_at_end (β = −5.49) and brand_visible_from_start (β = −3.33)—were negative, contradicting Hypothesis H2, which assumed a positive impact of early brand presence on attention retention. For ads where the brand appeared only at the end, the effect was nearly statistically significant (p = 0.068), suggesting that explicit brand presence—especially when introduced at the end of the video—may negatively affect an ad's ability to retain attention. The coefficient for brand visibility from the beginning (p = 0.104) also did not reach statistical significance, though the effect followed a similar negative trend. Based on these results, H2 is not supported.

These findings open the door for further discussion around concepts such as brand aversion or ad-skipping behavior, where strong identification of content as advertising may reduce user attention (see Rasheed et al., 2005; Aslan Oğuz et al., 2023). It is also possible that videos without explicit branding appeared more authentic or narrative-driven (i.e., "native-like content"), which may have contributed positively to viewer retention.

The overall model explains 21.9% of the variance in the dependent variable 15s_views_rate ($R^2 = 0.219$), which is a relatively acceptable level of explained variance for behavioral data, especially given the strong influence of contextual factors, platform algorithms, and creative quality.

Although neither of the tested hypotheses reached statistical significance at conventional levels, the directionality of the effects offers several important insights:

Emotionally framed videos may enhance attention retention, in line with assumptions of behavioral psychology and prior findings on the impact of storytelling in advertising.

Strong brand visibility, paradoxically, showed a negative relationship with attention retention, suggesting that overt branding may reduce user engagement.

The results underscore the importance of balancing brand identifiability with narrative style—especially in digital environments where users make decisions about content engagement in a matter of seconds.

These findings are preliminary and limited by the sample size (n = 20), but they demonstrate the practical applicability of behavioral metrics such as 15s_views_rate as a valuable tool for evaluating creative effectiveness. To confirm and generalize the observed effects, further research with larger and more diverse datasets is required.

5. Discussion

This pilot study focused on analyzing the relationship between selected visual and psychographic features of video advertisements and the level of user attention on Meta platforms. While the results did not provide statistically significant evidence to support the formulated hypotheses, they offer several important insights and observations that may inform both future research and the practical development of advertising creatives.

One of the most notable findings is the indicated positive effect of emotional framing on view rates, which aligns with prior research on affective media processing (e.g., Pieters & Wedel, 2004). Although this effect did not reach statistical significance, the difference between groups was relatively substantial (approximately +2%), suggesting the potential of creatives that employ storytelling, metaphor, or lifestyle elements to enhance user engagement.

In contrast, the presence of branding within the video—whether from the beginning or only at the end—showed a negative relationship with the 15s_views_rate. This finding contradicts certain marketing recommendations that emphasize early brand visibility. In the context of behaviorally oriented campaigns, this may indicate that users are more likely to skip or ignore content that is immediately identifiable as advertising—a phenomenon related to concepts such as banner blindness or ad fatigue. Interestingly, ads without visible branding had the highest average view rates, which may reflect the effectiveness of native-like or "organic" creatives that do not trigger immediate resistance.

At the level of the research framework, the study confirms that 15s_views_rate can serve as a pragmatic indicator of attention, suitable for quantitative modeling of user behavior in digital environments. Moreover, the findings suggest that manually coded formal features of video ads—such as emotional tone and brand visibility—can be successfully applied in predictive modeling, even with a relatively small sample.

However, these results must be interpreted in light of the study's limitations: the sample consisted of only 20 ads from a single brand in the luxury watch segment; variables were coded subjectively, albeit based on predefined criteria; and the model did not account for other influential factors such as target audience characteristics, creative quality, ad placement, or time of day.

5.1 Practical Implications

For advertisers, creative teams, and digital strategists, this study offers several actionable recommendations. Emotional framing and narrative elements may foster greater user interest than explicit product demonstrations—particularly in brand awareness campaigns. Branding should not be assumed to be inherently beneficial; overly early or overt brand presence may reduce attention, especially when users quickly recognize the content as an advertisement.

Analyzing creative features through behavioral metrics such as *15s_views_rate* provides an accessible and practical method for campaign optimization without the need for post-test surveys. The findings also highlight the importance of testing multiple creative variants (e.g., A/B testing), particularly when it comes to brand visibility and the tone of communication.

5.2 Limitations and Directions for Future Research

This study presents several methodological and contextual limitations that must be considered when interpreting the results. First and foremost is the limited sample size—the analysis was based on data from only 20 video advertisements, all of which were part of campaigns for a single brand in the luxury goods segment. This constraint reduces the statistical power of the tests and prevents the formulation of generalizable conclusions across industries. Moreover, the specific visual identity and target audience of a luxury watch brand may influence user behavior differently than mass-market products, services, or brands with markedly different communication strategies.

Another limitation lies in the manual coding of ad features such as emotional tone and brand visibility. Despite the use of predefined categories and efforts to ensure consistency, this process remains partly subjective. Future studies should consider verifying coding reliability through multiple independent

raters (inter-rater reliability) or employing automated tools for extracting visual characteristics from video content. The current model also did not account for broader contextual variables in which the ads were displayed—such as placement (feed vs. stories), time of exposure, video length, or qualitative aspects like editing rhythm, character presence, or language.

Despite these limitations, the results suggest that behavioral metrics like 15s_views_rate have strong potential as valuable tools for assessing creative effectiveness, particularly in brand-focused campaigns. Future research should aim to replicate the study on a larger and more diverse sample of video ads from various sectors and platforms. It is also advisable to expand the set of predictors to include additional visual, audio, and narrative features, and to enrich the models with contextual variables related to platform dynamics and audience behavior. From a methodological perspective, there is room for applying more advanced analytical techniques, including machine learning, as well as for experimentally testing the effects of specific creative adjustments through A/B testing. Combining behavioral data with physiological measures (e.g., eye-tracking or biometric feedback) could further deepen our understanding of visual attention processes in digital advertising environments.

Conclusion

This study examined the relationship between visual and psychographic features of video advertisements and user attention on Meta platforms. Using multiple linear regression, we tested the impact of emotional tone and brand visibility on the 15-second view rate (15s_views_rate), which served as a proxy metric for attention retention and, indirectly, brand awareness. Although the tested hypotheses were not statistically confirmed, the results indicated a positive directional effect for emotionally driven ads and a negative relationship between explicit branding and view rates. These findings suggest that even with a limited number of ads, behavioral metrics can be used to identify patterns that may help optimize creative performance. Moreover, the study demonstrated that 15s_views_rate is a practically applicable indicator of attention that can be effectively modeled based on observable features of the video.

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Emotional Factors as Determinants of Purchasing Decision-Making in E-Commerce

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Abstract

Research background: The study explores the impact of emotional factors on consumer purchasing decisions in the context of e-commerce. Recent scientific findings emphasise that emotions influence not only purchase intent but also the overall decision-making process, often preceding conscious rational evaluation.
Purpose of the article: The aim was to analyse the emotional factors influencing consumer buying behaviour in the e-commerce environment through a secondary analysis of available academic literature. Special attention was given to the role of neuromarketing methods in identifying and interpreting emotional responses.
Methods: By conducting a secondary analysis of eight scientific studies published between 2021 and 2024, the most common emotional stimuli and their influence on purchase intent were identified.
Findings & Value added: The findings show that emotions such as trust, excitement, and a sense of urgency can mediate the relationship between marketing stimuli and the consumer decision-making process. Elements such as reviews, discounts, and live-streaming interactions also play a significant role. Additionally, visual, auditory, and interactive elements in digital environments were found to enhance emotional engagement and customer loyalty. Neuroscientific methods (EEG, eye-tracking, FACS) have proven to be practical tools in examining these processes. The study underlines the importance of personalised, emotionally driven marketing strategies based on real-time consumer feedback.

Keywords: Emotional factors, Purchase behaviour, E-commerce

JEL classification: M31, L81

1. Introduction

Neuromarketing represents the intersection of neuroscience and marketing, examining the neural and psychological processes of consumers to understand their purchasing decisions better (Janiga, 2021).

Professor Ale Smidts was the first to use the term neuromarketing in 2002. He defined neuromarketing as a field concerned with analysing the brain processes that explain customer behaviour in purchasing situations (Iloka and Onyeke, 2020). In other words, the goal of neuromarketing is to examine the processes that occur in consumers' minds when they are exposed to marketing stimuli, such as advertisements, product packaging, or websites, and how these stimuli subsequently influence their purchasing behaviour. In terms of the impact of neuromarketing on customer behaviour, it is important to note that, as early as the beginning of the 21st century, Zaltman (2003) pointed out that up to 95% of our purchasing decisions occur in the subconscious.

Neuromarketing seeks to mitigate uncertainty in marketing decisions by utilising objective neuroscientific data, rather than relying on traditional surveys that rely on subjective responses from respondents. Neuromarketing uses methods such as functional magnetic resonance imaging (fMRI), electrocardiogram (ECG) measurements, as well as eye movement and other physical response measurements to track customer responses to various stimuli (Kirk, 2024). Abuín Vences, Díaz-Campo, and García Rosales, 2020). These methods enable the capture and analysis of emotional responses, attention levels, and the degree of customer engagement during interactions with marketing stimuli. For

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example, eye tracking and so-called "heat maps" can reveal which parts of a website or advertisement customers focus on most (Kirk, 2024), thereby indicating which visual elements elicit the strongest emotional response.

In e-commerce, neuromarketing can help optimise website design and improve the user experience (Powell, 2024). For example, the use of colours to evoke emotions can influence purchasing behaviour. Red is associated with urgency, blue with trust, and black with high quality (Jules, 2019). Emphasising limited product availability can also create a sense of scarcity, which encourages customers to make a purchase more quickly (Jules, 2019).

Neuromarketing helps reveal hidden emotional stimuli (Darázs, 2024) that influence customers' purchasing decisions. The theoretical frameworks of neuroscience in marketing thus confirm that consumers are not purely rational "homo economicus" (Chen, 2021), but rather, as Portuguese-American neuroscientist António Damásio aptly noted, *"we are not thinking machines that feel, but feeling machines that think"* (Graves, 2015). Emotions are therefore not secondary to decision-making, but are its essence.

Neuromarketing research has also yielded a wealth of specific insights into customer behaviour. For example, the well-known Coca-Cola and Pepsi taste test experiment demonstrated that when test subjects were unaware of which drink they were consuming, their brain activity was associated with the desire for reward. However, when they recognised the brand, a different area of the brain associated with thought processes was activated. This suggests that brands and previous experiences can evoke emotions that can directly influence product perception (Jha, 2004). In the context of e-commerce, this may mean that a strong brand that evokes positive emotions (a feeling of trust, quality) may have a competitive advantage because customers subconsciously prefer products from well-known brands, even if the rational parameters (price, specifications) are similar to those of other products.

Theoretical foundations emphasise that emotional factors are a key determinant of purchasing decisions. Neuromarketing provides a means to measure and analyse these factors using scientific methods, thereby contributing to a deeper understanding of customer behaviour in the digital environment. For e-commerce, where the battle for customer attention and trust is intense, neuromarketing offers valuable insights for creating more effective marketing strategies that are grounded in the customer's emotional experience.

2. Methods

The methodological procedure aimed to analyse the emotional factors influencing consumer purchasing behaviour in the e-commerce environment through a secondary analysis of available academic literature.

The basic selection consisted of eight scientific studies published between 2021 and 2024. The selection was made based on predefined criteria, with an emphasis on:

- thematic relevance (studies focusing on the connection between emotions, purchasing behaviour, and e-commerce),
- methodological diversity (studies applying different research approaches and techniques),
- topicality of the published findings.

The studies were searched for in the Web of Science (WoS) academic database, with the keywords used in the search including the following combinations: ("consumer behavior" OR "online shopping" OR "e-commerce" OR metaverse) AND (emotions OR "purchase decision" OR "impulse buying" OR "perceived value" OR neuromarketing OR "eye-tracking").

The following filter criteria were applied to the search:

- Years of publication: 2021–2024 – to ensure the relevance of the findings,
- Open Access: Yes – to ensure access to full texts,
- Document type: Article – only original scientific articles were included,
- Language: English,
- Web of Science categories: Business, Psychology Multidisciplinary, Multidisciplinary Sciences, Management, Neurosciences.

Based on the above criteria, 352 articles were identified. After evaluating the titles and abstracts, a final selection of 8 studies was made that best met the requirements of the research project. The analysis was conducted in two phases:

- Descriptive phase – a summary table (Table 1) was created, containing basic data on individual studies (title, authors, year, journal title).
- Analytical phase – each of the studies was examined in detail in terms of the research objective, methodology used, and main findings (Table 2). This procedure made it possible to identify common features and differences in approaches to examining emotional influences in the digital shopping environment.

Table 1. Overview of selected research articles

Title	Author and year	Journal
Positive emotions influencing consumer shopping behavior on e-commerce platforms	Cuong (2024)	Management & Marketing
Exploring advertising stimulus, hedonic motives, and impulse buying behavior in Indonesia's digital context: demographics implications	Juanim et al. (2024)	Cogent Business & Management
Exploring consumers' perceptions of online purchase decision factors: electroencephalography and eye-tracking evidence	Pšurný et al. (2024)	Frontiers in Human Neuroscience
Online Reviews Meet Visual Attention: A Study on Consumer Patterns in Advertising, Analysing Customer Satisfaction, Visual Engagement, and Purchase Intention	Riswanto et al. (2024)	Journal Of Theoretical And Applied Electronic Commerce Research
From E-Commerce to the Metaverse: A Neuroscientific Analysis of Digital Consumer Behavior	Fici et al. (2023)	Behavioral Sciences
Relationship between time pressure and consumers' impulsive buying—Role of perceived value and emotions	Sun et al. (2023)	Heliyon
The Impact of Online Reviews on Consumers' Purchasing Decisions: Evidence From an Eye-Tracking Study	Chen et al. (2022)	Frontiers in Psychology
Customer emotions when making an online purchase decision: Results of neuromarketing experiments	Yarosh et al. (2021)	Upravlenets

Source: Own processing (2025)

3. Results

Table 2 provides a more detailed analysis of the individual research articles listed in Table 1. It lists the authors and year of publication, the main objective of the article, the research methods used, and the key results or conclusions of the study. This overview provides an understanding of the main contributions of each article.

Table 2. Analysis of the objectives, methods, and results of selected research articles

Author (year)	Objective of the study	Method used	Results and conclusions
Cuong (2024)	To create an analytical framework that includes factors such as sales promotion, hedonistic motivation to shop, and personalisation, to examine their impact on positive customer emotions in an e-commerce environment.	The theoretical basis for the research was cognitive emotion theory, which explores the link between emotions and action tendencies. Data were collected via an online questionnaire.	The results showed that customers' positive emotions were significantly influenced by factors such as sales promotion, hedonistic motivation, and personalisation, with promotion having the greatest impact. At the same time, it was demonstrated that positive emotions have a strong influence on customers' purchase intentions, which in turn significantly impacts their behaviour.
Juanim et al. (2024)	To examine the mediating role of hedonic motivations in the relationship between online advertising stimuli and the impulsive purchasing behaviour of online shoppers.	Quantitative survey using a questionnaire on a sample of 330 respondents. Conditional process analysis was used to analyse the data.	The results showed that online advertising can influence impulsive purchases by stimulating emotional and hedonic motivations. A moderating effect of gender and age was also observed, highlighting the importance of considering demographic factors when developing effective digital marketing strategies.
Pšurný et al. (2024)	The research aimed to investigate how various factors influencing online purchasing decisions affect information processing in the consumer's brain.	EEG combined with eye tracking. Using evoked potential analysis (specifically the P200 and LPP components), differences in the processing of utilitarian and hedonic products were monitored, which were presented alongside visual cues such as reviews, discounts, and quantity discounts.	The findings showed that factors such as reviews and discounts are processed faster by the brain than the products themselves. These responses often occurred even without direct visual focus, suggesting the use of peripheral vision.
Riswanto et al. (2024)	To explore consumer patterns in advertising by integrating big data analysis, eye-tracking technology, and questionnaires to analyse customer satisfaction, visual engagement, and purchase intent.	The study employed big data analysis to identify sentiment clusters from online reviews (product, model, promotion, and effect). Then, it used eye-tracking analysis to measure visual attention when participants viewed advertisements, as well as a questionnaire to determine purchase intent and preferences among the same participants.	The results showed that sentiment clusters related to products, promotions, and effects had a positive influence on customer satisfaction. Eye-tracking data revealed that ads featuring products and models received the most visual attention, while questionnaire results indicated that promotional content had a significant influence on purchase intent. The study emphasised the importance of integrating consumer sentiment analysis with visual engagement metrics in developing effective marketing campaigns.

Fici et al. (2023)	Compare the emotional and cognitive experience of shopping in conventional e-commerce vs. on a metaverse platform.	Researchers used neuroscientific methods (EEG, galvanic skin response, and volume pulse) to capture participants' responses while shopping. Each participant purchased the same product once in the metaverse (Second Life) and once through a conventional e-commerce site. They completed questionnaires after each shopping task.	The findings showed that shopping in the metaverse elicits higher cognitive activity than traditional online shopping, but also places greater demands on memory and mental processing. The metaverse failed to elicit a significantly positive emotional response, which was reflected in a poorer overall shopping experience.
Sun et al. (2023)	To explore the impact of time pressure in live-streaming e-commerce on impulsive shopping and emotions.	Stimulus-Organism-Response (S-O-R) theory and Schachter-Singer theory (SST).	Findings indicate that time pressure is associated with impulsive buying, with more attention being paid to emotional aspects than cognitive ones. Additionally, perceived value mediates the relationship between time pressure and emotional (as opposed to cognitive) impulsive buying. This relationship is strengthened by positive emotions and weakened by negative emotions.
Chen et al. (2022)	The study focused on examining the impact of online product reviews on consumer purchasing decisions.	Eye-tracking experiment: tracking eye movements while reading positive vs. negative user reviews.	Negative comments attracted more attention than positive ones, especially among women. A significant correlation was found between the way reviews were viewed and the intention to make a purchase. At the same time, it was found that consumers were unable to distinguish between fake and genuine comments reliably.
Yarosh et al. (2021)	Identify emotions that predict product selection when ordering food online.	Neuromarketing experiments (eye tracking, facial analysis, polygraph) and statistical methods such as the Kolmogorov–Smirnov test, Mann–Whitney U nonparametric tests, and Kruskal–Wallis H test	The results of the experiment showed that neither the placement of the product on the virtual shelf nor its visibility influenced the consumer's decision. The key factor in purchasing is the established stereotypical attitude towards the product. Statistically significant differences were found between men and women in their online product selection, specifically in emotions such as surprise, pleasure, disgust, and anger. No such differences were observed in sadness and fear. If a product evokes a positive mood, customers prefer it.

Source: Own processing (2025)

Selected studies from 2021 to 2024 confirm that emotions have a significant impact on consumer behaviour in the e-commerce environment. Several studies agree that emotions are not just a side effect of

shopping, but a key determinant that influences both the purchase intention itself and the decision on product selection.

Cuong (2024) identified three main factors that influence positive emotions in e-commerce: sales promotion, hedonistic motivation, and personalisation. Promotion had the most decisive influence, suggesting that consumers are sensitive to marketing stimuli. Pšurný et al. (2024) used EEG and eye tracking to find that visual stimuli such as reviews and discounts are processed by the brain faster than the product itself, even without direct visual focus. This finding supports the thesis that decision-making in an online environment can be influenced more intuitively and emotionally than analytically. From a practical point of view, this means that e-shops should thoroughly optimise visual elements on the home screen.

Using the S-O-R model, they demonstrate that emotions such as enthusiasm, trust, and a sense of urgency arise in response to a charismatic presenter and their interactions with the audience. These emotions play a mediating role between the stimulus and the purchase decision. In this context, impulse purchases are not an anomaly but a typical manifestation of consumer behaviour. Similarly, Sun et al. (2023) highlight the time pressure exerted on customers, which intensifies impulsive buying behaviour, particularly in the presence of positive emotions. This effect is weakened when negative emotions prevail.

Micheletto et al. (2023) compared the shopping experience in traditional e-commerce and in the metaverse. They found that the metaverse increases cognitive load but does not achieve a comparable level of positive emotional response. This discrepancy raises a discussion about whether innovative technologies inherently enhance the shopping experience. Yarosh et al. (2021) draw attention to the specifics of individual emotional experiences. Age, gender, and education influence emotional responses and their intensity. These findings underscore the need for more personalised marketing communications. For example, women statistically pay more attention to negative reviews (Chen et al., 2022), which can influence their decision-making more than price or product brand.

A key finding is that most emotions are not consciously experienced. Methods such as EEG, eye-tracking, and FACS reveal that consumers respond to stimuli even before they are consciously aware of them.

4. Discussion

The results of the secondary analysis confirm that emotions play a crucial role in the e-commerce environment—not only in shaping purchase intent, but also in the consumer's decision-making process itself. This fact highlights the importance of systematically considering emotional factors in marketing strategies, particularly in the design of visual and interactive stimuli within the digital environment.

Neuromarketing techniques, such as eye tracking, EEG, and brain imaging, play a crucial role in identifying website elements that capture attention and facilitate information processing. Their use contributes to more effective searching, evaluation, and selection of products in the online environment (Cenizo, 2025). In line with these findings, optimising visual design, reducing decision options, and personalising content reduce the cognitive load on consumers and streamline the entire purchasing process (Saldaña-Bocanegra et al., 2024).

The findings of the analysed studies also suggest that emotional responses to marketing stimuli often arise before they are consciously and rationally processed. This finding challenges the traditional concept of "homo economicus" and supports the use of complementary neuromarketing tools that allow researchers and marketers to capture nonverbal, subconscious customer responses. EEG and other neuroimaging tools, for example, enable the distinction between positive and negative emotional responses, which can serve as the basis for more accurate tailoring of offers to individual preferences (Ouzir et al., 2024).

Neuromarketing also provides tools for identifying visual, audio, or text stimuli that evoke positive emotions. Such stimuli contribute to higher brand recall, satisfaction with the experience, and customer loyalty (Song et al., 2025; Roy, 2025). Their appropriate application can increase emotional engagement, creating a stronger connection between the consumer and the brand.

However, the degree to which these findings can be generalised remains questionable. Given the methodological diversity of the studies analysed and the variability of the research samples, it is not possible to unequivocally declare their validity across different cultural, age, and technological environments. Moreover, emotional responses are highly individual—their intensity, direction, and consequences vary depending on personality traits, social context, and previous experiences. These differences point to a growing need for personalisation in e-commerce, particularly through the use of advanced real-time analytics (Praveen et al., 2025; Zeng & Marques, 2023).

Creating sensory-rich experiences—particularly through a combination of visual, audio, and interactive elements—can significantly strengthen emotional bonds and increase post-purchase satisfaction (Roy, 2025). However, it is important that these elements are not an end in themselves, but are integrated into a comprehensive strategy focused on consumer well-being and long-term engagement.

Encouraging impulsive buying behaviour is another area where emotional conditioning is applied. Banjongprasert (2024) highlights the crucial role of e-commerce platforms and social media in promoting impulsive purchases, which is closely tied to users' emotional motivations and attitudes. The results of this study suggest that positive emotions and trust in the online environment, especially when using live streaming, increase the likelihood of impulsive decisions.

This assumption is also supported by the findings of Deng et al. (2024), who state that short videos and live broadcasts in social selling influence purchasing behaviour through both emotional and rational processes. Real-time interaction and visual stimuli contribute significantly to impulsive purchases, particularly by activating emotional engagement.

At the same time, it should be emphasised that not all technological innovations in e-commerce automatically lead to positive experiences. The shopping environment in the metaverse, despite its innovativeness, can increase the cognitive demands on the user without guaranteeing adequately strong positive emotions. Singh et al. (2025) point to the complex relationship between value dimensions, customer engagement, and subjective perceptions of satisfaction. Their findings correspond with the results of this study, which suggest that technological complexity does not guarantee emotional intensity.

It follows that neuromarketing approaches represent a promising tool for a deeper understanding of consumer behaviour. Thanks to their ability to reveal implicit, often undeclared customer responses, they offer brands the opportunity to target their communication strategies more accurately. Emotional factors are thus not only the subject of research but also a practical tool for increasing the effectiveness of marketing communication.

Beyari et al. (2024) confirm that the integration of neuromarketing methods—particularly EEG, eye tracking, and AI tools—enables more accurate mapping of customers' emotional responses and their connection to purchasing behaviour. These findings underscore the importance of applying neuroscience tools in practice to develop more targeted, emotionally engaging, and sustainable marketing strategies.

Conclusion

An analysis of selected studies from 2021 to 2024 confirms that emotions are a key determinant of purchasing behaviour in e-commerce. Emotional responses often precede rational thinking and have the ability to influence decisions in real time. Marketing stimuli, such as discounts, reviews, time pressure, or personal contact in a live stream, can trigger positive or negative emotions that shape purchasing intent and behaviour. Neuroscience methods such as EEG, eye-tracking, and FACS provide a helpful tool for analysing these processes, opening up new possibilities for effective digital marketing communication.

The findings also confirm that sensory and interactive elements in the online environment—such as colours, sounds, and moving visuals—play a significant role in shaping emotional engagement and customer loyalty. Personalised and emotionally charged digital strategies based on real-time data appear to be an effective way to build longer-term relationships with customers.

An important implication for marketing practice is that technological innovation (e.g., the metaverse) may not automatically lead to higher customer satisfaction if it fails to consider the emotional needs of users. Neuromarketing, therefore, offers not only a diagnostic framework but also application potential in designing sustainable and emotionally effective communication strategies.

The limitations of this study are the limited number of works analysed and the fact that it was a secondary analysis. Future research could expand knowledge, for example, on the influence of cultural environment, age, or digital literacy on emotional decision-making, as well as verify selected findings.

It is also recommended to conduct experimental studies in real e-commerce environments that would combine neuroscientific methods with the monitoring of behavioural indicators (e.g., conversion rate, customer return rate). Such an approach could contribute to a better understanding of the dynamics between emotional stimulation and specific consumer decision-making behaviours.

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The Marketing Power of Customer Reviews in Hospitality Industry

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Abstract

Research background: Customer feedback has become a key factor in shaping consumer behavior and influencing service quality, especially in the hospitality industry. Online reviews are now perceived as a modern form of word-of-mouth communication that significantly impacts the reputation and performance of businesses. Simultaneously, mystery shopping remains a structured method for evaluating service standards and employee performance. Despite their relevance, limited research exists on how hospitality decision-makers perceive and use these tools in practice—particularly in smaller urban markets like Bratislava.
Purpose of the article: This article explores how hospitality decision-makers perceive and utilize online reviews and mystery shopping. It aims to identify current attitudes and practices related to customer feedback, and assess the potential of these tools for improving service quality, marketing strategies, and overall performance. The study also examines future business opportunities arising from the strategic use of feedback mechanisms.
Methods: The study employs qualitative methods, specifically semi-structured in-person interviews with five Bratislava-based hospitality decision-makers. Participants included owners and managers with direct influence on service and marketing. Interviews were thematically structured around four areas: perceptions of online reviews, their application in business, the role of mystery shopping, and potential business opportunities. The data were analyzed using qualitative content analysis to identify key patterns and insights.
Findings & Value added: The findings indicate that although respondents do not consistently rely on reviews in their personal decisions, they recognize their influence on customer decisions and business reputation. Most respondents actively manage reviews, particularly negative ones, and view them as valuable feedback. Mystery shopping is used informally but appreciated for its targeted evaluation. The findings reveal a gap between current practices and the strategic potential of feedback tools. The study suggests opportunities for further development, particularly in services supporting review management and customized mystery shopping solutions for the hospitality sector.

Keywords: Online reviews, Mystery shopping, Hospitality industry, Customer feedback, Review management

JEL classification: M31, L83.

1. Introduction

With customer feedback influencing both perception and performance, this research explores how decision-makers in hospitality understand and respond to reviews, offering insights into their foundational attitudes toward service quality. The aim of this article is to explore the initial attitudes and perspectives of decision-makers in relation to the provision of services within the hospitality sector. It focuses on understanding how these stakeholders perceive key aspects of service quality, customer feedback, and operational improvement.

Reviews play a key role in shaping consumer choices regarding products, services, and retailers (Thakur, 2018). Online user ratings are often associated with some form of social influence, where one consumer bases his or her purchasing behavior on the judgment of another (Gavilan, Avello & Martinez-Navarro, 2018). Online reviews have seen a significant boom in recent times as the source of crucial information for consumers, influencing approximately 20% to 50% concerning online purchases (Mathwick Mosteller, 2016).

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Reviewers serve as valuable sources of information for prospective buyers. For instance, many consumers return to specific websites to browse and read reviews while considering the decision to choose those products or services (Mathwick & Mosteller, 2016).

Online ratings are considered to be among the most trusted sources for e-commerce decisions, with consumers typically viewing them as reliable and credible. Consumers believe such ratings to be the second most reliable source of brand information, holding the second place right after recommendations from friends and family (Gavilan, Avello & Martinez-Navarro, 2018).

Online reviews generated by consumers are often viewed as more trustworthy than information provided by sellers, due to the perceived reliability of the source (Bickart & Schindler, 2001). According to research by Bickart and Schindler (2001), consumers who interact with peer-generated content display higher rates of engagement and interest levels compared to those exposed to marketer-generated information.

Online reviews are defined as follows: assessments provided by individuals with direct and hands-on experience, emphasizing the importance of sharing personal experience with other consumers. As a result, this is most likely to lead to enhanced sales and shifts in consumer attitudes (Mudambi & Schuff, 2010; Sparks & Browning, 2011).

Online consumer reviews are seen and perceived as a form of word-of-mouth communication (Godes & Mayzlin, 2004). Similar to word-of-mouth communication, studies have found that online reviews are thought to be more credible, empathetic, and relevant to customers in comparison to the information which is provided by the marketing teams (Bickart & Schindler, 2001; Godes & Mayzlin, 2004).

Unlike traditional word-of-mouth communication, online reviews are most likely to reach a global audience while technology enables sellers to easily share reviews on their websites (Chen & Xie, 2008).

The measurement of customer satisfaction is a widely known and proven practice in the hospitality sector, commonly achieved through the use of customer feedback mechanisms such as: comment cards, online surveys, and third-party evaluations by consultants or mystery shoppers (Chen & Barrows, 2015).

As the Internet becomes an integral part of our daily communication, online reviews are getting more and more relevant for evaluation of service quality for certain products or services or businesses as a whole (Selem et al., 2023).

Customers often rely on online reviews to guide their decisions when choosing a restaurant or hotel (Lee & Kim, 2020). Building enough trust in user reviews on hotel sites now surpasses travel agent recommendations. Hospitality marketers should recognize the influence of consumer power as well as their ability to change public opinion, yet many remain uncertain about how to manage user reviews and social media (Ong, 2012).

Meira et al. (2022) found that human resource practices and employee motivation significantly influence online hotel reviews. While motivation driven by external factors also known as extrinsic showed a very positive impact on overall ratings, on the other hand motivation driven by internal factors, also known as intrinsic, showed a negative effect. These findings suggest that hoteliers can enhance review rating, a key performance indicator, by leveraging human resource strategies to further improve employee motivation. However, the question still remains as to how hotels can identify if negative reviews originate from underlying issues in their human resource practice or if there are other factors in place.

Reviews strongly influence customer behavior and are widely used by hospitality businesses to guide improvements. However, there is still limited understanding of how businesses interpret this feedback and how it aligns with customer expectations, highlighting the need for further research into both perspectives.

Mystery shopping vs. Online reviews

Mystery shopping is recognized as a valid method for performance evaluation across various industries (Allison & Severt, 2011). Employee training has emerged as a critical factor influencing business outcomes (Ostin, 2023), mystery shopping serves as the valid method for objectively evaluating employee attachment to organizational standards. On top of that, it also creates a feedback loop that supports the development of targeted training programs and ensures consistent service quality (Chen & Barrows, 2015).

The main principle of mystery shopping is as follows: assigning individuals to evaluate the real-time quality of services, documenting their assessments of service delivery and determining whether employees meet or exceed the company's established standards (Chen & Barrows, 2015).

Research (Torres et al., 2013) shows and mainly highlights a strong correlation between feedback coming from consumers, particularly online reviews, and increased customer satisfaction. While some hospitality managers prioritize digital platforms e.g. TripAdvisor, others continue to still put value into

traditional feedback channels, including direct customer correspondence. The study identified two primary aspects of feedback influence: one emphasizing online reviews alongside meeting planner input, and another integrating online reviews with consumer ratings. These findings underscore the need for a holistic feedback management strategy that incorporates diverse sources to effectively enhance service quality and overall customer satisfaction.

The study by Boukhaoua, Habbache, and Zerouati (2025) shows that while rated hotels apply relationship marketing, improvements are needed in service culture and communication, with complaints management being the weakest area. Strengthening these elements can enhance guest satisfaction, loyalty, and hotel performance.

Both mystery shopping and online reviews contribute to understanding service performance - one through controlled assessment, the other through customer perception. Future research should explore how best to align these tools for optimal impact.

2. Methods

The research focused on understanding how decision-makers in the hospitality sector perceive online customer reviews, how they leverage them in marketing, and what business opportunities they associate with this form of customer feedback. The aim was to identify not only current attitudes and practices but also potential for more strategic use of reviews in improving service and customer experience.

Semi-structured individual interviews

The study was conducted through semi-structured face-to-face interviews with decision-makers from the hospitality industry in Bratislava, Slovakia. The participants included owners, managers, and operators of hospitality establishments, all of whom hold the authority to make decisions related to service quality, marketing, and customer experience in their businesses. The selection of participants was based on recommendations, with the intent to cover a diverse sample of businesses within the industry.

A total of five interviews were conducted in May 2025. All interviews were conducted in person, allowing for deeper engagement and richer data collection. The qualitative approach was chosen to explore in depth the perceptions and practices related to online reviews, rather than to quantify responses.

Table 1. Respondents

No.	Role	Facility type	Length of business operation	Target customers
1.	owner	a network of food court establishments	june 2017	urban professionals, trendy food lovers, families, and value-conscious customers who seek authentic, healthy, and visually appealing food with a story – served quickly, with quality, and in a modern, engaging way
2.	owner	multiple cafes	first cafe in 2020	people who value comfort, well-being, and a welcoming atmosphere - a community-oriented audience from the local area who appreciate quality over low-cost options
3.	owner	restaurant	april 2022	all people and visitors in the surrounding area
4.	owner	multiple restaurants	july 2017	local residents, families with children, and professionals such as senior managers, politicians, actors, and athletes who value a high-quality dining experience - whether for a relaxed family meal or a refined business lunch
5.	owner and manager	restaurant	february 2025	local customers who seek high-quality experiences without traveling to Bratislava, aiming for premium offerings with the potential to attract a broader regional audience in the future

Source: custom processing

Each interview was structured around four core thematic blocks. The first block explored how respondents perceive the significance of online reviews. The second focused on how reviews are used as part of the business's marketing strategy. The third examined the identification of potential business opportunities stemming from online feedback. The final block addressed the use of mystery shopping as a tool to improve services and its connection to online customer feedback.

The data were analyzed using a simplified qualitative content analysis. Although the coding and interpretation were conducted by a single researcher, care was taken to ensure consistency in categorizing key themes across interviews. The insights presented below reflect recurring patterns and unique perspectives collected during the interview process.

3. Results

The findings reveal that while not all respondents personally consider online reviews as a critical factor in their own consumption decisions, they consistently recognize their importance in shaping the decisions of potential customers regarding their establishments. Respondents perceive online reviews as trustworthy primarily when written by verified users who have posted a significant number of constructive reviews. Conversely, reviews from fake profiles or those several years old are generally viewed as unreliable.

Respondent 2 highlighted the importance of reviews for visibility in digital search engines: "Reviews are necessary not only for the owner but also for Google, where they determine how Google recommends you." Respondent 3 noted the practical value of reviews in business management: "Reviews-ours and those of the competition-are useful because they show what bothers people, what they notice, and help us improve our service." Respondent 5 does not consider online reviews a replacement for traditional advertising, but views them as a highly important tool for verifying the quality of a specific restaurant. They attach significant value to them, considering reviews that include photos to be the most relevant.

Respondents reported monitoring reviews on a regular basis. In some cases, the establishment's online profile was created by customers, prompting the business owner to start engaging with the platform. Most respondents actively monitor reviews and assign responsibility either to the owner or a designated staff member. Majority (3 out of 5) of respondents stated that responses to reviews are typically provided within 48 hours, with particular attention given to negative feedback. While positive reviews are appreciated, they are rarely addressed in detail unless they contain descriptive content. Reviews without explanation, whether positive or negative, were largely considered meaningless by respondents.

The style and tone of responses vary: some use a standardized corporate communication style, others respond based on the tone of the review, and a few contact customers directly to resolve specific issues. Respondent 1 reported maintaining a 100% response rate and having a compensation framework based on the nature of the feedback.

Efforts to gather reviews differ by establishment. Respondent 2 stated they use QR codes, respondent 1. noted they use contactless chips placed on tables, while others rely on verbal prompts from staff after a positive customer experience. Respondent 1 also mentioned a staff training program specifically focused on how to ask for reviews. Despite these efforts, some respondents noted that Slovak customers are often reluctant to raise issues directly with staff during their visit, preferring instead to express dissatisfaction later through an online review.

All respondents acknowledged the value of customer feedback in improving staff performance, product quality, and service standards. In several cases, staff were confronted with review content, and in extreme situations, termination of employment was considered if issues were not resolved.

While respondents appreciate public reviews, they also highly value direct, in-person feedback from regular customers. Traditional advertising still plays a role; respondent 3 stated that large physical banners are often more visible to the public than online reviews, suggesting that not all customer segments engage with digital reviews equally.

Review management practices are typically handled in-house, although respondent 2 mentioned occasional cooperation with an agency or through public relations articles. The current level of review utilization was described as insufficient, and some respondents acknowledged room for improvement.

Although offering rewards for positive reviews is common practice abroad, most respondents were hesitant to adopt such strategies, citing concerns about authenticity. Some respondents expressed interest in tools that could support review management, while others felt such tools were unnecessary given their current review volume.

Regarding mystery shopping, respondents who use it (respondent 2 and 3) tend to rely on informal methods, such as asking friends or acquaintances to visit anonymously and report their experiences. Respondent 3 explicitly stated a reluctance to pay for mystery shopping services, noting that "Google reviews are free." Nevertheless, mystery shopping was seen as useful, especially for evaluating service quality, employee behavior, upselling, first impressions, visual aspects of the venue, cleanliness, and employee presentation.

4. Discussion

The results demonstrate a widespread recognition among hospitality decision-makers of the influence online reviews exert on customer behavior. While personal reliance on reviews varies, all respondents acknowledged their significance in the context of business visibility and customer acquisition.

Credibility plays a critical role in how reviews are perceived and utilized. Reviews from active, authentic profiles that provide constructive criticism are regarded as highly valuable, while anonymous or outdated reviews are dismissed.

Respondents' practices indicate a proactive approach to review management, particularly in addressing negative feedback. The form and style of responses are tailored, and mechanisms for compensation or resolution are present in more organized businesses. Importantly, most participants emphasized that reviews without specific content offer little managerial value, reinforcing the importance of actionable feedback.

Despite using informal tools and internal resources, several respondents expressed a need for improved systems to manage and respond to reviews effectively. While some employ digital methods to collect reviews, such as QR codes and staff training, their effectiveness appears mixed.

Mystery shopping was viewed as a complementary tool to online reviews. Although often conducted informally, it was valued for its ability to provide focused, specific insights into service performance. Unlike online reviews, which are public and user-generated, mystery shopping is private and controlled, allowing businesses to target key service parameters.

Interestingly, the findings suggest that direct, face-to-face feedback is still regarded as highly valuable. Respondents also indicated that traditional advertising plays an important role, especially in reaching customer segments less engaged with online platforms.

Conclusion

This study provides insight into how hospitality decision-makers in Bratislava perceive and utilize online reviews and mystery shopping as tools for improving service and reputation. The findings confirm that while not all respondents rely on reviews in their personal decisions, they fully acknowledge their influence on customer perceptions and business visibility.

Respondents take an active role in monitoring and responding to reviews, particularly negative ones, which they see as opportunities for improvement. Mystery shopping, although less formalized, is employed selectively as a means of obtaining targeted feedback. Both forms of feedback are considered valuable, but each serves distinct purposes.

The study also highlights areas for further development, particularly in the strategic use of online reviews. While there is interest in technological support for review management, uptake remains limited. Similarly, while review-driven marketing practices are recognized abroad, Slovak respondents tend to avoid incentivizing positive reviews.

This research may serve as a foundation for further studies. It is essential to explore online reviews from the customer's perspective and assess their actual impact on purchasing decisions. In addition, in-depth research on the use of mystery shopping is warranted, as it appears to be a relevant yet underexamined tool. Specifically, future research should aim to identify which factors and evaluation parameters are most important for businesses and compare them with the criteria valued by customers during their decision-making processes.

Finally, the findings suggest several business opportunities. These include the development of services that collect, analyze, and deliver structured review insights to hospitality businesses, as well as the creation of a mystery shopping agency tailored specifically to the needs of the hospitality sector. Such initiatives could help bridge the gap between customer expectations and service delivery, enhancing competitiveness and overall guest satisfaction.

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The Impact of Unexpected Changes on the Determinants of Family Business in the Slovak Republic

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Abstract

Research background: Family businesses form an essential part of the Slovak economy, characterized by generational continuity and close ties between owners and employees. However, their long-term sustainability is often threatened by unexpected external shocks. The COVID-19 pandemic exposed several vulnerabilities in family businesses, particularly in areas such as finance, marketing, and human resource management, highlighting the importance of preparedness and adaptability.
Purpose of the article: The main aim of this article is to analyze the impact of unexpected changes on the key internal and external determinants of family businesses in the Slovak Republic. The research also seeks to identify which areas were most affected by the pandemic and how these enterprises responded to the challenges it presented.
Methods: The study is based on a quantitative research design using a questionnaire survey conducted with 403 family businesses across Slovakia. The obtained data were analyzed using descriptive statistics and the Analysis of Variance (ANOVA) method. The statistical tools used included Microsoft Excel and Statistica 14.
Findings & Value added: The results show that the most affected internal areas were finance, marketing, and human resources, while external pressures mainly stemmed from disrupted supply chains, shifts in customer behavior, and increased competition. The majority of businesses relied on their own resources rather than state aid. The findings underline the importance of strategic resilience, financial planning, and digital transformation in increasing the robustness of family businesses. The paper provides valuable insights for policymakers and entrepreneurs in designing more effective support mechanisms to prepare businesses for future crises.

Keywords: Family Business, Unexpected Changes, Business Environment, Determinants, Agility

JEL classification: L26, M10, G32, D22, O33

1. Introduction

The COVID-19 pandemic, declared by the World Health Organization in March 2020, has caused unprecedented global disruptions that have had serious economic consequences. Globally, there has been a significant decline in GDP, rising unemployment, and disruption of supply chains, which has caused significant problems for the business sector (Brodeur et al., 2021). Family businesses, which make up a substantial part of the economy of many countries, including Slovakia, have been significantly affected (Sedliačiková et al., 2024). Although these businesses are known for their flexibility, resilience, and ability to quickly adapt to changing market conditions, the pandemic has exposed their weaknesses, especially when it comes to financial reserves and generational renewal (Poláková et al., 2023).

Family businesses represent a specific segment of the business sphere that is characterized by a long-term vision, close ties between family members, and generational continuity (Rovelli et al., 2021). They provide up to 60% of jobs in the European Union, underlining their importance at the macroeconomic level (Sharma, 2004). In Slovakia, family businesses are estimated to contribute 30-40% to GDP and employ more than 40% of the workforce (Halasz et al., 2023). Although family businesses have some advantages over large multinational corporations, they faced several challenges during the pandemic that affected their stability and long-term sustainability.

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During the crisis period, it has been shown that although family businesses are able to respond more quickly to changes compared to large firms, their strong links to local markets and limited financial reserves have made them vulnerable to economic shocks (Poláková et al., 2023). The pandemic has led to fundamental changes in consumer behaviour, with the decline in demand for certain products and services causing financial difficulties for many family businesses (Aparicio et al., 2021). Many companies have had to rethink their business models, intensify digitization, switch to online sales, and look for alternative forms of financing (Kocianová et al., 2022). The problems were not limited to economic factors; A large number of businesses have also experienced generational change, as the pandemic has caused health complications or deaths of key leaders in family businesses. Many businesses were not prepared for the sudden loss of leaders, which caused uncertainty in the long-term strategic direction (Sedliačiková et al., 2024).

In addition, external factors such as disrupted supply chains, shortages of skilled labour, and rising raw material costs have complicated the functioning of family businesses and reduced their competitiveness (Halasz et al., 2023). Despite these challenges, however, many family businesses were able to adapt and look for new ways to strengthen their market position. The rise of digitization, automation, and the implementation of innovative solutions has allowed some businesses not only to survive, but also to increase their efficiency and market competitiveness (Sedliačiková et al., 2024). The long-term impacts of the pandemic have shown that the resilience of family businesses and their preparedness for future crisis situations is a key factor in their survival and growth.

Family businesses play an irreplaceable role in the global and local economy. They form the basis of economic stability, promote employment and contribute to regional development. In many countries, they are a pillar of the national economy, and their ability to withstand crises is crucial for the stability of the entire economic system (Sharma, 2004). In Slovakia, family businesses have a long tradition and significantly affect the economic development of the country. They form a substantial part of the SME sector, thus contributing to market diversification and strengthening local economies (Halasz et al., 2023). Their survival and development in times of crisis is essential for the stability of the domestic economy, which is why it is important that they have access to effective support mechanisms such as tax breaks, financial incentives and expert advice (Sedliačiková et al., 2024).

This research aims to analyze the impact of unexpected changes on the determinants of family business in the Slovak Republic, identify the key challenges that family businesses faced during the pandemic, and provide recommendations to improve their resilience to future economic shocks. The results of this analysis will provide valuable insights for policymakers, entrepreneurs and academia.

2. Methods

The chosen methodological procedure of the conducted research was divided into several consecutive parts, which have a logical interconnection with each other. In the first part, in the form of analysis, synthesis, deduction, description, comparison, summarization and analogy, an analysis of secondary sources focused on the COVID-19 pandemic, its impacts on the local and global sphere as well as family business along with its specifics was carried out.

The second part of the research was devoted to the analysis of primary data obtained through conducting a questionnaire survey. The survey was conducted through the Google platform in the period from February 2024 to May 2024. In the conditions of the Slovak Republic, 60% to 80% of businesses are family businesses (Peráček et al., 2020). In our research, we worked with an average value of 70%. It follows from the above that our basic set consisted of 403,556 family businesses (Finstat, 2024) in Slovakia, operating according to the legislatively anchored definition of family business valid from 1 January 2023, which sets criteria for family businesses in the area of ownership, management and involvement of family members in business activities. Our sample consisted of 4,690 family businesses, which were selected using a random selection generator. This method also ensured that each of the family businesses had an equal chance of being selected, with RPs from all regions of the Slovak Republic being selected. In total, we managed to receive 403 completed questionnaires from family businesses.

The questionnaire survey was divided into several parts. In the first part of the questionnaire, we focused on identification questions regarding our research sample. We were interested in the position in the company, the number of employees, the legal form and the age of the company.

In the second part of the questionnaire, the determinants that had a major impact on the family business due to unexpected changes during the COVID-19 pandemic were examined. In this part, we asked respondents about the impact of the pandemic on their business, their satisfaction with the government

measures taken and the fact that they have received help from available sources. We were also interested in the comparison of internal barriers in terms of their challenge before and during the pandemic, as well as the comparison of external barriers in terms of their challenge before and during the pandemic.

The third part of the research focused on the evaluation of the data contained from the questionnaire survey. The data were primarily evaluated using descriptive statistics and the statistical method analysis of variance (ANOVA), using Microsoft Excel and Statistica 14. At the beginning, it was necessary to determine the minimum size of the research sample (n), which is a fundamental condition for generalizing the results (Labudová et al., 2021):

$$n \geq \frac{z^2 \,.\, p \,.(1-p)}{c^2} \tag{1}$$

Where "z" is the critical value of the normalized normal distribution for 95% confidence, "n" is the minimum number of respondents surveyed, "p" is the estimate of the proportion of the population and "c" is the tolerable error level. For the research in question, it is necessary to make a correction in terms of specific RP characteristics, variability within RP and accuracy and reliability of results. The following calculation was performed to carry out this correction (Labudová et al., 2021):

$$n_{correction} \geq \frac{n}{1+\frac{n-1}{pop}} \tag{2}$$

Where variable "n" expresses the sample size without considering the population and "pop" expresses the population size. The results of the comparison of individual barriers before and during the pandemic were verified through a variance analysis, which told us whether there were statistically significant differences in the intensity of perception of individual barriers before and during the pandemic. The analysis of dispersion allowed us to identify which barriers have experienced more significant changes and thus better understand the impacts of the pandemic on the business environment. The test characteristics were as follows (Pacáková et al., 2009):

$$F = \frac{MSA}{MSE} = \frac{\frac{SSA}{k-1}}{\frac{SSE}{n-k}} \tag{3}$$

Where „MSA“ represents the mean of the deviations of squares for factor A, MSE represents the mean of the deviations of squares for chance E, SSA expresses the sum of variability between individual groups, SSE expresses variability within groups, and relations k – 1 together with n – k express individual numbers of degrees of freedom.

3. Results

The return on the questionnaire survey reached 8.59%, i.e. 403 Slovak family businesses. With a population size of 576 508 enterprises with a 5% margin of error and a 95% confidence level, the minimum number of respondents required is 384. From the above, we conclude that the condition of generalization of the results to the entire population has been met.

The results regarding the identification of our research sample are presented in the form of Table 1.

Table 1. Basic identification of research sample

Questions	**Answers**				
Position in the enterprise	Owner	Manager	O or M	Employees	Other
	22.5 %	*17.9 %*	*31 %*	*28.1 %*	*0.5 %*
Enterprise size	Micro (1 – 9 employees)	Small (10 – 49 employees)	Medium (50 – 249 employees)	Large (500 or more employees)	
	49.3 %	*28.1 %*	*15.7 %*	*6.9 %*	
Enterprise age	< 5 years	6 to 15 years	16 to 25 years	26 years >	
	6.5 %	*87.1 %*	*5.6 %*	*0.8 %*	
Enterprise legal form	Self-employed	Ltd.	Joint Stock	Other	
	10.6 %	*39.9 %*	*27.2 %*	*22.3 %*	

Source: own processing (2024)

From Table 1, we can see that the majority of respondents hold the position of owner (86 enterprises), manager (69 enterprises) or combined function (119 enterprises). Micro enterprises dominate by enterprise size (189 enterprises), followed by small enterprises (108 enterprises), with medium and large enterprises accounting for a smaller share. In terms of the age of the enterprise, the largest share is made up of enterprises with a lifespan of 6 to 15 years (334 enterprises), while younger enterprises under 5 years of age and older enterprises over 26 years of age represent only a small share. In terms of legal form, family businesses are most often found as limited liability companies (153 enterprises), with only 41 enterprises being self-employed.

In the next part of the research, we addressed questions about the pandemic impacts on family businesses as well as the determinants that affected family business. The results of the questions about the pandemic's intervention in business and satisfaction with the government measures taken are shown in Figure 1 and 2.

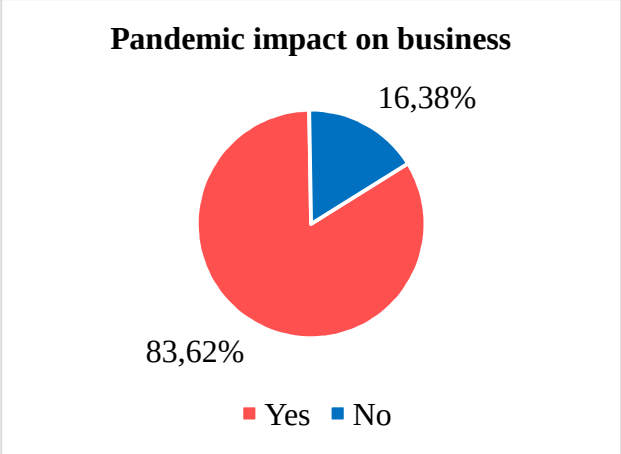

Figure 1. Pandemic impact on business
Source: own processing (2024)

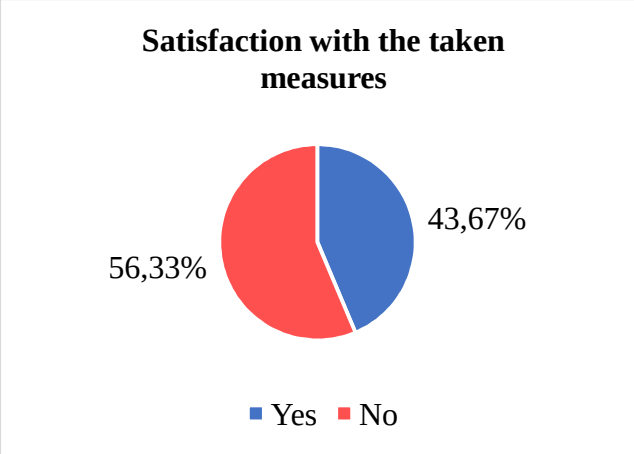

Figure 2. Satisfaction with the taken measures
Source: own processing (2024)

From Figure 1, we see that most family businesses (337 businesses) experienced a negative impact of the pandemic on their business, while only a minority (66 businesses) reported that the pandemic had no impact. This suggests that the crisis period significantly affected the operation of family businesses, probably due to the action of various determinants. Figure 2 shows the level of satisfaction of entrepreneurs with the government measures taken during the pandemic. The results indicate that most respondents (227 companies) were not satisfied with the measures, while 176 companies evaluated the measures positively. This ratio points to a prevalent dissatisfaction with support and regulations, which may be related to administrative burdens, insufficient compensations or inefficiencies of the measures put in place.

In the following graph, we have addressed the issue of drawing aid using various sources. The results are shown in Figure 3.

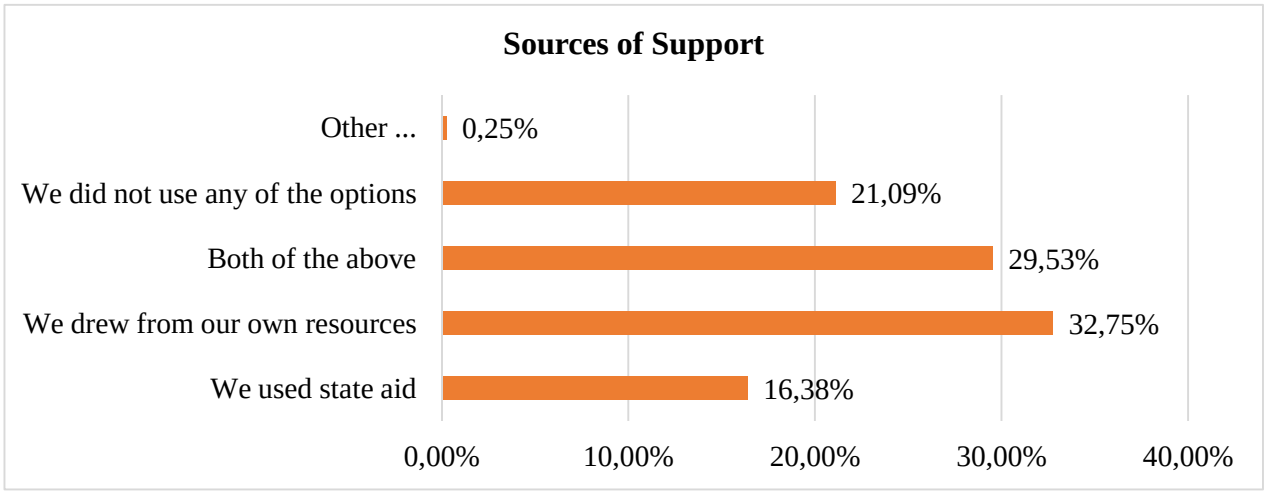

Figure 3. Sources of Support
Source: own processing (2024)

In Figure 3, we can see that most family businesses drew financial resources from their own reserves (132 enterprises), which represents 32.75% of respondents. The second most common strategy was the use of a combination of own resources and state aid, which was chosen by 119 enterprises (29.53%). By contrast, 85 enterprises (21.09%) did not make use of any of the support options and relied on normal operation without additional resources. State aid was drawn independently by 66 enterprises (16.38%). In the "other" option, respondents answered only in a few cases (1 enterprise; 0.25%), and their answer was that they did not use state aid because the company was still operating during the pandemic, and at the same time they refused state aid due to the strict controls that this aid entailed.

The following section of the results deals with the determinants that affected the family business before and during the COVID-19 pandemic. The results are presented separately for internal barriers and separately for external barriers. Figure 4 presents a comparison of the internal barriers of family business in terms of their challenge.

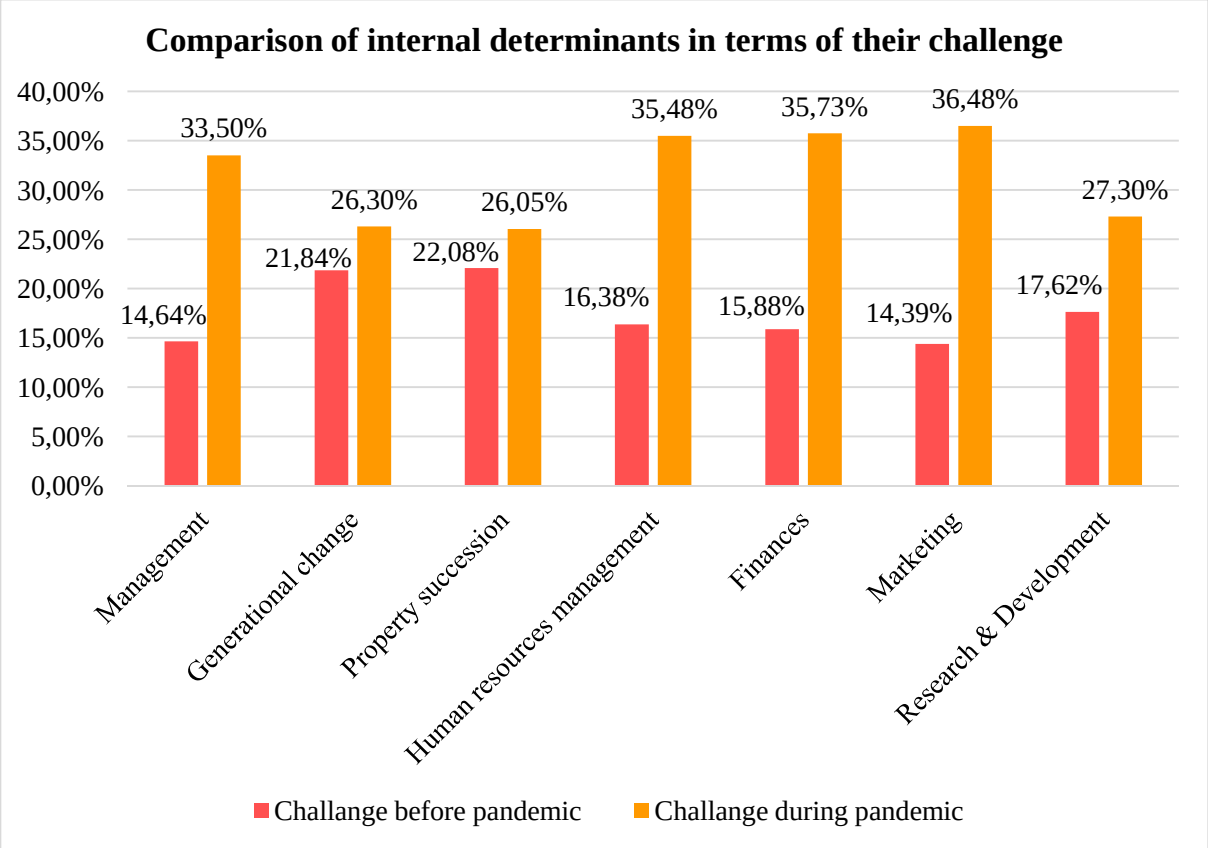

Figure 4. Internal determinants before and during pandemic
Source: own processing (2024)

From Figure 4, we can see that the pandemic has hit the determinants in marketing, finance and human resources the hardest, which have become much more difficult challenges for family businesses than before the pandemic. Marketing was perceived as a problem by 58 businesses before the pandemic, but during the pandemic this number rose to 147, suggesting that businesses had to look for new ways to reach customers and adapt to changing market conditions. Before the pandemic, 64 companies experienced financial challenges, but during the pandemic they rose to 144, pointing to increasing financial constraints, impaired access to liquidity and cash flow problems. The area of human resources has also seen a significant increase – before the pandemic, 66 companies perceived it as an important determinant, but during the pandemic their number rose to 143. This suggests that family businesses have had to deal with staff shortages, changes in working conditions and a shortage of skilled labour. The results thus show that family businesses faced financial difficulties, problems with employees and the need to adapt their marketing strategies to new market conditions during the pandemic. These factors have significantly affected their stability and ability to respond effectively to a crisis situation.

The comparison of individual internal determinants was supplemented by the use of the statistical method of variance analysis, which made it possible to verify statistically significant differences in the intensity of perception of determinants before and during the pandemic, thus providing an objective view of changes in their perception. The results are presented in the form of Figure 5.

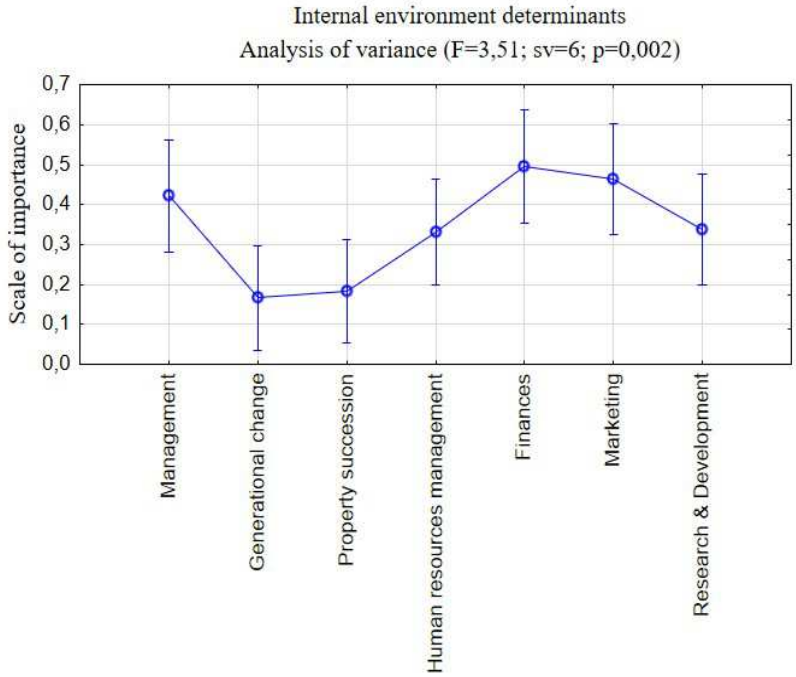

Figure 5. Internal environment determinants
Source: own processing (2024)

From Figure 5, we observe that finance, marketing and management were perceived as the most important internal determinants of family businesses during the pandemic. The analysis of variance confirmed statistically significant differences between the assessment of determinants before and during the pandemic (p = 0.002), suggesting that certain areas of business were hit harder by the crisis period. Other factors, such as generational renewal and R&D, remained present, but to a lesser extent influenced business decisions during the pandemic.

We focused on the external determinants of the microenvironment that directly affected the external environment of family businesses before and during the pandemic. The results are shown in Figure 6.

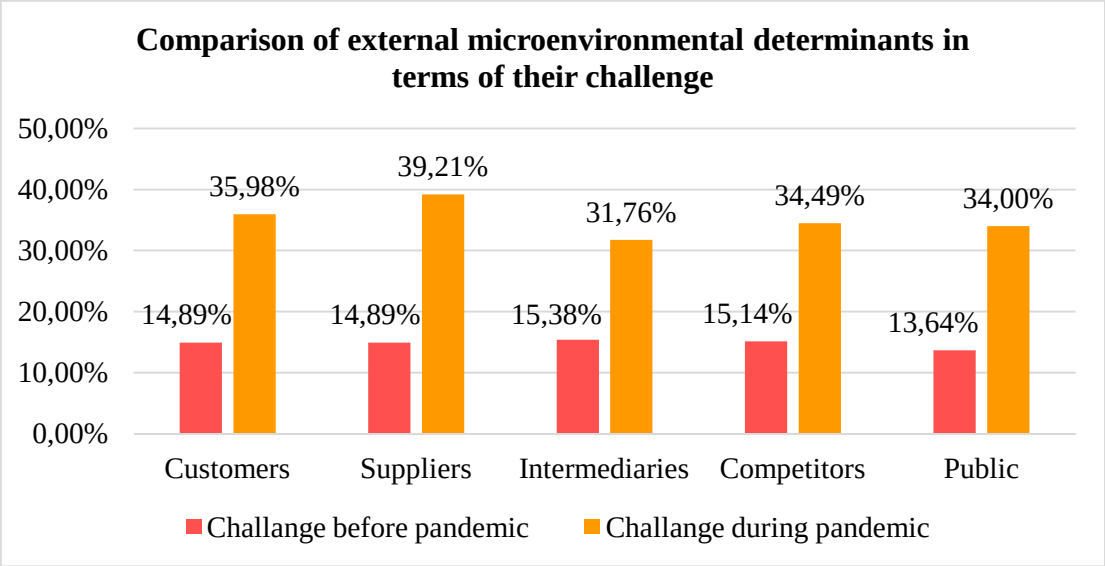

Figure 6. External microenvironmental determinants before and during pandemic
Source: own processing (2024)

From Figure 6, we can observe that during the pandemic, the determinants associated with suppliers, customers and competition deepened most significantly. Supply problems have grown from 60 to 158 businesses, indicating disruption of supply chains. The number of businesses perceiving customers as a barrier has increased from 60 to 145, which may be related to the decline in demand. Competition has become a challenge for 139 businesses compared to 61 before the pandemic, reflecting the intensified struggle for survival in the market. These results show that the pandemic has had a major impact on business relationships and market conditions for family businesses.

The comparison of individual external determinants of the microenvironment was supplemented by the use of the statistical method of variance analysis. The results are presented in the form of Figure 7.

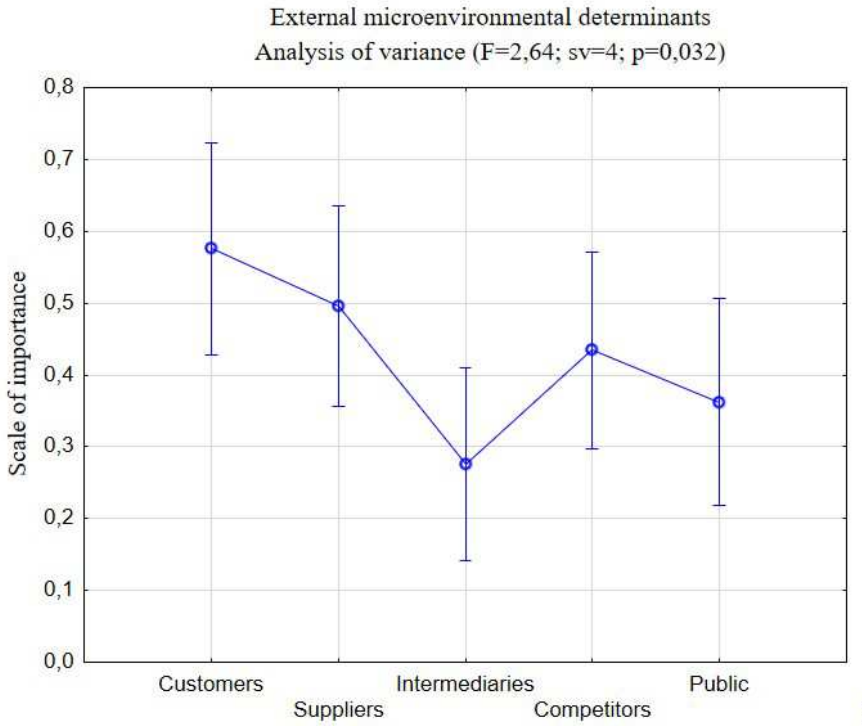

Figure 7. External microenvironmental determinants
Source: own processing (2024)

In Figure 7, we can see that the analysis of variance confirmed statistically significant differences between the external determinants of the microenvironment of family businesses during the pandemic ($p = 0.032$). The most important determinants became the customers and suppliers who achieved the highest values of importance. This suggests that family businesses have had to deal mainly with changes in demand and supply chain issues during the pandemic. On the contrary, the determinants associated with competition, and the public manifested themselves less intensely, although they still influenced the business environment. The results show that external factors have played a key role in the adaptation of family businesses to new market conditions.

In our research, we also focused on the external determinants of the macroenvironment (economic, socio-cultural, demographic, political-legal, technological-innovative, ecological). The results show that during the pandemic, economic and political-legal determinants increased most significantly, which significantly affected family businesses. Economic determinants were perceived as a challenge by 48 companies before the pandemic, with their number rising to 147 during the pandemic, indicating widespread financial and market problems. The political and legal determinants increased from 59 to 151 enterprises, which may be related to stricter regulations and uncertainty in the legislative environment. A significant increase was also recorded in technological and information determinants, where the number of companies facing this challenge increased from 78 to 143, which points to accelerated digitization and the need to adapt to new technological requirements. Socio-cultural determinants deepened from 83 to 142 enterprises, which may reflect changes in customer behaviour or deterioration of interpersonal relationships in the business environment.

Using the analysis of variance, we found that no statistically significant differences were found between the individual external determinants of the macroenvironment at the significance level of 5% ($p = 0.184$). This suggests that family businesses perceived economic, political-legal, socio-cultural, technological-informational, demographic and ecological determinants relatively equally, with none of them perceived as a dominant challenge compared to the others.

4. Discussion

The results of the questionnaire survey clearly demonstrated that the determinants of family businesses are key factors affecting their stability and ability to adapt to unexpected changes. The COVID-19 pandemic has shown that, while family businesses have considerable flexibility and resilience, their operations are vulnerable to factors that alter their ability to be adaptable and competitive. The results show that respondents have actually felt the pandemic impact on their business, which has affected their ability to function. This finding coincides with the work of authors Fairlieh and Fossen (2021), who found that COVID-19 led to a massive decline in business activity. Similarly, Meyer et al. (2020) points to the fact that businesses perceived the pandemic mainly as a demand shock, weakening consumer demand and financial stability of businesses. The survey also showed that the majority of respondents were not satisfied with the government measures taken to mitigate the effects of the pandemic situation on Slovak businesses. As reported by Gajdošíková et al. (2022), businesses in the construction sector in Slovakia faced significant financial and operational challenges, with many of them having to reduce or completely stop their activities. The claim is also supported by a study by Valášková et al. (2023), where they concluded that the pandemic has significantly affected the indebtedness of companies through an analysis of the financial performance of Slovak companies. The findings also point to the fact that most of the enterprises benefited from their own resources. The authors Belas et al. (2022) confirm this statement by conducting research that examined the impact of the pandemic on selected areas of management in small and medium-sized enterprises in the Czech Republic and Slovakia. From the point of view of the internal determinants of family businesses, it was clearly demonstrated that the determinants of marketing, finance and human resources were most significantly affected. Authors Čepel et al. (2020) agree with this statement, adding that businesses needed to clearly rethink their financial and HR strategies. Belas et al. (2022) add that crisis management was primarily focused on cash flow stabilization and cost optimization, where only a small proportion of enterprises focused their investments on innovation or digitalization. From the point of view of external microeconomic determinants, suppliers, customers and competitors have proven to be the most affected determinants on the basis of research. This claim is supported by the work of the authors Gajdošíková et al. (2022), who state that the demand for goods and services has become polarized. At the same time, Belas et al. (2022) add that businesses faced significant supply disruptions, leading to the collapse of supply chains and consumer behaviour. The most affected external determinants of the macroenvironment were economic and political-legal determinants, which significantly affected the stability of the business environment and the ability of enterprises to maintain competitiveness. As Bedianashvili (2022a, 2022b) states, the macroeconomic consequences of the pandemic manifested themselves in the form of a triple economic shock: demand, supply and financial. These factors significantly weakened economic growth and put pressure on businesses in various sectors. Belchior and Teixeira (2021) add that citizens' trust in government measures played a key role in adhering to pandemic measures. In the short term, confidence was manifested through various short-term political effects, but in the long term it depended mainly on the ability of national leaders to deal with the crisis. The pandemic situation represented a crucial test of the resilience of family businesses, and its management depended not only on their internal flexibility and strategic management, but also on the stability of the external business environment and the effectiveness of government measures, which determined their ability to recover and maintain competitiveness in the post-pandemic period.

Conclusion

Based on the research carried out, we concluded that family businesses in Slovakia play a key role in the economy, but their ability to withstand unexpected changes such as the COVID-19 pandemic was significantly influenced by several internal and external determinants. Although these companies have shown considerable flexibility and resilience, their ability to adapt to changing market conditions has been limited mainly by financial constraints and the instability of supply chains.

The results of the research suggest that family businesses perceived the pandemic primarily as a demand and financial shock, with marketing, finance and human resources management being the most significantly affected. In terms of external factors, disrupted supply chains, changes in consumer behaviour and increasing competition proved to have had the most significant impact. The findings point to the fact that family businesses have struggled to adapt to the crisis period through digitalisation, cost optimisation and the introduction of new business models. Nevertheless, only a minority of enterprises actively invested in innovation, indicating persistent barriers to business development and modernization.

An important finding is also the fact that family businesses faced limited support from the state and often had to rely on their own financial resources. This factor may have contributed to higher indebtedness and lower competitiveness of businesses in the post-pandemic period. However, with continued legislative changes and EU support, there is room for family businesses to improve their financial stability, digitalisation and long-term sustainability.

The limitation of this research is the dynamic nature of the external environment, where constantly changing economic and legislative conditions can affect the ability of family businesses to adapt and implement effective strategies to mitigate the effects of crisis situations.

Future research should focus on the long-term impact of crisis situations on the strategic management of family businesses and the identification of key mechanisms to increase their resilience to future economic shocks. Furthermore, future research could focus on agile family business management as an important concept for managing unpredictable situations.

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Analytical View of Online Consumer Behavior in Influencer Marketing within a Post-Pandemic Market Environment

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Abstract

Research background: Over the last decade, marketing communication has undergone fundamental changes, especially due to the rise of influencer marketing as a response to declining consumer trust in traditional advertising. Influencers, through their authenticity and close connection with followers, have become key players in shaping consumer preferences – particularly in the fast fashion segment, which is strongly influenced by social media trends and post-pandemic shifts in consumer behavior.
Purpose of the article: The aim of the paper is to identify the impact of influencers on the purchasing behavior of consumers in the Slovak fast fashion market, with a focus on generational differences and key motivational factors.
Methods: The research was conducted using a quantitative method – an online questionnaire distributed through social media platforms. The survey involved 121 participants, primarily from Generation Z, and focused on the frequency of fast fashion purchases, type of influencers followed, key decision-making factors, and perceived trust in influencer content. The analysis was based on descriptive statistics.
Findings & Value added: The results show that most consumers purchase fast fashion items occasionally, and that the number of followers an influencer has is less important than their authenticity and trustworthiness. Micro-influencers emerged as the most influential category. The most decisive factors in consumer purchasing were authentic product reviews and discount codes. The findings provide insight into how brands can effectively tailor their influencer strategies, particularly by partnering with credible micro-influencers to target younger audiences in the post-pandemic landscape.

Keywords: Influencer, Influencer marketing, Consumer, Purchasing behavior, Fast fashion

JEL classification: M30, M31

1. Introduction

Marketing is undergoing significant changes to which brands must respond if they want to attract potential customers. As consumers become increasingly resistant to traditional forms of advertising, brands have had to seek more creative ways to promote their products or services. One such approach is leveraging the ability of influencers to impact their followers' decisions. Therefore, companies have started collaborating with influencers to make use of the relationships they have built with their audiences (Khamis et al., 2017). Influencer marketing can be considered a form of word-of-mouth, where influencers communicate product-related information through their social media channels to their audience (Burešová, 2022). It is a social media marketing strategy based on recommendations and product mentions from influencers.

This type of marketing is currently one of the most widespread forms of marketing communication and represents a significant component of the marketing mix for many companies. A company must choose and motivate the right online influencers to reach their social media followers and thereby promote their offerings. These individuals have a loyal follower base and are perceived as experts in their

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fields (Leung et al., 2022). It is one of the most effective types of marketing due to the high level of trust influencers have built with their followers. Their recommendations act as social proof for potential brand customers.

This trend, involving influencers, has elevated influencer marketing to a global level, making it a core part of corporate marketing strategies (Leung et al., 2022). An influencer is a person who has the ability to influence the opinions and purchasing decisions of both potential and existing customers. They are individuals who have established credibility in the social media space through their authenticity (Atherton, 2022). Influencers can be real people or virtual characters who have gained significant social influence through their presence on social media.

Through blogging, vlogging, and content on platforms such as Instagram, TikTok, and others, influencers share their daily lives and opinions, creating a unique personality that resonates with their followers (Lee et al., 2020). As social media has evolved, so has the definition of an influencer. Today, anyone with a certain number of followers and influence on social networks can be considered an influencer (Wilkens, 2023). Influencers can also be described as "mini-celebrities" because they form a new group of people capable of shaping public opinion in specific areas.

This trend became more pronounced with the rise of social networks. Celebrities have also been part of this category, often transferring their image to brands in marketing campaigns (Cheah et al., 2019). Many people believe that influencers and celebrities are the same, but they differ significantly in concept. Traditional celebrities are known beyond social media and thus have influence over people who do not use these platforms, whereas influencers are mostly known only to those who actively use social networks (Schouten et al., 2019). Celebrities gain fame based on their professional talent, while influencers achieve popularity by successfully presenting themselves as experts online (Khamis et al., 2017).

Their reputation depends on the type of content they produce and how they communicate with their followers. They usually target specific groups with similar interests. This means that influencers who share their views and values with their followers appear more trustworthy than traditional celebrities, with whom the audience might not resonate (Schouten et al., 2019).

Social media is one of the most popular online marketing tools, with studies indicating it is 20–30% more effective than other online ads (Černikovaitė, 2018). According to Statista (2024), there were over 5 billion internet users worldwide as of October 2024, representing approximately 63.1% of the global population, and 5.22 billion social media users. It is estimated that this number will increase to nearly 6 billion by 2027.

Consumer decision-making processes involve steps that individuals go through when making purchase decisions (Influance, 2024). The literature on online consumer behavior highlights many variables influencing decision-making, including product selection, information search, consumption, and post-purchase satisfaction. Consumer behavior encompasses searching, buying, consuming, and forming opinions about products that meet individual needs. Traditional consumers tend to be more conservative in their purchases, while digital consumers are more open to trying new things (Belingher et al., 2011). They prefer interactive and communicative marketing elements on social media over traditional advertising forms.

Influencer marketing can play a crucial role in each of these stages by providing consumers with information, recommendations, and motivation to make a purchase (Influance, 2024). Consumers prefer content from influencers in the form of videos and photos with explanations, indicating that products recommended by influencers are more attractive and effective in advertising terms.

Metrics such as likes, comments, the use of discount codes, and others are used to measure the impact of influencers on social media, consumer purchasing behavior, and the sales of promoted products (Kavaliauskienė et al., 2019). Influencers play a key role in shaping consumer preferences and demands, directly contributing to increased sales. A survey conducted by Matter (2023) found that up to 81% of consumers said influencer posts on social media had caught their attention and encouraged them to purchase a product or service.

Statistics also show that the most active users follow influencers daily on Instagram (87%), YouTube (65%), and Facebook (58%), often engaging in discussions and interactions (Černikovaitė, 2018). More than 69% of consumers consider influencers a trustworthy source of brand information. They primarily look for influencers with whom they can identify (61%), experts in their field (43%), entertaining

personalities (32%), and ambitious role models (28%). Only 11% prefer well-known celebrities (Matter, 2023).

The core functions of an influencer include communicating with followers, recommending products, advertising in stories, spreading information, and sharing opinions. The para-social relationship between influencers and their audience is a key element of their popularity, as it supports belief in their opinions. This type of relationship creates the illusion of personal communication and helps followers identify with the influencer.

Influencers create and organize content based on the available formats and technologies on social media, and their posting frequency strategy is set to strengthen brand positioning in consumers' minds. Well-planned posts by fashion influencers lead to increased followers and engagement. Therefore, companies that monitor consumer behavior, needs, and preferences gain a competitive advantage (Kotler & Armstrong, 2018).

2. Methods

The aim of this paper is to identify the impact of influencers on the purchasing behavior of consumers in the fast fashion sector on the Slovak market.

Based on this main objective, the following sub-objectives were formulated:

- To determine how often consumers purchase fast fashion products.
- To identify which type of influencers (nano, micro, macro, mega) is the most effective in influencing purchase decisions.
- To determine which influencer attributes (e.g. trustworthiness, authenticity, quality of presentation) most influence consumer purchasing behavior.
- To identify the main reasons why consumers purchase fast fashion products.

As part of this article, a quantitative survey was conducted with the aim of analyzing the impact of fashion influencers on consumer purchasing behavior in the fast fashion segment. Data collection was carried out using an online questionnaire via Google Forms, which was distributed through social media and communication platforms. This method enabled the gathering of relevant data on consumers' shopping behavior, their perception of fashion influencers, and the factors influencing their decisions when purchasing fast fashion products.

The questionnaire consisted of 20 questions, including closed-ended multiple-choice items as well as questions based on Likert scales and linear scales. The questions were designed to meet the objectives of the article and to allow for an in-depth analysis of the influence of influencers on consumer decision-making in the fast fashion sector. The questionnaire was divided into three main sections:

- Demographic data, covering age, gender, place of residence, level of education, and income;
- Respondents' relationship to fast fashion influencers, including the frequency of following influencers on social media, the number of influencers followed, and the frequency of purchases based on their recommendations;
- The influence of influencers on purchasing behavior, where factors such as trust in influencers, preferred forms of influencer marketing, perception of the quality of recommended products, and overall purchasing decisions were evaluated.

The survey participants were fast fashion consumers, with the target group consisting of individuals with a positive attitude toward fast fashion and who follow fashion influencers on social media. The sample was selected using a non-probability sampling method, specifically purposive sampling, targeting respondents who met the criteria of interest in fast fashion and influencer following. The research primarily focused on Generation Z, as this demographic is the most active on social media and the most frequent buyers of fast fashion products. Geographically, the research was conducted mainly in the eastern region of Slovakia.

The data analysis highlights the key findings of the survey and is presented in the form of descriptive statistics, primarily using tables.

A total of 121 respondents participated in the survey. For clarity, the number and percentage representation of each gender were processed into a summary table. The majority of respondents were women, totaling 78, which represents 64.5% of the total sample. Men accounted for 43 responses, or 35.5% of the total. The "other" gender option was not selected by any respondent.

The results indicate that the survey primarily reached female participants, which may be attributed to the fact that fast fashion influencer marketing is predominantly targeted at this demographic. Nevertheless, the participation of male respondents provides a more comprehensive view of influencer impact across different consumer segments. The total number of responses corresponds exactly to the number of respondents, ensuring the accuracy and reliability of the data.

The results presented in this paper are part of a broader study, with additional interesting findings discussed in the conclusion of the article. From an age perspective, the largest group of respondents belonged to Generation Z (aged 16 to 30), totaling 114 individuals, which constitutes 94.21% of the total sample. The second largest group comprised Millennials (aged 31 to 45), with 6 respondents (4.96%), and there was 1 respondent from Generation X (0.83% of the sample).

3. Results

This chapter presents the survey results through descriptive statistics, mainly in the form of tables.

Table 1. Frequency of Fast Fashion Purchases

PURCHASE FREQUENCY	NUMBER OF RESPONSES	PERCENTAGE
Very rarely	29	23,97 %
Rarely	18	14,88 %
Occasionally	42	34,71 %
Often	28	23,14 %
Very often	4	3,31 %
TOTAL	**121**	**100 %**

Source: own elaboration (2025)

The largest group of respondents purchases clothing from fast fashion stores occasionally (several times per quarter); this option was selected by 42 respondents (34.71%). On the other hand, 29 respondents (23.97%) shop very rarely (a few times a year). Another 28 respondents (23.14%) reported shopping frequently (several times a month). A further group of 18 respondents (14.88%) indicated they shop rarely (a few times per half-year). The smallest group, 4 respondents (3.31%), reported shopping very often (several times a week). These results show that most respondents purchase fast fashion occasionally, with quarterly frequency being the most common. Monthly purchases are less frequent, indicating that fast fashion remains popular, but consumers generally approach their purchases rationally rather than impulsively or excessively.

Table 2. Types of Followed Fast Fashion Influencers

TYPE OF INFLUENCERS FOLLOWED	NUMBER OF RESPONSES	PERCENTAGE
Nano-influencers	5	4,13 %
Micro-influencers	30	24,8 %
Macro-influencers	21	17,36 %
Mega-influencers	2	1,7 %
Follower count does not matter	63	52,01 %
TOTAL	**121**	**100 %**

Source: own elaboration (2025)

The results revealed that as many as 52.01% of respondents do not consider the follower count of an influencer to be important. However, micro-influencers have a significant influence on purchasing decisions, as preferred by 30 respondents (24.8%). The next influential group were macro-influencers (21 respondents, 17.36%). Nano-influencers influence 4.13% of respondents, while mega-influencers were considered the most influential by only 1.7% of respondents. These results indicate that follower count is not a key factor for most respondents. Instead, consumers prioritize authenticity and trustworthiness over popularity, with micro-influencers having the greatest influence. For brands, this suggests that more effective collaborations may be achieved with smaller but more credible content creators.

Table 3. Factors Influencing Purchase Decisions

FACTORS INFLUENCING PURCHASE	NUMBER OF RESPONSES	PERCENTAGE
Trustworthiness	42	34,71 %
Authentic review	70	57,85 %
Quality of presentation	60	49,59 %
Discount code	61	50,41 %
None of the above	2	1,6 %

Source: own elaboration (2025)

The most significant factor influencing purchases based on recommendations from fast fashion influencers is an authentic review, selected by 70 respondents (57.85%). Interestingly, 50.41% of respondents indicated they were influenced by a discount code. The third most influential factor was the quality of product presentation (60 respondents, 49.59%). Trustworthiness was cited by 42 respondents (34.71%), and only 2 respondents (1.6%) reported that none of the listed factors influenced their purchase decisions. These findings suggest that consumers place the greatest trust in authentic reviews when buying products recommended by influencers. Discount codes are also an important motivational factor, enhancing the appeal of purchases.

Table 4. Reasons for Purchasing Fast Fashion

REASONS FOR PURCHASE	NUMBER OF RESPONSES	PERCENTAGE
Availability & wide selection	93	76,86 %
Low price	72	59,50 %
Trendy design	60	49,59 %
Fast-changing collections	35	28,93 %
Influence of influencers	13	10,74 %
Other	2	1,65 %

Source: own elaboration (2025)

The most common reason for purchasing fast fashion products is their availability and wide selection, marked by 93 respondents (76.86%). The second most cited reason is the low price (72 respondents, 59.50%). In third place was the trendy design of fast fashion products (60 respondents, 49.59%). Another significant reason was the fast turnover of collections (35 respondents, 28.93%), while 13 respondents (10.74%) stated that influencer or social media influence was the primary reason. Two respondents selected "other." Overall, consumers perceive fast fashion primarily as an affordable option with a varied and trendy selection. Rapid collection turnover and up-to-date design are also important considerations.

4. Discussion

The findings of this study support current academic and practical insights into the influence of social media influencers on consumer behavior, particularly within the fast fashion segment. The results indicate that authenticity, personal experiences shared by influencers, and practical value of content—such as reviews and styling tips—play a key role in purchase decision-making. These observations align with existing research emphasizing the growing importance of trustworthiness in digital marketing (e.g., Khamis et al., 2017; Atherton, 2022).

An interesting aspect of the survey is the clear preference for micro-influencers, who proved to be more effective than macro- or mega-influencers. This trend can be interpreted as a result of a stronger para-social relationship between smaller influencers and their followers, fostering a sense of intimacy and trust. In the context of the Slovak population, particularly among Generation Z, this is crucial, as this demographic tends to be highly digitally literate and more sensitive to marketing tactics.

Another important finding is that most respondents do not shop impulsively, but purchase fast fashion items only occasionally. This suggests a shift toward more conscious consumer behavior, even within a segment often associated with rapid consumption. This shift could reflect growing environmental and social awareness among consumers.

Notably, the number of followers is not a decisive factor for most consumers, which contrasts with earlier research that emphasized reach as the primary indicator of influence. The results suggest that the quality of the relationship between influencer and audience matters more than quantitative metrics. Therefore, brands should consider not only the size of an influencer's audience, but also their communication style and level of engagement.

From a practical standpoint, the findings suggest that fast fashion brands should invest in long-term and transparent collaborations with influencers who build trust through consistent and authentic content. At the same time, they should focus on formats that promote personal connection, such as videos, Q&A sessions, and behind-the-scenes content.

Conclusion

This study confirmed that influencer marketing plays a significant role in shaping consumer behavior in the fast fashion sector, particularly among Generation Z. The findings highlight that authenticity, credibility, and practical content formats are the most influential factors in consumers' purchasing decisions. Micro-influencers, despite having smaller audiences, generate a greater impact due to their perceived trustworthiness and personal approach.

The research also revealed a trend toward more deliberate and rational shopping behavior, even in a market segment traditionally associated with fast consumption. This presents both a challenge and an opportunity for brands seeking to adapt their influencer strategies to evolving consumer expectations.

Future research should expand the sample size and geographic scope, and consider longitudinal studies to capture shifts in consumer attitudes over time. Additionally, examining the role of sustainability communication by influencers may offer valuable insights, as consumers become more environmentally conscious.

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Verbal Communicative Strategies in Intercultural Business Communication: a Theoretical Perspective

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Abstract

Research background: The current global instability and uncertainty underlines the importance of effective intercultural business communication. The intercultural communication effectiveness, however, is not an outcome of global interaction itself but rather a result of developing intercultural communicative competence, including strategic competence as its integral component. Verbal communicative strategies should help manage the complexities and potential misunderstandings inherent in intercultural encounters. Numerous approaches exist in the academic literature concerning the definition and taxonomy of verbal communicative strategies in various contexts. However, the conceptualization of these strategies lacks uniformity, exhibiting significant diversity across various theoretical frameworks. Therefore, a systematic overview of the existing knowledge on this topic relevant to intercultural business communication would be beneficial.
Purpose of the article: The aim of the paper is to identify existing definitions and taxonomies of verbal communicative strategies used in intercultural communication and identify key verbal communicative strategies relevant to intercultural business communication.
Methods: The paper employs an analytical method to examine the literature on intercultural communication, business communication, sociolinguistics, and pragmatics and to identify relevant verbal strategies.
Findings & Value added: The paper identifies several crucial verbal communicative strategies for managing intercultural business communication. These include question strategies, inserting interim summaries, and avoiding adjectives and adverbs referring to relative sizes. The theoretical contribution provides a foundation for future empirical research and the development of practical guidelines for management and business students and professionals operating in diverse intercultural environments.

Keywords: Intercultural business communication, Verbal communicative strategies, Theoretical perspective

JEL classification: D83

1. Introduction

In the process of globalization, societies are becoming more interconnected, integrated, and interdependent (Neugebauer & Vokoun, 2024). The rise of such complexity is, however, accompanied by the increasing intensity of global uncertainty (Urteaga, 2023). In the present, such uncertainty is often described, for example, in terms of economic uncertainty (Tang & Cao, 2025), global financial uncertainty (Caggiano & Castelnuovo, 2023), techno-geopolitical uncertainty (Luo & Van Assche, 2023), energy-related uncertainty (Dang et al., 2023), uncertainty arising from climate change (Baum, 2024) or intercultural encounter (Prechtl & Lund, 2007).

Effective intercultural communication is considered to be one of the possible ways how to address uncertainty at personal, interpersonal, and international levels in various situations and environments (Baldwin et al. 2023), including the environments of business (for the role of effective intercultural communication in the sphere of business, see, e.g., Ng & Lillevik, 2017) and management (for the role of

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effective intercultural communication in organizations, see, e.g., Tocar, 2024). Intercultural communication effectiveness, however, is not merely an outcome of global interaction itself; it is rather the result of cultivating intercultural communicative competence, which is not innate but must be learnt deliberately (Liu et al. 2023).

Intercultural communicative competence consists of several components comprising, inter alia, strategic competence, which refers to the knowledge of verbal and non-verbal communicative strategies to overcome communication difficulties and improve the effectiveness of communication (Yao & Du-Babcock, 2023). As using verbal code in communication is primary in organizations, and especially in business operations, verbal communicative strategies seem to be crucial to help manage the complexities and potential misunderstandings that may arise from intercultural communication. The academic literature contains a plethora of approaches to the definition and taxonomy of verbal communicative strategies in a variety of contexts. However, the conceptualization of these strategies is inconsistent, displaying considerable variation among different theoretical frameworks. Therefore, a systematic review of the current knowledge on this subject pertinent to intercultural business communication would be beneficial.

The paper aims to identify existing definitions and taxonomies of verbal communicative strategies used in intercultural communication and identify key verbal communicative strategies relevant to intercultural business communication.

2. Methods

The paper employs an analytical method to examine the literature on intercultural communication, business communication, sociolinguistics, and pragmatics accessible in databases such as *Web of Science*, *Scopus*, *SpringerLink*, *ProQuest Central*, *Google Books*, *Google Scholar*, and *Semantic Scholar* and to identify relevant aspects of verbal communicative strategies.

3. Results and Discussion

The results of the analysis indicate that definitions of verbal *communicative strategies* are dependent on the definitions of a broader concept of *communicative strategies*. In the examined academic literature, at least five distinct understandings of communicative strategies were identified.

One of the broadest understandings refers to communicative strategies as "language use strategies". In this sense, communicative strategies are defined as "techniques that learners employ when attempting to use the target language for the purpose of communication" (Oxford, 2004, p. 130). This understanding of communicative strategies is based on Cohen's (1998) concept of *language use strategies*. Nevertheless, Cohen himself did not prefer to use the term *communicative strategies*. It is also worth noting that a considerable debate is ongoing among scholars regarding whether *language use strategies* overlap with or differ from *language learning strategies* (Oxford, 2017). According to Oxford (2004), language use strategies and language learning strategies overlap, which makes her understanding of communicative strategies one of the most comprehensive. See Table 1 for Oxford's taxonomy of communicative strategies.

Table 1. Oxford's taxonomy of communicative strategies

Type of communicative strategies	**Subtype of communicative strategies**	**Communicative strategies**
Retrieval (mnemonic) strategies		Mnemonic strategy creating retrieval via - an orderly string (acronyms) - sounds - images - a combination of sounds and images - body movement - mechanical means - location
Rehearsal (practice) strategies		Grammatical rehearsal Vocabulary rehearsal Pronunciation rehearsal
Cover (masking or image-protection) strategies	*Linguistically-based cover strategies*	Using a memorized and partly understood phrase to keep the conversation going Producing simplified utterances Producing overly complex utterances

	Social-psychological cover strategies	Laughting Joking Diverting the conversation partner Smiling Nodding The appearing to be interested or fascinated by the conversation while not understanding what it being said
'Communication' (restricted-knowledge) strategies		Overgeneralising a grammar rule or vocabulary meaning from one context to another when it does not apply Avoiding or abandoning a topic that is too difficult Reducing a message Code switching Paraphrasing Using circumlocution

Source: adapted by the author from Oxford (2004)

Related to the previous one is the understanding of communicative strategies as a synonym for "communication strategies" and "problem-solving mechanisms" (Brunner, 2021). This understanding follows Tarone's (1977, p. 195) definition of communication strategies. According to him, "conscious communication strategies are used by an individual to overcome the crisis which occurs when language structures are inadequate to convey the individual's thought". This definition has evolved and has been elaborated upon, incorporating both linguistic and psychological approaches. The result of this process is a wide range of definitions and overlapping taxonomies using different terminology. An overview of such definitions and taxonomies was elaborated, e.g., by Dörneyi and Scott (1997) or Brunner (2021). See Table 2 for Dörneyi and Scott's taxonomy of communication strategies.

Table 2. Dörneyi and Scott's taxonomy of communication strategies

Type of communicative strategies	Subtype of communicative strategies	Communicative strategies
Direct strategies	*Resource deficit-related strategies*	Message abandonment Message reduction Message replacement Circumlocution Approximation Use of all-purpose words Word-coinage Restructuring Literal translation Foreignizing Code-switching Use of similar sounding words Mumbling Omission Retrieval Mime
	Own-performance problem-related strategies	Self-rephrasing Self-repairing
	Other-performance problem-related strategies	Other-repair
Interactional strategies	*Resource deficit-related strategies*	Appeals for help
	Own-performance problem-related strategies	Comprehension check Own-accuracy check
	Other-performance problem-related strategies	Asking for repetition Asking for clarification Asking for confirmation

		Guessing Expressing nonunderstanding Interpretive summary Responses
Indirect strategies	*Processing time pressure-related strategies*	Use of fillers Repetitions
	Own-performance problem-related strategies	Verbal strategy markers
	Other-performance problem-related strategies	Feigning understanding

Source: adapted by the author from Dörneyi and Scott (1997)

Another understanding of communicative strategies is close to Gumperz's (1982) understanding of "discourse strategies". Using the term *communicative strategies* in this sence, Platt (1989, pp. 13–14) defines communicative stratgies as "verbal and/or non-verbal rule-governed behaviour in interpersonal exchanges which, on the one hand, serves to convey a message, [...] and, on the other hand, serves to establish or re-establish interpersonal relationships." At the same time, he identifies six sensitivity areas and possible problems in balancing interpersonal relationships, as, according to him, the communication problems may arise due to the use of inappropriate (or 'other-system') strategies or inappropriate interpretation of strategies. Platt thus elaborated on the taxonomy of sensitivity areas and possible problems rather than the taxonomy of communicative strategies; however, this taxonomy can be extended with some appropriate strategies mentioned in his text. See Table 3 for the extended taxonomy.

Table 3. Platts's extended taxonomy of sensitivity areas, communication problems and communicative strategies

Sensitivity area	Communication problems	Communicative strategies
Engaging (starting a verbal exchange)	First presentation of ego Placement of alter ego by ego Effecting the placement of ego by alter ego	Greeting routines The decision whether or not to engage
Disengaging (ending a verbal exchange)	A deliberate withdrawal automatically puts ego higher than alter ego, cushioning effect is needed	Disengagement routine
Requesting something from someone or requesting someone to do something	Putting ego in 'vulnerable' position (e.g. alter ego may refuse request) but also involving threat to alter ego	Requesting conventions
Acceding to a request	Placement of ego and alter ego	Appropriate verbalizing or non-verbalizing of willingness or ability to execute request
Positive responding to an offer or invitation	Balancing problem – do not want to push ego up or down excessively	Appropriate accepting strategy depending on communicative and culture system
Negative responding to an offer or invitation	Balancing problem – do not want to push ego down excessively	Appropriate 'cushioning' strategy

Source: adapted and extended by the author from Platt (1989)

The next understanding of communicative strategies, which occurred in academic literature, relates them to the "communicative process". In the functional model, Levy (1979, p. 197) proposed that the terms *communicative strategies* or *communicative process* denote the process through which the speaker's goal changes into the linguistic expression. In his understanding, the communicative strategy is defined as "the mental process whereby the speaker realizes a particular communicative goal as a linguistic expression". Levy did not elaborate on any systematic taxonomy of communicative strategies; however, he stated that these mental processes can be linguistic or nonlinguistic, and as an example, he presented the Refer strategy as a linguistic process and the Express-choice strategy as a nonlinguistic process (Levy, 1979).

The term *communicative strategies*, also called "strategies of use", was similarly used in the Columbia School theory to refer to "the conventionalized ways in which language users deploy the signals and meanings of their linguistic system. The concept of strategies captures the fact that speakers routinely exploit the meanings of their linguistic system in specific ways" (Stern, 2019, p. 19). The proponents of this theory give many examples of these strategies rather than elaborate on their taxonomy.

The outcomes of the analysis reveal that the term *communicative strategies* refers to five distinct phenomena: 1) *language use strategies*, 2) *communication strategies* or *problem-solving mechanisms*, 3) *discourse strategies*, 4) *communicative process*, or 5) *strategies of use*. *Verbal communicative strategies* constitute a subset of communicative strategies, specifically those employing verbal codes.

In the context of intercultural business communication, verbal communicative strategies are studied for practical reasons to enhance the effectiveness of business communication and achieve overall success. Intercultural business communication is a type of communication characterized by unique features that necessitate the deployment of specific communicative strategies.

Firstly, in intercultural business communication, content accuracy and the use of business-specific vocabulary are prioritized over general vocabulary, with grammar accuracy being the last emphasized, especially in oral communication. In written communication, adherence to standard language rules is crucial. Business professionals often employ a "let it pass" strategy, ignoring linguistic anomalies to prioritize content accuracy over form accuracy, though in some critical situations where safety is paramount, repair and reformulation strategies are employed to prevent misunderstandings (Dedović-Attila & Dubravac, 2022).

Secondly, clarity and directness are essential in intercultural business communication. Information is presented explicitly, clearly, and directly, especially given the diverse backgrounds of participants. Consequently, this communication typically avoids complex structures, such as idioms, complex sentence structures, or phrases. For this reason, backchanneling – "a strategic competence where a listening party offers confirmation, comprehension signals and support using different verbal or non-verbal utterances or asks for a clarification in the case of misunderstanding or non-understanding" (Dedović-Attila & Dubravac, 2022, p. 29) – seems to be vital. Furthermore, sociocultural competence, which includes the ability to understand diverse accents and engage in attentive listening, is also considered critical. Thus, asking for clarifications, repetitions, paraphrasing, and checking for understanding are frequent and crucial pre-emptive strategies to avert costly communication breakdowns (Dedović-Attila & Dubravac, 2022).

The success of intercultural business communication ultimately depends on employing a variety of communicative strategies tailored to each specific interaction (Dedović-Attila & Dubravac, 2022). Given the complexities of intercultural communication, the development and application of communicative strategies that are "helpful for intercultural business communication independent of the interacting individuals' cultures of origin" (Rathmayr, 2017) appear highly beneficial. While much existing literature has focused on cultural differences, often reinforcing stereotypes, a "focus on commonalities and sensitisation rather than individual cases" (Rathmayr, 2017) would offer a more universally applicable approach.

In pursuit of new communicative strategies for intercultural business communication, the following recommendations are currently proposed: questioning, inserting interim summaries, and avoidance of adjectives and adverbs referring to relative sizes (Rathmayr, 2017).

Questioning is essential for avoiding misunderstandings and asking for clarification. In general, it is better to enquire repeatedly than to be misunderstood and act incorrectly. However, excessive use of this guideline may make one appear less competent. Therefore, it is adviced to consider the wording of questions; it is recommended to avoid using question tags (e.g., who, when, where, how much) and instead, describe the rationale for the question, for example, "I am not sure how I should understand that: do I have to do it immediately, or is it up to me whether I do it?" (Rathmayr, 2017, p. 240). When striving for maximum clarity, specific questions help ensure understanding. It is worthwhile to address potential interculturally determined discrepancies clearly, such as: "What does... mean?" "What is usual in your country if...?" "Do you also take a break if the negotiations are at a standstill?" (Rathmayr, 2017, p. 241).

Inserting interim summaries is strongly advised after clarifying a point. It guarantees that both parties possess the same information and are in agreement before proceeding to subsequent stages or decisions. Without these summaries, interactions can become excessively time-consuming.

Avoidance of adjectives and adverbs referring to relative sizes is also recommended because the meaning of relative adjectives and adverbs like “far”, “expensive”, “large”, and “soon” may differ from culture to culture. For example, what one culture considers “not far” (e.g., a 500-kilometer journey in Russia) may be regarded as “very far” by another (for example, in Slovakia). To minimise misconceptions, it is preferable to seek clarification by proposing a particular measure (e.g., “Does that mean that you can get there in 20 minutes with a car?”) rather than asking a direct “how far” question. To avoid vague words like “far”, “expensive”, “large”, and “soon”, specific terms like “300 km away”, “$750”, “4m long”, and “on the 27th of August” can be used. The strategy of achieving maximum clarity by eliminating ambiguity might also help rectify imbalances in linguistic and cultural knowledge (Rathmayr, 2017, p. 242).

Conclusion

The current understanding of *verbal communicative strategies* is challenged by diverse conceptualizations of a more general term of *communicative strategies*. However, as relates to intercultural business communication, the study of verbal communicative strategies is pragmatically focused on enhancing the effectiveness of communication. Some studies aim to identify communicative strategies that are beneficial in intercultural business communication regardless of the language and culture involved, so that linguistic and cultural differences in such communication do not pose a barrier. Such attempts, stemming from the linguistic approaches, seem promising and could be a starting point for further empirical research and practical guidelines for management and business students and professionals seeking to enhance “conscious communicative behaviour” (Rathmayr, 2017, p. 243) in an increasingly globalized and uncertain world.

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An Analytical Examination of Consumer Purchasing Behaviour in the Context of E-Commerce Sustainability

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Abstract

Research background: The rapid expansion of e-commerce has brought about a range of environmental and social sustainability challenges. While online retail continues to reshape traditional consumer behaviour, it must also respond to the growing consumer awareness of environmental and ethical considerations in shopping. This evolving landscape calls for a more nuanced analysis of consumer behaviour, preferences, and motivations within the digital marketplace.
Purpose of the paper: This study aims to investigate consumer purchasing patterns in the context of e-commerce, with particular attention to sustainability. The research explores key factors including consumers' environmental engagement, online shopping behaviour, the influence of social norms, willingness to pay for sustainable alternatives, and their intention to make future sustainable purchases.
Methods: Primary data were collected via a questionnaire survey, completed by 161 participants. The data were analysed using descriptive statistics and correlation analysis, enabling the examination of correlations between environmental engagement, social norms, willingness to pay for sustainable products in the online environment, and future purchase intentions.
Findings & Value added: The findings indicate that the majority of respondents recognise the importance of sustainability, actively engage in environmental issues and activities, and demonstrate a willingness to pay a premium for sustainable products. However, their intentions to purchase sustainable products in the future remain somewhat uncertain. The results further reveal a significant positive correlation between environmental engagement, willingness to pay, purchase behaviour, and future purchase intentions. This study contributes to the theoretical understanding of online consumer behaviour with a focus on sustainability, while also offering practical insights for businesses seeking to develop effective strategies in sustainable e-commerce.

Keywords: Sustainability, Electronic commerce, E-commerce, Consumer behaviour, Online consumer

JEL classification: M14, M30, M31

1. Introduction

Over the past decade, e-commerce has experienced substantial growth. It offers numerous advantages, including convenience, a broader selection, and access to products from around the world. Consumers can shop from the comfort of their own homes, compare prices, and choose from an extensive range of products. However, this rapid expansion also presents sustainability challenges. These include an increasing carbon footprint, greater energy consumption, transportation impacts, and packaging waste. Simultaneously, consumers are becoming more aware of the environmental consequences of their purchasing decisions.

E-commerce—also referred to as electronic commerce—is widely recognised as one of the most significant developments in contemporary business and trade. It is a complex and dynamic process encompassing the buying and selling of goods and services via the Internet. This sector includes diverse activities such as online retail and electronic auctions, enabling businesses and consumers to interact in real time and overcoming geographical and temporal barriers (Ardakani et al. 2024). According to the OECD (2011), e-commerce encompasses all transactions conducted using digital technology to facilitate commercial activities. The sector continues to evolve rapidly, transforming business-consumer interactions and unlocking new opportunities for global trade.

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Today, e-commerce stands as a cornerstone of digital transformation and innovation in commerce. This dynamic platform not only enables businesses to manage inventory more efficiently, engage with partners and customers more rapidly, and significantly reduce operating costs, but it is also increasingly recognised as a vital factor in sustaining long-term competitiveness. By transcending geographical boundaries, e-commerce expands the availability of products and services to a global audience, opening new markets and customer segments for businesses.

Simultaneously, it facilitates the adoption of sustainable business models, such as optimising supply chains to reduce transportation and emissions, minimising resource waste through improved demand forecasting and waste management, and lowering the overall carbon footprint of business operations. Driven by the ongoing advancement of technologies—including artificial intelligence for personalised shopping experiences and big data analytics for enhanced decision-making—e-commerce is evolving beyond a mere sales channel into a complex ecosystem that is continuously reshaping both business practices and consumer behaviour (Matušovičová, Červenka 2024; Roszko-Wójtowicz et al. 2024; Chilicaus et al. 2025).

From the consumer's perspective, the benefits of e-commerce are undeniable. Foremost among these is convenience, as purchases can be made anytime and from anywhere, unrestricted by the opening hours of traditional brick-and-mortar stores. This offers significant time savings and broadens geographical accessibility, enabling consumers to obtain products and services from distant locations or foreign markets that would otherwise be out of reach.

Additionally, e-commerce affords a high degree of flexibility, allowing consumers to take their time to examine product details, read reviews, and compare offers without the pressure of time constraints or social influences. The range of products available online often surpasses that of physical stores, providing access to specialised or rare items that might be difficult to source locally.

Another key advantage lies in the ease of comparing products and prices across different sellers, empowering consumers to make more informed purchasing decisions and achieve potential savings. Many platforms enhance this experience by offering detailed descriptions, images, videos, user reviews, and even virtual try-on features, thereby providing a comprehensive overview prior to purchase. This combination of efficiency, breadth of choice, and personalised information transforms shopping into a more informed and tailored experience (Biswas et al. 2024; Thomas, Vedi & Gupta 2023).

In recent years, sustainability has become an increasingly prominent focus, playing a pivotal role in the evolution of e-commerce. Within this context, sustainability encompasses environmental, social, and economic dimensions that shape both business decisions and consumer behaviour. A growing number of consumers are showing a preference for brands that demonstrate a genuine commitment to sustainable practices and environmental responsibility. This shift is placing considerable pressure on businesses to adopt eco-friendly measures across all facets of their operations. Embracing sustainability in e-commerce is no longer merely a moral or ethical consideration; it represents a strategic imperative for companies aiming to secure long-term success in a rapidly evolving market (World Economic Forum 2020; Kaur et al. 2024).

Consumer interest in environmental issues is on the rise, prompting notable changes in lifestyles and fostering greater environmental responsibility. Growing awareness of the benefits associated with sustainable products is driving a shift towards more sustainable consumption patterns. Environmental consciousness influences human behaviour in multiple ways, with numerous studies indicating that consumers are willing to pay a premium for products perceived as sustainable or ethically produced. These consumers recognise the environmental challenges facing society and consequently adopt more environmentally sensitive behaviours, showing a preference for sustainable goods. Thus, sustainability emerges not only as an ethical obligation but also as a crucial factor in maintaining market competitiveness (Nielsen 2015; Kim, Oh 2020; Lestari, Septifani & Nisak 2021; Queiroz et al. 2021).

Despite the clear advantages that e-commerce offers both businesses and consumers, its rapid expansion also poses significant environmental challenges that demand urgent attention. Consumer behaviour concerning sustainability remains an area requiring further in-depth exploration. Consequently, this study was motivated by the need to examine consumer perceptions of sustainability in relation to their purchasing behaviours and intentions within the online environment.

Research of this nature is vital not only for advancing academic understanding but also for informing strategic decision-making by businesses and policymakers, thereby supporting long-term sustainability in an ever-evolving global commercial landscape.

2. Methodology

The aim of this study was to investigate consumer purchasing patterns in the context of e-commerce, with particular attention to sustainability, and to explore the interrelationships between these factors. Drawing on the study's objectives and existing literature, four research questions and corresponding hypotheses were developed.

Q1: Is there an association between environmental engagement and future purchase intention?

H1: It is hypothesised that there is a significant association between environmental engagement and future purchase intentions.

Q2: Is there an association between willingness to pay for sustainable products and future purchase intention?

H2: It is hypothesised that there is a significant association between willingness to pay for sustainable products and consumers' future purchase intentions.

Q3: Is there an association between sustainable purchasing behaviour and future purchase intentions?

H3: It is hypothesised that there is a significant association between sustainable purchasing behaviour and consumers' future purchase intentions.

Q4: Is there an association between subjective norms and future purchase intentions?

H4: It is hypothesised that there is a significant association between subjective norms and consumers' future purchase intentions.

Secondary data to inform the theoretical framework were primarily sourced from research studies indexed in international databases, predominantly Web of Science. Primary data were collected via an anonymous questionnaire survey administered through Google Forms. The initial section of the questionnaire aimed to identify respondents by gathering socio-demographic information, including gender, age, education, and net monthly income.

The first substantive section explored consumers' purchasing behaviour in the online environment, alongside their perceptions of and satisfaction with e-commerce in general. Subsequent sections focused on examining four specific aspects of the e-commerce process with an emphasis on sustainability: environmental engagement (*EE*), purchasing behaviour in the online environment (*PB*), willingness to pay for sustainable products (*WP*), perception of subjective norms (*SN*) related to online shopping, and future purchasing intentions (*PI*).

The research sample was selected using a non-probability convenience sampling method, based on availability and voluntary participation (Lunsford & Lunsford 1995). Data collection took place between January and February 2025. The data were analysed using frequency analysis and descriptive statistics via IBM SPSS Statistics 26. Given the non-normal distribution of the data, Spearman's rho correlation analysis was conducted to test the research hypotheses.

A total of 189 responses were collected, of which 161 were retained after excluding incomplete or irrelevant entries. The sample was composed of 51% female and 49% male respondents. The age distribution indicated a relatively young cohort, ranging from 22 to 46 years old, with the largest subgroup comprising 28-year-olds. Regarding educational attainment, 61% of participants held a university degree. Concerning net monthly income, approximately one third of respondents reported earnings between €1,000 and €1,499, while nearly another third fell within the €500 to €999 range.

3. Results and Discussion

The following section presents and analyses the findings of the questionnaire survey. The results are primarily interpreted descriptively, with selected data also displayed in tables to enhance clarity.

The initial part of the questionnaire explored consumers' purchasing behaviour in the online environment, alongside their perceptions of and satisfaction with e-commerce overall. When asked about the *frequency of online shopping*, the most common response was "once a week" (34.78%). Regarding *satisfaction with e-commerce*, 64.60% of respondents reported being either definitely satisfied or rather satisfied. Nearly 80% *perceived e-commerce as sustainable*. Furthermore, 62.11% expressed a definitely or rather positive *attitude towards online shopping in general.*

The subsequent section of the questionnaire examined consumers' environmental engagement (*EE*), purchasing behaviour (*PB*), willingness to pay for sustainable products (*WP*), perception of subjective norms (*SN*) in online shopping, and future purchasing intentions (*PI*). Descriptive statistics for these variables are presented in Table 1.

Table 1. Descriptive Statistics of Questionnaire Items

Aspect	Item ID	Mean	Median	Standard Deviation	Minimum	Maximum
Environmental Engagement – *EE*	EE1	3.90	4.00	1.15	1	5
	EE2	3.75	4.00	1.15	1	5
Purchasing Behaviour – *PB*	PB1	3.78	4.00	1.12	1	5
	PB2	3.86	4.00	1.10	1	5
	PB3	3.91	4.00	1.10	1	5
Willingness to Pay – *WP*	WP1	3.93	4.00	0.99	1	5
	WP2	3.75	4.00	1.22	1	5
Purchase Intention – *PI*	PI1	3.25	3.00	1.22	1	5
	PI2	3.45	4.00	1.24	1	5
	PI3	3.42	4.00	1.26	1	5
Subjective Norms – *SN*	SN1	2.99	3.00	1.13	1	5
	SN2	3.24	3.00	1.26	1	5

Source: Author's own work (2025)

The average scores for the individual items comprising the "Environmental Engagement" aspect ranged from 3.75 to 3.90, with the statement *"Environmental protection is always a priority for me when shopping online"* registering the highest mean value. These results indicate a relatively strong consensus among respondents regarding their environmental consciousness in everyday life. The standard deviation of 1.15 suggests considerable variability in responses, reflecting a degree of diversity in opinions.

Regarding the "Purchasing Behaviour" aspect, mean scores for individual items ranged from 3.78 to 3.91, indicating general agreement with statements related to sustainable purchasing practices. This suggests a predominantly positive attitude towards sustainability within the purchasing process. Standard deviations between 1.10 and 1.12 point to modest variability, implying that while respondents largely concurred with the statements, the strength of agreement varied somewhat across individuals.

Regarding the "Willingness to pay" aspect, the average scores for individual items ranged from 3.75 to 3.95, reflecting a relatively high level of consumer readiness to pay a premium for sustainable products. The statement *"I will always prefer a product with a higher price if it is sustainable"* recorded the highest mean value. Standard deviations for this aspect ranged from 0.99 to 1.22, indicating modest variability among respondents.

For the "Purchase Intention" aspect, average scores ranged from 3.25 to 3.45, suggesting a somewhat lower level of agreement compared to the other aspects, though still reflecting a generally positive tendency. This finding implies that despite respondents' environmental engagement and willingness to pay for sustainable products, their future purchase intentions remain less definitive. The variability in this aspect was slightly higher than in others, indicating greater divergence in responses.

In the "Subjective Norms" aspect, the average scores for individual items ranged from 2.99 to 3.24, indicating a comparatively lower level of agreement than observed in the other aspects. The highest agreement was found for the statement, *"Mass media (e.g., television, radio, newspapers, internet) influence my decision to buy sustainable products online."* Similar to other aspects, the response variability was relatively high, suggesting considerable ambiguity and greater diversity of opinions among respondents.

Table 2. Correlation Analysis Results

Aspect 1	Aspect 2	p-value (α = 0.05)	Spearman's rho	Conclusion
Environmental Engagement	Purchase Intention	0.000 (<0.05)	0.62	H1 supported
Purchasing Behaviour	Purchase Intention	0.000 (<0.05)	0.55	H2 supported
Willingness to Pay	Purchase Intention	0.000 (<0.05)	0.54	H3 supported
Subjective Norms	Purchase Intention	0.000 (<0.05)	0.56	H4 supported

Source: Author's own work (2025)

The results of the correlation analysis revealed statistically significant relationships among the variables examined (see Table 2). According to Cohen's (1988) guidelines, a strong positive correlation was found between environmental engagement and purchase intention (rho = 0.62), indicating that consumers with a higher level of environmental engagement are more likely to intend to purchase sustainable products. Similarly, a strong positive correlation was observed between sustainable purchasing behaviour and purchase intention, suggesting that consumers who engage in sustainable purchasing are inclined to continue doing so in the future. Additionally, a strong positive relationship was identified between willingness to pay for sustainable products and future purchase intention, implying that consumers willing to pay a premium for sustainable products tend to maintain this behaviour over time. Lastly, a strong positive correlation was found between subjective norms and future purchase intention, demonstrating that consumers influenced by their social environment are more likely to intend to purchase sustainable products in the future.

Previous research has demonstrated that factors such as consumer attitudes, a sustainability-oriented lifestyle, willingness to pay for sustainable products, and subjective norms significantly influence sustainable purchasing behaviour. Studies have also found that a sustainability-oriented lifestyle, willingness to pay for green products, and subjective norms significantly affect future purchase intentions (Cuc 2022; Peterson 2021; Štofejová et al. 2023). However, some studies report that current online consumers are generally reluctant to change their consumption habits or pay more for environmentally friendly products (Hao et al. 2019; Gong et al. 2020; Ma, Park & Moultrie 2020). Conversely, other studies highlight a growing willingness among consumers to pay for sustainable alternatives (Rhein & Schmid 2020; Greenwood et al. 2021; Herrmann, Rhein & Sträter 2022). These mixed findings underscore the need for further investigation into consumer behaviour in this context.

Sustainability is increasingly becoming a core component of business strategy, offering the potential for long-term success and growth for companies that adopt such an approach. Given rising expectations from both consumers and regulators, sustainability in e-commerce is not merely a passing trend but a necessity (Nielsen 2015). As consumer demand for sustainable products continues to grow, so too does the need for environmentally responsible solutions. Well-designed sustainability policies can promote sustainable behaviour not only among businesses but also among consumers. Beyond environmental benefits, sustainable business practices can enhance customer satisfaction and brand loyalty, ultimately contributing to improved long-term business performance (Oláh 2023).

Conclusion

The aim of this study was to investigate consumer purchasing patterns in the context of e-commerce, with particular attention to sustainability, and to explore the interrelationships between these factors. This objective was successfully achieved.

The findings revealed that while most respondents are aware of the importance of sustainability and actively participate in environmentally friendly initiatives, their future purchasing intentions regarding sustainable products remain somewhat ambiguous. Nevertheless, the results confirmed strong positive correlations between environmental engagement, willingness to pay more for sustainable products, current purchasing behaviour, and declared future intentions. These findings highlight the complexity of translating environmental awareness into consistent sustainable purchasing behaviour.

One limitation of the study lies in its geographical restriction to the Slovak Republic, combined with an uneven distribution of socio-demographic characteristics within the sample. However, as these variables were not included in the analytical procedures, their impact on the results was minimal. At the same time, these limitations suggest directions for future research—specifically, expanding the geographic scope beyond Slovakia, achieving greater sample representativeness, and incorporating socio-demographic variables to explore potential significant differences.

This study makes a significant contribution to the theoretical understanding of online consumer behaviour, particularly in the context of the increasing emphasis on sustainability. While e-commerce offers numerous advantages as a dynamic and rapidly evolving phenomenon, its environmental and social impacts are becoming more evident. The research deepens our understanding of the complex interplay between environmental engagement, willingness to pay for sustainable products, purchasing behaviour, and future purchasing intentions in the online environment. By identifying strong positive relationships among these variables, the study contributes to the refinement of existing consumer behaviour models, which may have previously overlooked the specific dynamics of sustainable purchasing in the digital

space. Moreover, the findings underscore the ambiguity surrounding future purchasing intentions despite high levels of sustainability awareness, highlighting the need for further academic inquiry into the attitude–behaviour gap in sustainable consumption.

The practical implications of this study are highly relevant for businesses operating in the e-commerce sector. The findings offer valuable insights for shaping effective strategies in sustainable e-commerce. Companies can leverage consumers' strong environmental engagement and willingness to pay a premium for sustainable products to design targeted marketing campaigns and develop product offerings that align with the growing demand for environmentally responsible alternatives. By understanding the links between environmental engagement, willingness to pay, and purchase intentions, businesses can improve market segmentation and tailor their messaging more effectively. Moreover, the study underscores the importance of addressing the ambiguity surrounding future purchase intentions. This highlights the need for greater transparency, credible certification, and consumer education initiatives that build trust and encourage more consistent sustainable purchasing behaviour. Such measures not only enhance a company's competitiveness but also contribute to reducing the environmental footprint of e-commerce.

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The Use of Neuromarketing Tools in Evaluating the Effectiveness of Advertisements in E-commerce Environments

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Abstract

Research background: Increasing competition in the e-commerce sector requires new approaches to reaching customers. Neuromarketing is an interdisciplinary discipline that enables the discovery of hidden consumer preferences through technologies such as eye-tracking and emotion recognition (AFFDEX).
Purpose of the article: This paper aims to evaluate the effectiveness of three online video advertisements for different products by combining the conscious and unconscious responses of the respondents. It examines the influence of advertising on emotional responses and purchasing motivation, highlighting the distinctions between conscious and unconscious perceptions.
Methods: The research was conducted at the FMEO's Neuromarketing Lab, using three video advertisements from pharmaceutical companies that focused on the link between ad spot length, emotional reactions, and purchase motivation. Eye movement was captured via Smart Eye AI-X eye-tracking, and emotional facial responses were recorded with a Logitech C980 webcam and AFFDEX software.
Findings & Value added: The results suggest that video ad length does not significantly affect positive emotions, but ad pleasantness positively correlates with purchase motivation. At the same time, no significant difference was confirmed between conscious and unconscious emotional reactions. The findings contribute to a deeper understanding of consumer behavior in the online environment.

Keywords: **E**-commerce, Neuromarketing, Video advertising, Eye-tracking, AFFDEX, Purchase behaviour, Emotions, Motivation

JEL classification: M31, M37, C91

1. Introduction

Neuromarketing has become a new and important topic in marketing in recent years. Consumer behaviour research has gained increasing attention. In the last decade, the importance of marketing has also been recognized in many fields, such as consumer behavior, advertising, information systems, and e-commerce (Zhu et al., 2022). With the growth of e-commerce and the dominance of video formats in online advertising, the need to investigate how consumers respond to these stimuli not only consciously but also unconsciously is coming to the fore. Interdisciplinary neuromarketing research shows that the conscious and rational consumer is an illusion, while emotions significantly impact consumer behavior (Piazza et al., 2019).

This paper aims to use neuromarketing tools to investigate the impact of video advertising in e-commerce environments on consumers' emotional responses and purchase motivation, emphasizing the difference between conscious and unconscious perceptions of ads.

1.1 Neuromarketing in Digital Environments and the Importance of Video Advertising in E-Commerce

The growing interest in consumer behavior in digital environments has led researchers and companies to increasingly focus on consumers' decision-making processes on digital platforms (Fici et al., 2024). With the rise of e-commerce and online marketing strategies, it is becoming apparent that

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traditional approaches to the study of consumer behaviour can no longer capture the complexity and dynamics of the current digital environment.

Neuromarketing is an interdisciplinary field that uses neurological and psychophysiological methods to identify the deep, often unconscious, decision-making mechanisms. These insights are extremely useful in optimizing advertising campaigns, building brands, and increasing conversion rates in digital marketing (Zhu et al., 2022). Unlike traditional methods that rely mainly on conscious feedback from respondents (questionnaires, interviews), neuromarketing enables real-time monitoring of emotional and cognitive responses, leading to a more accurate understanding of decision-making processes (Khurana et al., 2021; Mashrur et al., 2022).

Modern technologies such as brain-computer interfaces (BCIs), electroencephalography (EEG), eye tracking and facial expressions provide detailed data on how consumers react to marketing stimuli, even when unaware of these reactions. With these approaches, neuromarketing is gaining prominence in digital marketing, enabling content optimization based on users' unconscious reactions (Yadava et al., 2017; Ouzir et al., 2024; Upadhyay et al., 2024). However, it is also important to consider technical and contextual factors of the research, such as the lighting in eye-tracking measurements (Yüksel, 2023) or consumers' characteristics (Chang et al., 2024).

Video advertising, which plays an increasingly important role in e-commerce, deserves special attention. Video formats combine visual and auditory stimuli, engaging the consumer's senses more effectively and reinforcing an emotional connection to the product. Lehr (2023) states in his study that the multisensory stimuli in videos help to create a stronger emotional connection between the product and the consumer. Similarly, Saari et al. (2004) state that video-form advertising generates greater attention and more intense emotional responses than text advertising, making it more effective in online sales.

The basis of the effectiveness of video advertising is the use of emotional mechanisms, not only conscious but mainly unconscious. Research by Shen et al. (2020) shows that unconscious thinking can be more effective than conscious thinking in complex decisions such as online purchases. In turn, Huang et al. (2023) highlight the importance of the phenomenon of "immersion", i.e., absorption in the experience, in the context of livestream advertising, which is a largely unconscious process with a significant impact on purchase decisions. The study by Berčík et al. (2023) confirms that neuroscientific approaches provide deeper insights into consumers' subconscious responses to mobile ads, thus enabling more precise targeting of emotional brand communication.

From the above, understanding the conscious and unconscious components of consumer behaviour is essential for effective marketing campaigns in the online environment. Neuromarketing provides tools that can capture this complexity, which is particularly valuable in video advertising, which is becoming the dominant form of communication in e-commerce. Current research also highlights the need for hybrid approaches, combining neuroscience techniques with traditional methods and tailoring research to individual and contextual behavioural factors in digital environments.

2. Research Methodology

This paper aims to use a combination of neuromarketing tools (AFFDEX) and traditional tools (questionnaire) to investigate the impact of advertising in the e-commerce environment on consumers' emotional reactions and purchase motivation, emphasizing the difference between conscious and unconscious perceptions of advertisements.

The research was conducted in the specialized Laboratory of Neuromarketing of the Faculty of Management, Economics and Business of the University of Prešov. All participants were informed in advance about the biometric testing procedure, including the processing conditions and personal data protection. Participation was possible only after giving informed consent through a handwritten signature. Data collection took place in March 2025.

The stimuli consisted of three video advertisements from pharmaceutical companies: omega 3 (Walmark), Celaskon (Zentiva) and Elmetacin (Stada). The videos were selected concerning comparable length, ranging from 10 to 20 seconds, to ensure equal attention span and to allow for comparative analysis.

The video advertisements were presented on a 24-inch monitor with a 1920 × 1080 px resolution. Eye movement was captured using a 60 Hz Smart Eye AI-X eye-tracking system built directly into the monitor. Emotional facial responses were recorded using a Logitech C980 webcam (1920 × 1080 px) in

combination with AFFDEX software in the Imotions 10 environment, which allows simultaneous tracking of both eye movements and facial expressions. Measurements were performed on a computer with an Intel Core i5 processor.

The R program in the R-interface was used to process the obtained data, and the following statistical methods were applied:

- Shapiro-Wilk test to verify the normality of the distribution of the variables (joy, anger, sadness, smile); since the test showed a deviation from a normal distribution ($p < 0.05$), non-parametric tests were used,
- Kruskal-Wallis test to compare the intensity of emotional reactions between spots,
- Spearman's correlation coefficient to analyze the relationships between the variables of interest.
- Wilcoxon rank sum exact test (also known as the Mann-Whitney U test) to compare emotional responses between selected spots pairwise.

The neuromarketing software AFFDEX was used to detect and analyze emotions based on facial expressions, identifying basic emotions such as joy, sadness, anger, fear, disgust, and surprise, thus allowing the evaluation of each ad's emotional impact (Imotions, 2017).

A supplementary research tool was a questionnaire that respondents completed after watching each commercial. The questions focused on purchase motivation, subjective advertisement evaluation and conscious experience of emotions. As mentioned in the theoretical background, several studies confirm differences in conscious and unconscious emotions (Piazza et al., 2019; Shen et al., 2020; Huang et al., 2023; Bercik et al., 2023), and neuromarketing tools allow capturing precisely those unconscious reactions that play a key role in consumers' decision-making in digital environments. Table 1 summarises the fundamental statistical indicators for the three questions, focusing on viewers' motivation, overall exposure, and emotional reactions to the three different video advertisements.

Table 1. Descriptive statistics of researched aspects and items

Video 1	Mean	Median	SD	Skewness	Kurtosis
QO1: How much did the advertisement motivate your interest in the product?	2,3	2	0,88	0,3	-0,67
QO2: How do you rate the overall impact of advertising?	3,17	3	0,75	0,7	0,48
QO3: Did you feel any specific emotions while watching the commercial?	1,93	2	0,25	-3,3	9.21
Video 2					
QC1: How much did the advertisement motivate your interest in the product?	3,73	4	1,05	-0,17	-1,29
QC2: How do you rate the overall impact of advertising?	4	4	0,74	0	-1,25
QC3: Did you feel any specific emotions while watching the commercial?	1,5	1,5	0,51	0	-2.07
Video 3					
QE1: How much did the advertisement motivate your interest in the product?	3,2	3,5	1,03	-0,57	-0,77
QE2: How do you rate the overall impact of advertising?	3,73	4	1,08	-0,75	-0,28
QE3: Did you feel any specific emotions while watching the commercial?	1,47	1	0,51	0,13	-2,05

Source: own processing (2025)

2.1 Description of the research sample

In neuromarketing research, smaller research samples are used as a standard, which is mainly related to the technical difficulty of measurement and the large volume of data generated when monitoring the brain and visual responses of respondents. As reported by Puprediwar and Tapas (2024), given the universality of emotional responses and the high density of data obtained from a single participant (e.g., recording from 32 sensors scanned 250 times per second), a sample of around 30 respondents is considered sufficient to draw relevant conclusions. The present research works with a sample of 30 respondents.

Table 2. Research sample

Gender	**Male**	**9**	**30 %**
	Female	21	70 %
	Total	**30**	**100 %**
Nationality	Slovak	26	87 %
	Ukrainian	4	13 %
	Total	**30**	**100 %**
Education	Elementary	0	0 %
	Secondary without high school diploma	1	3 %
	Secondary with high school diploma	17	57 %
	University (bachelor's)	8	27 %
	University (master's/engineering)	1	3 %
	University (doctoral)	3	10 %
	Total	**30**	**100 %**
Employment	Student	17	57 %
	Full-time employee	8	27 %
	Part-time employee	2	7 %
	Unemployed	0	0 %
	On maternity/parental leave	1	3 %
	Retired	0	0 %
	Other	2	6 %
	Total	**30**	**100 %**

Source: own processing (2025)

Thirty respondents participated in the study, 70% of whom were female and 30% were male. The age range of the respondents was from 19 to 50 years (M= 26.3; SD= 8.415). Regarding education, most respondents had attained secondary education with a high school diploma (56.7%), followed by university first degree (26.7%), and the least attained university second degree and secondary education without a high school diploma, both 3.3%. Regarding occupational status, students predominated (57%), corresponding with a higher proportion of younger respondents. This was followed by those employed full-time (27%) and part-time (7%). A small proportion of respondents were on parental leave (3%) and in the other category (6%). The sample did not include the unemployed or pensioners.

3. Research Results

Initially, the normality of the data distribution was verified using the Shapiro-Wilk test, where all four variables (joy, anger, sadness, smile) achieved p-values less than 0.05, indicating that the data is not normally distributed. Therefore, it was necessary to use non-parametric tests that do not assume normality of distribution.

Table 3. Verifying the normality of data distribution with the Shapiro-Wilk test

	W	p-value
Questionnaire		
QO1	0,870	0,002
QO2	0,793	9,924e-05
QC1	0,865	0,001
QC2	0,813	0,000
QE1	0,853	0,001
QE2	0,854	0,001
Emotions		
Joy	0.230	2.2e-16
Anger	0.240	2.2e-16
Sadness	0.374	2.2e-16
Smile	0.386	2.2e-16

Source: own processing (2025)

We hypothesized an association between positive emotions and ad spot length. Based on this, we formulated the following hypothesis, namely:
H1: Shorter videos elicit higher values of positive emotion indices than longer videos.

The shortest video was video1 (10 sec.), which was about the product Omega3, followed by video2 (Celaskon, 15 sec.) and the longest video3 (Elmetacin, 20 sec.). In the following table, we can see the results of verifying hypothesis H1.

Table 4. Results of the Kruskal-Wallis test for hypothesis H1

	chi-squared	p-value
Smile	0,542	0,763
Joy	0,674	0,714

Source: own processing (2025)

Based on the p-value and chi-squared test, we can see that the video length has no statistically significant relationship with the index of positive emotions. Neither the emotion of a smile nor joy showed a difference in the duration of the commercial spot for the three videos studied.

Consequently, we tested the association between commercial spots and respondents' motivation to purchase. We set the following hypotheses:

H2: There is a positive correlation between the evaluation of ad exposure and the degree of purchase motivation.
H2a: There is a positive correlation between the evaluation of the effect of advertisement A and the degree of purchase motivation.
H2b: There is a positive correlation between the evaluation of the effect of advertisement B and the degree of purchase motivation.
H2c: There is a positive correlation between the evaluation of the effect of advertisement C and the level of purchase motivation.

Spearman's correlation coefficient was used to test the hypotheses. The results of the test can be seen in the following table.

Table 5. Testing the hypothesis H2 (2a,2b,2c) using Spearman correlation

	S	p-value	Rho
Video 1	3767,6	0,393	0,162
Video 2	922,65	1,565e-07	0,795
Video 3	1555	8,846e-05	0,654

Source: own processing (2025)

Based on the p-value, we can see that videos 2 and 3 show that there is a positive correlation between the evaluation of the impact of advertising 2 and 3 and the level of purchase motivation. Regarding video 2, we can see that there is a strong positive correlation; regarding video 3, it is a medium to strong positive correlation and therefore, the more pleasant the advertising had on the respondents, the higher their motivation to make a purchase was.

We decided to verify whether there is a difference between conscious and unconscious emotional reactions, and so we formulated the following hypothesis.

H3: There is a statistically significant difference between the intensity of unconscious and conscious emotional reactions to the advertising spot.

Unconscious reactions were measured using the AFFDEX face-reader, and conscious reactions were measured with item Q7 from the questionnaire, which read: Did you feel any specific emotions while watching the advertisement? This question was measured after each advertising spot.

Table 6. Wilcoxon rank sum exact test for testing hypothesis H3

Emotions	Video 1	Video2	Video3
Positive	0,901	0,775	0,193
Negative	0,837	0,267	0,423

Source: own processing (2025)

No statistically significant difference existed between the intensity of conscious and unconscious reactions for any of the commercials. Thus, the differences between the commercials can be considered random in our study. None of the analyzed videos showed a difference at the $p<0.05$ level; thus, we cannot confirm hypothesis H3.

4. Discussion

Emotions affect the perception of time. Volkinburg and Balsam (2014) pointed out in their study that emotionally tinged videos, whether positive or negative, are perceived as longer videos compared to neutral ones. Our study hypothesized that short videos elicit higher values of positive emotional indices than longer ones. According to Arrie et al. (2011), positive emotions are only transient when a special immediate response occurs. Authors Wen and Wei (2022) pointed out that short videos can stimulate positive emotions, which was not shown in our case. Bhattacharya et al. (2023) addressed emotions and video length by looking at multimodal elements such as facial expressions, the tone of voice used in the commercial or the text, and the length of the emotional episode. They found that these particular elements were more effective for videos with a shorter time track than for videos with a longer time track; they also pointed out that it was more effective for positive emotions.

According to Adolphs and Andler (2018), an emotional state can last longer than the reason that triggered it, meaning that the experience of positive or negative emotions lasts beyond the end of the cause that preceded it. They also pointed out that the elicitation of the emotion and its feeling influence subsequent behavior, which is related to our current emotional state. This confirms the findings from our study, where we found that there is a relationship between the evaluation of an advertisement, i.e. feeling about it, and purchase motivation. Also, authors such as Lench et al. (2011) have pointed out that emotion may be the main reason for a change in cognition, judgment or behavior, which is also supported by our results.

Regarding the difference between the intensity of unconscious and conscious emotional reactions to an advertisement spot, no statistically significant difference between the two was shown, but this is in line with the results of Höfling and Alpers (2023), who in their study focused on the automatic encoding of the face and the relationship between its movements and the self-assessment of emotions from an advertisement, focusing on facial expressions. They concluded that automatic facial coding correlates with subjective evaluations of advertisements, so we can say that unconscious emotional reactions can predict conscious ones, confirming the statistical insignificance of our third hypothesis.

5. Limitations and Future Research Directions

Despite the valuable insights provided by this study, several limitations should be acknowledged. First, the sample size was limited to 30 participants, which, although standard in neuromarketing research

due to the technical intensity of data collection, restricts the generalizability of the results. The predominance of younger respondents and students may also influence the findings, as their online behavior and responsiveness to advertisements could differ from other demographic groups, such as older consumers or those with greater purchasing power.

Second, the study utilized only three video advertisements from pharmaceutical companies. While this ensured content comparability, it also limited the applicability of the findings to other product categories or industries. Future research should incorporate a wider range of products, brands, and advertising styles to test the consistency of emotional and motivational responses across contexts.

Third, although neuromarketing tools like AFFDEX and eye-tracking provide valuable insights into unconscious reactions, technical factors such as ambient lighting, screen quality, and facial recognition sensitivity can affect data accuracy. Additionally, using facial expression analysis alone might not fully capture complex emotional states; combining it with EEG or GSR (Galvanic Skin Response) could offer more robust results.

Fourth, the study explored only immediate emotional responses and purchase motivation. However, actual behavioral outcomes such as click-through rates, product purchases, or long-term brand recall were not measured. Future research should explore how neuromarketing indicators correlate with real consumer behavior over time, ideally through field experiments.

Conclusion

Nowadays, consumers' emotional expression is a necessary element to monitor during marketing communication. Nowadays, it is not enough to measure numbers; it is necessary to get under the skin of consumers. It is the measurement of emotions while watching advertising spots, the impact of negative or positive, conscious or unconscious reactions that we consider highly necessary. It is essential to realize that it is the emotions evoked in the consumer that have an impact on the brand, and this, in turn, has an impact on their purchase intent, just as we have been looking at the link between the evaluation of an advertising spot and the motivation to buy.

However, our study did not show a difference in terms of eliciting higher positive emotions when watching shorter videos, as we had assumed, according to the results of other authors. This may be due to the small difference between the lengths of the videos, as all three fall into the category of short videos, which range from a few seconds to several minutes (Li et al., 2021). Regarding the link between ratings and purchase motivation, this is where a positive relationship was found. Thus, the more positively the respondents perceived the commercial, the higher the ratings were, and they felt more motivated to purchase it. We observed this relationship across multiple ad spots; hence, some consistent mechanism emerges.

Thus, watching advertising spots leads not only to cognitive processes, such as the formation of an attitude towards advertising but also to emotional processes that are manifested by the need to act, as in our case, the motivation to buy.

However, in the future, it would be good to investigate age or generational differences since, as Isacowitz et al. (2017) pointed out, people's age has different effects on emotional perception, affective experiencing, and emotional state regulation.

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Resources

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The Effect of Omnichannel Logistics Service Quality on Customer Loyalty

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Abstract

Research Background: Even though most of the researchers have conducted their research based on Omni channel, they did not consider how the logistics service quality of Omni channel impact on customer Loyalty.
Purpose of the Article: The purpose of this research is to analyses the Logistics Service Quality in the context omni-channel purchasing scenarios while considering four dimensions such as timeliness, availability, condition and return of the product and to assess their impact on customer loyalty
Methods: The data were collected structured questionnaires from 200 respondents who use omnichannel shopping in Sri Lanka. Researcher used snowball sampling methods due ensures access to respondents who have relevant shopping experience. The data was further processed statistically using SPSS and SmartPLS 4.
Findings and Added Value: Condition has a positive impact on customer loyalty, while other independent variables, availability, timeliness and return has no significant impact on customer loyalty.
This study only used several dimensions of the Omni channel logistics service quality. The future researcher can use dimension like Personalization in Logistics Services, Sustainability & Green Logistics, AI-Enabled Customer Support in Logistics etc.
By applying practice implication fashion retailer can enhance the customer loyalty, brand loyalty and operational efficiency. Leveraging the advance technology and delivering personalized customer experience creates the competitive advantages for the Omni channel fashion retailers.

Keywords: Fashion retail Sector, Logistics service quality, Loyalty, Omni channel

1. Introduction

In the dynamic environment omnichannel has positive impact for the customer loyalty (Jones et al., 2022; Butkouskaya et al., 2023). This study deep dive into the interplay between omnichannel logistics service quality consist of availability, timeliness, product condition, and returns its impact of customer loyalty. Studying the logistics service quality of the omnichannel and impact on customer loyalty is important (Hamouda, 2019) because, omnichannel play huge role in different fields by doing different tasks, which is a positive sign for people because they can ease their work. In the modern technologically advanced era, marketing firms prioritize providing the best possible customer experience to enhance customer satisfaction and loyalty(Salem et al., 2022).Customers always search the best easy way to search information, make purchase and achieve their needs. The evaluation of shopping format friction the Customers can get limitless selection and transparent the price and reviews(Truong, 2021). Omnichannel becoming the main key topic under the converging trends and needs. Then the rapid expansion of the online channel and digitalization shift to omnichannel(Zhang et al., 2022). Although it is an important aspect to modern business world, few studies only conducted related to this area to give the comprehensive model(Salem et al., 2022).

With the growing of business world, the impact of omnichannel logistics service quality on customer loyalty gains more insights (Beck and Rygh, 2015). Most of the previous studies focused customer behaviors and individual aspects. Under this researcher identifies a gap in research that examines how different combinations of Omni-channel services impact retailer performance comprehensively, including

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both demand and supply perspectives(Jones et al., 2022).It is one of the theoretical limitation that few researchers have done research on the impact of logistics service quality on customer loyalty(Cotarelo et al., 2021). While previous studies (Lemon & Verhoef, 2016; De Borba et al., 2020) have examined customer experience and satisfaction in omnichannel retailing limited attention has been given to the specific dimensions of service logistics quality availability, timeliness, condition, and return and their direct impact on customer loyalty. Moreover, there is a need for more empirical studies that explore how cross-channel consistency affects long-term customer retention and competitive advantage in the fashion retail industry (Verhoef et al., 2015). While the Omnichannel Customer Experience (OCE) Theory highlights the need for seamless cross-channel consistency, there is still a lack of a unified framework addressing how specific logistics service quality dimensions availability, timeliness, condition, and return affect customer loyalty in fashion retail (Cotarelo et al., 2021). This study aims to bridge this theoretical gap by developing a more comprehensive understanding of omnichannel logistics service quality and its influence on consumer behavior. The main purpose of that study is, therefore, analyzing the logistics service quality of omnichannel purchasing scenario considering under four factors availability, timeliness, product condition, and returns and examine impact of the customer loyalty.

2. Methods

Figure 01 illustrates the effect of omnichannel logistics service quality on customer loyalty in the Sri Lankan fashion retail sector. There are four independent variables: the availability, timeliness, product condition, and returns, meanwhile the dependent variable is customer loyalty.

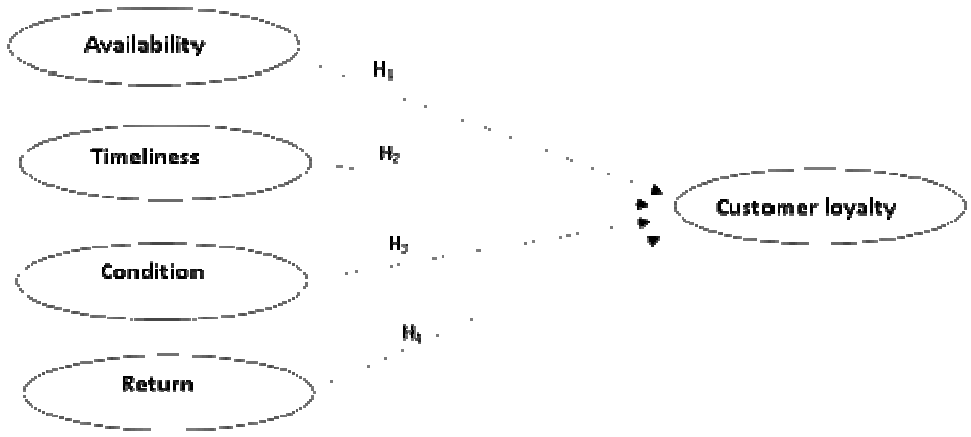

Figure 01. Conceptual Framework
Source: Developed for the study (2025)

According to Mainardes et al., (2020) Customer Loyalty can be defined as an attitude that refers to the individual's overall attachment to the brand or the company. Another definition is "Loyalty can be defined as an attitude that refers to the individual's overall attachment to the brand or the company"(Hamouda, 2019,p.613). Timeliness means speed and accuracy of the order delivered, including meeting promised delivery dates (Cotarelo et al., 2021). According to Derhami et al., (2021) availability concern to related products are stock and accessible to the purchase when customer needed. Condition represents the quality and intact state of products upon delivery. Final independent variable is return. Under the return variable , process by which customers send back purchased products through various channels, including physical stores, collection points, or postal services(De Borba et al., 2020).Another definition for that Encompasses the ease and efficiency of the product return process across channels(Cotarelo et al., 2021).

2.1 Hypothesis

Omnichannel product availability ensure the customer can easily access to the product through online or offline without any disturbance (Chen et al., 2019). This ability directly affects to the customer loyalty. If this hypothesis is supported by the research findings, it implies that investing in improving the quality of availability provided by omnichannel could lead to increased customer loyalty. Then, the organizations can increase the logistics service quality of the omnichannel availability to improve

customer loyalty for their product and services. The reasons are creating strong bond with customer and brand, reduce the switch behaviors from customers (Chen et al., 2019).
H_1: There is a positive impact of Availability on customer loyalty

Timeliness in an omnichannel means the promptness and speed with which services, products, or information are delivered to customers across multiple channels like online and offline. This includes real-time stock updates, speedy order processing, quick delivery, and timely responses to customer inquiries. Omnichannel timelines directly affect to the customer loyalty because enhancing customer satisfaction, building trust, and creating a seamless and efficient customer experience. For instance, a study analyzing logistics service quality (LSQ) across various omnichannel purchasing scenarios found that timeliness was the most crucial factor influencing customer satisfaction, which in turn positively affected customer loyalty(Chen et al., 2019).
H_2: There is a positive impact of Timeliness on customer loyalty

Condition means simply how the product arrived for the customer, whether it comes undamaged, clean, based on online description. Based on fashion retail sector it means clothes without wrinkled, stained, or defective upon delivery(Bernon et al., 2016). The prove that condition affect customer loyalty because Customer repeat purchase, trust based on the condition. although there is effect of condition on customer loyalty. Research suggests that product condition significantly affect customer loyalty, as customers are more likely to make repeat purchases and develop trust in a brand when they consistently receive products in pristine condition.
H_3: There is a positive impact of Condition on customer loyalty

The idea of the return ability to return product without disturbance. This hypothesis indicates that when customers find it easy to return products, their loyalty level also increases. If the products easy to return, then the customers are more likely to have favorable minds toward the product or service or the organization. If there is a good return system, it helps to increase the customer loyalty.
H_4: There is a positive impact of Return on customer loyalty

2.2 Research design

This study seeks to provide a comprehensive analysis, contributing to theoretical knowledge and what it really means for the fashion retail sector using the descriptive research design. Because this research mainly collected the data based on online survey although it provides a snapshot of how customers experience these logistics factors in different omnichannel scenarios (Chen et al., 2019).

2.3 Research context

The research context means the specific background, geographical location that conducted the research or prepared the research. In this study conducted in the Sri Lankan context. This study based on the fashion retail sector in Sri Lanka. The research context in this study includes the unique socioeconomic, legal, technological, and cultural features of the Sri Lankan fashion retail sector. Firstly, in the socioeconomic context, dimensions such as income level and education level of the customers in the fashion retail sector. Furthermore, Sri Lanka's technological infrastructure, including internet connectivity, mobile phone penetration, and digital literacy rates influence both consumer interaction.

2.4 The Sample, Study Variables, Questionnaire Design and Data Collection

The population in this study is all citizens in Sri Lankan who are using the Omni channel. Therefore, the researcher selected a sample among this population it is 200 respondents who are using the Omni channel in Western province. Researchers used snowball sampling methods due to ensure the access to respondents who have relevant shopping experience without needing a formal sampling frame (Chen et al., 2019). The research conducts on 95% confidence. The data collection had happened from December 2024 to March 2025 from the individual customers in Western Province, Sri Lanka. The achieved sample consists of 208 questioners. Out of 208 questioners, 200 were usable. Six questioners were unable to use. The overall response rate was 96.1%. This study, therefore, uses PLS to process the data because of sample size is somewhat sufficient. Demographic data analysis has done through the SSPS and 76 respondents were government sector employees and that was 19.2%, 126 were private sector employees that was 31.8%. Nevertheless, 91 were represent the other sectors. The gender of the respondents was as follows, 137 respondents were female and 63 respondents were male. The questionnaire is composed of

two parts. The first part of the questionnaire was designed to operationalize key variables under the customer loyalty, availability, timeliness, product condition, and returns. The second part of the questionnaire asks demographic information about respondents. The four study constructs of the study i.e., timeliness, availability, product condition, and returns were operationalized as multi-item constructs. To measure logistics service quality under four dimensions (i.e., timeliness, availability, product condition, and returns) twenty items from Cotarelo et al., (2021) were used. To measure customer loyalty, six items from Chen et al., (2019) was identified. The questions were developed by using a five-point scale ranging from "1= strongly disagree" to "5= strongly agree".

3. Results

This section presents the descriptive analysis, beginning with an assessment of normality through skewness, kurtosis, the Kolmogorov-Smirnov test, the Shapiro-Wilk test, QQ plots, and histograms. Finally, the analysis of scale-based data related to the three main constructs is conducted using mean and standard deviation.

3.1 Normality of the data

Conducting further statistical analysis, it is crucial to evaluate the normality of each variable. As suggested by Pallant (2013), the Kolmogorov-Smirnov test revealed statistically significant results for all variables, indicating a strong adherence to normality. Descriptive statistics, including mean, standard deviation, skewness, and kurtosis, were examined for both scale and demographic variables.A negative skewness value further indicates a heavier left tail in the distribution. The descriptive statistics, including mean, standard deviation, skewness, and kurtosis, were analyzed for all variables as illustrated in table 1.

Starting with the mean values, most logistics service quality (LSQ) dimensions Timeliness (LSQTI: 3.903), Availability (LSQAV: 3.939), Condition (LSQCO: 4.1225), and Return (LSQRE: 3.889) have mean values above 3.8, indicating generally positive perceptions. The overall Logistics Service Quality (LSQ: 4.244) also reflects a strong agreement among *respondents*. Given that the midpoint of the five-point Likert scale is 3, these results suggest that respondents rated the logistics service quality favorably.

Table 1. Normality of the data

DESCRIPTIVES	MEAN	SD	SKEWNESS	KURTOSIS
Gender	1.69	0.466	-0.803	-1.370
Age	1.97	0.324	-0.513	6.639
Working Sector	2.23	0.525	0.199	-0.137
Education Level	2.94	0.508	-0.339	7.311
Average Monthly Income	2.43	0.896	0.696	-0.541
CL (Customer Loyalty)	4.2440	0.61999	-2.142	8.120
LSQTI (Timeliness)	3.9030	0.58764	-1.561	6.428
LSQAV (Availability)	3.9390	0.67851	-1.263	2.907
LSQCO (Condition)	4.1225	0.64772	-1.975	5.230
LSQRE (Return)	3.8890	0.75786	-0.996	1.711

Source: Survey data (2025)

Analyzing skewness, all logistics service quality variables exhibit negative skewness, indicating that responses were concentrated toward the higher end of the Likert scale, meaning respondents tended to agree or strongly agree with the statements. The Logistics Service Quality (LSQ: -2.142) and Condition (LSQCO: -1.975) show the strongest negative skewness, suggesting a strong tendency toward agreement. The Logistics Service Quality (LSQ: 8.120) and Timeliness (LSQTI: 6.428) show particularly high

kurtosis, implying a strong central tendency and fewer neutral responses. The analysis suggests that respondents generally held strong and positive opinions about logistics service quality. The high mean values and negatively skewed distributions indicate high levels of agreement, while the peaked distributions suggest response consistency with limited neutral or extreme values.

3.2 Validation of Measurement Properties

To validate the measurement properties in this study, employed Structured Equation Modeling (SEM). SEM consists of two main components: the Measurement Model and the Structural Model. This statistical approach allows for the exploration of both direct and indirect relationships involving one or more independent latent variables and one or more dependent latent variables (Ringle et al., 2012). Through SEM, various multivariate analyses can be performed, including regression analysis, path analysis, factor analysis, canonical correlation analysis, and growth curve modeling (Urbach &Ahlemann, 1989). Given that our study includes both reflective and categorical constructs, we utilized Smart PLS 4.0. Ring et al., (2017) evaluating both the measurement and structural models. This software enabled us to assess the psychometric characteristics of the measurement model and to estimate the parameters of the structural model effectively.

3.3 Measurement Model Assessment

The measurement model is crucial for evaluating the quality of the constructs utilized in the study. The assessment of quality begins with analyzing factor loadings and proceeds to evaluate Construct Reliability and Construct Validity. A graphical representation of the measurement model will be provided to enhance understanding of this current study, The effect of omnichannel logistics Service Quality on Customer Loyalty. Within the measurement model, statistical relevance to factor loadings, reliability, validity, and multicollinearity is determined to evaluate the quality of the constructs as figure 2.

3.4 Unidimentionality

Unidirectionality is an essential aspect of factor analysis. As outlined by Sarstedt et al., (2021)factor loading refers to the extent to which each item in a correlation matrix is related to the identified principal component. Factor loadings can vary between -1.0 and +1.0, where values closer to extreme suggest a more robust relationship between items within the same construct. As illustrated table 2 below provides a visual representation of the factor loadings across the various dimensions of Logistics service quality, such as availability, timeliness, condition, and return of the product. As illustrated in table 2, it was shown that all the dimension of Logistics service quality are availability, timeliness, condition, and return had greater than 0.7-factor loading points. Thus, Also, all the items under each dimension had loading points above the recommended level of 0.7.

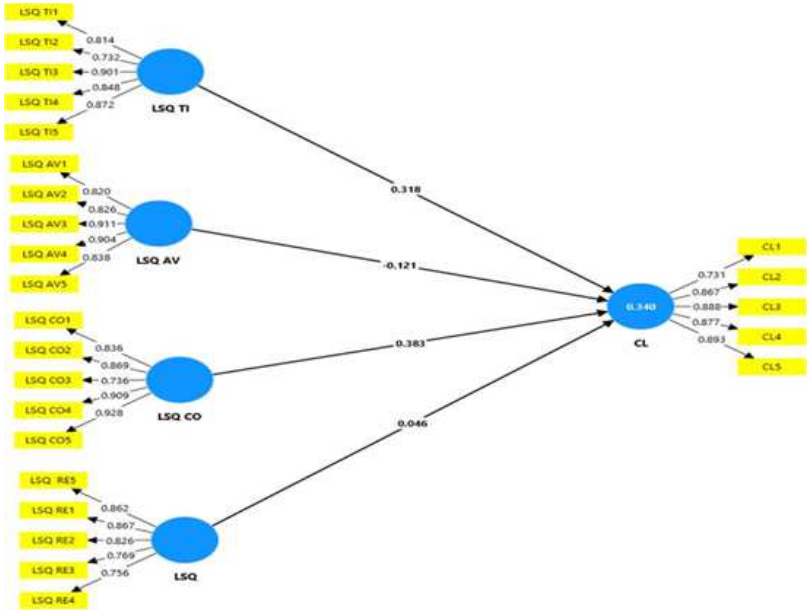

Figure 2. Structural Model
Source: Survey Data (2025)

Table 2. Factor Loadings of Logistics Service Quality

ariable	**Factor Loading**	**Variable**	**Factor Loading**
Availability		Condition	
AV1	0.820	CO1	0.836
AV2	0.826	CO2	0.869
AV3	0.911	CO3	0.736
AV4	0.904	CO4	0.909
AV5	0.838	CO5	0.928
Timeliness		Return	
TI1	0.814	RE1	0.867
TI2	0.732	RE2	0.826
TI3	0.901	RE3	0.769
TI4	0.848	RE4	0.756
T15	0.872	RE5	0.852
Customer Loyalty			
CL1	0.731		
CL2	0.867		
CL3	0.888		
CL4	0.877		
CL6	0.893		

Source: Survey data (2025)

3.5 Reliability and Internal Consistency

As noted by Sarstedt et al., (2021) reliability statistics are essential to confirm that outcomes are stable and reproducible across different measurement instances. Following the guidance of Hair, (2016), the dependability of the present study was examined as illustrated in table 3. Internal consistency serves as a measure of how closely related the items in an instrument are to one another (Hair, 2016). Among these, Cronbach's Alpha is the most commonly utilized reliability metric, with a threshold of 0.7 generally recognized as indicative of sufficient reliability.The results of these reliability assessments are visually represented in Table 3.

Table 3. Internal consistency

	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
LSQ Availability	0.914	0.937	0.935	0.741
LSQ Timeliness	0.892	0.910	0.920	0.698
LSQ Conditions	0.910	0.937	0.933	0.737

LSQ Return	0.894	1.032	0.909	0.668
Customer Loyalty	0.906	0.920	0.930	0.728

Source: Survey data (2025)

As illustrated in table 3, above shows all of Cronbach's alpha values for Logistics service quality dimension of availability, timeliness, condition, and return lie between 0.892 and 0.914 exceeding the threshold level of 0.7. In addition, the statistics for composite reliability have fallen between 0.909 and 0.935, further proving that the items used to measure each dimension are good enough to measure that particular dimension.

3.6 Discriminant Validity

Discriminant validity maintains that valid measures of distinct constructs should show minimal relationships when they are truly unique (Bagozzi et al., 1991). Moreover, it has been observed that summated scales may exhibit some correlation with measures that, while conceptually different, are still somewhat related (Hair, 2016). Heterotrait-Monotrait Ratio (HTMT Ratio is used to determine the Discriminant validity. According to the findings of (Hair, et al., 2016) and (Henseler et al., 2015), the discriminant validity of the current study was determined considering the (HTMT) value < 0.85 as the threshold level. Therefore, the data in the table 4 shows the results of discriminant validity under the HTMT method as follows.

Table 4. Heterotrait-Monotrait Ratio (HTMT Ratio)

	CL	**LSQ**	**LSQ AV**	**LSQ CO**	**LSQ TI**
Customer Loyalty					
LSQ Return	0.420				
LSQ Availability	0.464	0.859			
LSQ Conditions	0.577	0.765	0.799		
LSQ Timeliness	0.552	0.800	0.905	0.789	

Source: Survey data (2025)

3.7 Model Fit Indices

The overall fit of the structural model was assessed to determine how well the proposed relationships among latent constructs align with the research data before proceeding with hypothesis testing. Evaluating model fit is essential to ensure the validity and robustness of the structural model.

Table 5. Model Fit

	Saturated model	**Estimated model**
SRMR	0.125	0.125
d_ULS	5.043	5.043
d_G	2.922	2.922
Chi-square	2758.071	2758.071
NFI	0.572	0.572

Source: Survey data (2025)

A widely accepted criterion for model fit assessment is the Standardized Root Mean Square Residual (SRMR), which should be below 0.08 to indicate a good fit. The results show an SRMR value of 0.125

for both the saturated and estimated models, suggesting that the residual error exceeds the acceptable range, indicating a weaker model fit. The Normed Fit Index (NFI), which assesses the model's comparative fit, is 0.572. Since the ideal threshold for an acceptable fit is 0.90, this value indicates that the model fit is relatively low. In summary, the model fit indices indicate that the structural model does not provide an optimal representation of the data, suggesting the need for potential modifications before proceeding with hypothesis testing.

Table 6. Coefficient of Determination (R^2)

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
CL	0.340	0.390	0.097	3.513	0.000

Source: Survey Data (2025)

In line with the research objectives and research questions, the four main hypotheses were derived to measure the direct relationship between Logistics service quality and Customer Loyalty. According to the detailed explanation of each of the hypotheses, it can be illustrated as follows. Hypothesis 1 was formulated to test whether the effect of omnichannel dimension of logistics service quality availability on customer loyalty, with special preference to the fashion retail sector. It was revealed that there is a significant positive effect of omnichannel logistics availability on customer loyalty. There is enough evidence to conclude that the t-value of 8.756 along with the p-value of 0.000. in addition, the data on the effect size of 0.121. Hypothesis 2 was developed through careful investigation of whether timeliness as a sub- dimension of logistics service quality negatively effects customer loyalty. The t-value is 3.795, and the p-value is 0.003, comes under the hypothesis that timeliness has a positive effect on the customer loyalty. This hypothesis was aimed to test the effect of condition as a sub-dimension of logistics service quality on customer loyalty. The t-value is 2.372 and the p-value is 0.018 suggesting that there is enough evidence to conclude that condition has a statistically significant positive effect on customer loyalty. Further, the path coefficient is 0.383. Hypothesis 4 was formulated to test whether the return of the product positively effects on customer loyalty. It was revealed that there is no significant positive effect of return on customer loyalty. There is enough evidence to conclude that the lower t-value of 0.247 along with the p-value of 0.805. Finally, concluded that there is a negative effect of return on the product on customer loyalty.

4. Discussion

This research gives both theoretical and practical implications by contributing to the academic understanding of how omnichannel logistics service quality influences customer loyalty, particularly in the fashion retail sector. The study enhance knowledge on cross- channel integration, giving a foundation for future research in areas such as digital retailing and consumer behavior (Chen et al., 2019). Practically, it gives fashion retailers in maximizing their omnichannel strategies to create a seamless customer experience, ultimately fostering stronger customer loyalty (Bernon et al., 2016). Not only that, but the findings also provide as a valuable resource for academicians, enabling them to educate future professionals and motivate further research on emerging omnichannel trends and best practices. This research holds significant implications for policymakers by giving insights into how omnichannel logistics service quality influences customer loyalty, ultimately contributing to economic growth and market competitiveness (Cotarelo et al., 2021). Policymakers can use these findings to develop correct regulations on return and exchange policies, pricing transparency, and data protection, ensuring a seamless and high-quality service experience across online and offline channels (De Borba et al., 2020). By fostering technological innovations and setting industry standards, they can make an environment that enhance consumer trust, encourages business growth, and strengthens the overall competitiveness of the fashion retail sector (Chen et al., 2019). Not only that, but these insights also help the development of policies that reduce negative societal impacts while promoting sustainable and customer-centric retail practices (Hamouda, 2019). This research has significant managerial implications, particularly for business leaders navigating the competitive retail landscape. By understanding the impact of omnichannel

logistics service quality on customer loyalty, managers can create informed decisions to increase operational efficiency, optimize logistics, and enhance inventory management (Verhoef et al., 2015). Implementing seamless omnichannel strategies allows businesses to offer faster shipping, reduce stockouts, and elevate service quality, ultimately strengthening customer relationships and fostering long-term loyalty. Not only that additionally, by leveraging these insights, managers can help to business sustainability by creating a customer-centric approach that ensures continued growth and competitiveness in the evolving fashion retail sector (Lemon & Verhoef, 2016).

4.1 Limitation and recommendation

This research extends the current knowledge related to omnichannel logistics service quality. Under normal circumstances, high logistics service quality positively impacts customer loyalty. While analyzing this impact, a few limitations were identified. First, this study focused on assessing omnichannel logistics service quality using consumers from the fashion retail sector in the Western Province. Future researchers can explore other industries, such as supermarket sector, different electronic devices selling industries to broaden the understanding of omnichannel logistics service quality. Second, future studies can investigate additional dimensions of omnichannel logistics service quality, such as personalization, seamless integration across channels, and security aspects of digital transactions. Third, this study utilized a sample size of 200 respondents; future research can get larger sample to increase the accuracy and generalizability of the findings. The researchers used a convenience sampling strategy for data collection. However, future researchers are encouraged to adopt probability sampling methods to obtain more reliable and representative results and use qualitative methodologies to address future research in this area.

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Global Challenges and Digital Solutions: Communicating with Green Consumers in the Digital Era

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Abstract

Research background: Global environmental challenges, particularly climate change and depletion of natural resources, are significantly influencing the purchasing preferences of environmentally conscious consumers across different generational cohorts. Digitalisation has largely transformed the way brands communicate and opened up new opportunities for targeting eco-minded consumers. Shaped by the growing environmental crisis, Generation Z largely expects brands to not only provide sustainable products and services, but more importantly to communicate openly, authentically and transparently through various digital platforms.
Purpose of the article: The aim of the paper is to identify and analyze the key factors influencing the purchasing behavior of Generation Z in choosing green products, focusing on the role of digital communication in the decision-making process.
Methods: The research was conducted in the form of a quantitative questionnaire survey**, which** focused on identifying factors influencing the purchasing behaviour of green consumers in the digital era. The questionnaire also explored perceptions of sustainability and the impact of digitalisation on consumer habits. The data collected was processed and analysed using statistical methods.
Findings & Value added: Generation Z prefers digital campaigns that are transparent, authentic, visually appealing, and encourage interaction, especially through various digital channels. The paper offers recommendations for brands on how to effectively communicate with eco-minded Generation Z consumers. The paper also sets the stage for how companies can leverage digital solutions to promote sustainable consumer behavior with Generation Z.

Keywords: Environmental Communication, Generational Z, Environmental Consumer

JEL classification: M15, M20, M30, M31, Q56

1. Introduction

The current era is largely marked by limited natural resources as well as pressing global challenges such as climate change, biodiversity loss, air and water pollution, land degradation, deforestation, overexploitation of water resources, and increasing amounts of waste (Bhutto et al., 2023). These challenges, combined with a growing world population, are fundamentally changing the way we look at production and consumption, with a strong emphasis on sustainable and responsible management of natural resources. Changes in the global environment are significantly influencing consumer purchasing preferences across different generational cohorts, with the most pronounced impact on environmentally conscious consumers. Many studies confirm this trend. For example, the Voice of the Consumer Survey (PricewaterhouseCoopers, n.d.) reports that 85% of respondents feel the direct impact of climate change in their daily lives and consumers are also willing to pay an average of 9.7% more for sustainably produced products, despite the rising cost of living. This study reports that 46% of those surveyed prefer social media for their purchases, which appeals to the importance of using digital channels when reaching out to eco-conscious consumers. Similar findings are highlighted by Euromonitor International in its report (*Top Six Global Consumer Trends for 2024 according to euromonitor international*, n.d.), which finds that sustainability continues to maintain a key position in consumers' purchasing priorities across different

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generational cohorts. More than 60% of respondents actively seek to minimize their environmental impact while expecting companies to behave in a transparent and responsible manner. In this context, we can conclude that sustainability is moving from a marginal value to a competitive advantage that significantly influences brand trust and consumer loyalty. These findings point towards sustainability becoming a permanent part of the contemporary consumer's value system and also signal a profound transformation in which environmental responsibility is seen as one of the main pillars towards the company's success and credibility. In the wake of growing consumer emphasis on environmental responsibility and transparency, digitalisation plays a key role in how companies meet these expectations, particularly on the basis of communication. To a large extent, digitalisation has fundamentally transformed the way companies or brands communicate and has offered the space to reach out to eco-minded consumers in a personalised and targeted way. Companies that use digital platforms, social media or other online tools designed for transparent and authentic communication of their environmental initiatives to reach their audiences not only build trust and competitive advantage, but also strengthen their position in the market. Digitisation in the online space provides companies with the opportunity to communicate their activities, products or even commitments to their consumers in a fast, interactive and, above all, personalised way. This way of communicating ensures a continuous dialogue between the company and consumers. It can be said that digital communication is now increasingly being profiled as a key success factor for many companies, but especially from the perspective of environmentally conscious consumers.

1.1 Communicating with green consumers in the digital era

The growth of digital technology has become an integral part of consumers' digital lives. They have significantly changed not only the way companies communicate and reach out to their consumers, but also how customers themselves react and interact with companies. Most often, they use various digital channels such as web, mobile and social media to consume content, engage in interactions and make their purchases. Digital tools help companies optimise internal processes, use data efficiently and personalise their offerings to eco-conscious consumers. Author Chom (2024) points out that digital technologies can make consumers much more motivated to be more environmentally friendly in their everyday lives as well. With smart solutions such as smart homes, electric cars or systems for more efficient use of energy and resources, consumers can reduce their negative impact on the environment. At the same time, digital platforms and social networks open up the space for sharing, selling or exchanging products between consumers (C2C), but also between consumers and businesses (C2B), thus promoting the circular economy and reducing the consumption of new resources. In the context of the digital environment, the eco-consumer is acting as an active agent, seeking various sustainable solutions through digital platforms, actively participating in public debates and much more strongly preferring brands and companies that reflect environmental values. Naido states that the green consumer is an individual who is aware of the environmental impact of their purchasing decisions and actively seeks to minimise this impact. He or she prefers environmentally friendly products and services, thereby supporting the principles of sustainability in the long term (Naidoo, 2020). According to Kollárova and Kralovic (2022), green consumers consistently choose products to deliberately avoid those that may endanger their health while harming the environment during production, use or disposal. They also generate unnecessary waste, abuse animals in the production process, etc. In this way, eco-consumers not only protect the environment, but also promote ethical but especially sustainable principles throughout the value chain. Eco-consumers are increasingly using the online space, for example for shopping, as digital platforms provide them with a wealth of information about products (their origin, composition or certifications). They can make responsible decisions based on these options and easily compare offers. Nowadays, many e-shops approach their orders responsibly and use sustainable packaging and eco-friendly transport in their offer, thus reducing their environmental impact (Štofejová et al., 2023). A similar approach is reflected in another definition from the authors where they state that an eco-consumer is an individual who consciously follows green principles in their behaviour and purchasing decisions, while preferring environmentally friendly products over traditional products. (Deselnicu, Cioca, & Ioaniid, 2022). We can conclude that, based on the above definitions, the green consumer prefers products that are environmentally friendly and conform to the principles of sustainability. Currently, this target group is also directed by eco-design, which includes the use of renewable materials, reducing energy consumption and waste, as well as promoting recycling while maintaining functionality and simple aesthetics (Reichard & Martin, 2023). The authors Delmas and Colgan (2018) point to typologies of eco-consumers, which they categorize into 3 groups with regard to sustainability:

- Dark green consumers are actively engaged and consistently support green solutions,
- Brown consumers believe that individual behaviour does not have a significant impact on the environment and ignore green products in their consumption.

Based on the above, we can conclude that environmentally oriented consumers represent a diversified group that is shaped by a combination of value attitudes, individual motivation, and external factors influencing the practical implementation of green behaviour.

The authors distinguish between several generational cohorts, each of which has grown up in different historical as well as social and technological conditions. The oldest group is the so-called silent generation, followed by the post-war generation known as Baby Boomers (1946-1964), who are characterized by a preference for more traditional media, such as print, television, and direct mail, through which they most frequently consume media content (Ham & Chung, 2022). Next comes Generation X (1965-1979), which represents a bridge between traditional and modern consumer behaviour (Cagala & Babčanová, 2024), followed by Generation Y, also referred to as millennials (1980-1995), and then Generation Z (1996-2009), also known as zoomers or post-millennials. The youngest generation identified by the literature is the Alpha Generation - children born since 2010. This cohort is also often referred to as the 'glass generation' or 'screenagers', referring to their early and intense exposure to digital screens (Bernardes et al., 2022). In this paper, we focus on Generation Z, which is characterized by a strong orientation towards digital technologies, a constant online presence, as well as a sensitivity to areas such as sustainability, authenticity and social responsibility. Generation Z (1996-2010) has grown up in a digital world and is characterized by technological savvy, high levels of online activity and an emphasis on a personalized approach. As digital natives, they spend significant time online daily and expect quick, easy and authentic interactions with brands (George, 2024). The social environment also plays an important role - they see sustainability as a collective commitment, not just a personal choice. Generation Z has grown up in an era of climate crisis, digitalisation and increasing global awareness, which is why they see environmental issues as key to their future. According to research by GlobeScan and BBMG (Stewart, 2025), conducted in 31 markets, the results show that it is Generation Z that carries the greatest personal and emotional burden associated with climate change. As many as 73% of respondents expressed very strong concerns about environmental damage due to human activity. Almost half (49%) say they are experiencing climate change directly - more than any older generation. According to a report by First Insight (Insight, n.d.), up to 73% of those surveyed are willing to pay 10% more for sustainable products, and 62% of Generation Z shoppers are willing to buy green products specifically. It can be concluded that Generation Z prefers organic products if they meet their quality requirements, are affordable and functional at the same time. They have grown up surrounded by technology, constant access to social networks, streaming services or online applications, which they take for granted. Digital technologies and tools are a natural part of their daily life, communication but also entertainment. Their expectations are for fast access to information, and they emphasise the functionality and efficiency of the technologies they use. They value authenticity, flexibility and meaningfulness (Generation Z, n.d.)

From the above, it can be concluded that digital technologies and the online environment are having a major impact on eco-conscious consumers, with Generation Z playing a key role in this process. As a tech-savvy and value-sensitive group, they respond to various environmental challenges. With their constant online connectivity and sensitivity to sustainable topics, they expect transparent communication from brands. For companies, this presents an opportunity but also a challenge to effectively approach Generation Z whether through offering eco-oriented solutions that are largely supported by an authentic value frame using digital tools.

2. Methods

Based on the findings from the theoretical background, which pointed out the specifics of the ecological behaviour of Generation Z and the role of digital technologies in this process, we set the following research question and two hypotheses, which we tested within the framework of the conducted questionnaire survey.

Research question:

VO: Does the age of the respondent influence their use of digital platforms and their perception of the impact of digitalisation on environmental behaviour?

Hypothesis:

H1: There is a statistically significant relationship between the frequency of use of digital platforms and the perceived impact of digitalization on the environmental decision-making of Generation Z.

H2: Respondents aged 18-30 perceive digitalisation as more important for green behaviour than older respondents.

The research was conducted in the form of a quantitative questionnaire survey**, which** focused on identifying factors influencing the buying behaviour of green consumers in the digital era. The questionnaire was distributed through digital platforms and social networks in which the data collected was processed and analyzed using statistical methods. The total research population consisted of 211 respondents who participated in an online questionnaire survey focusing on perceptions of digitalisation and green consumer behaviour. The total sample was heterogeneous in terms of age, with the largest proportion of respondents aged 61 years and over (27.5%) and 51-60 years (20.4%). The 25-30 age group had the lowest representation (5.7%). Women were strongly represented at 81.5% compared to men at 18.5%. In terms of education, respondents with a first and second degree dominated with 30.3% and 34.1% respectively, while categories such as higher vocational, doctoral or postgraduate studies were also represented. Respondents were from Slovakia and regional diversity of the sample was also ensured, including all regions.

This suggests an age-diverse research population, but for the purposes of this paper we focus exclusively on Generation Z in the following sections. This target group is of particular interest because of its heavy use of digital technologies, as well as its specific approach to environmental issues that distinguish it from other age cohorts.

Statistical methods appropriate to the nature of the variables and research assumptions were applied in the quantitative analysis of the data obtained. Spearman's correlation, a non-parametric alternative to Pearson's correlation coefficient, was used to evaluate the relationship between the frequency of use of digital platforms for obtaining information about organic products and the perception of the impact of digitization on the organic decision-making of the selected Generation Z. Spearman's correlation is a non-parametric alternative to Pearson's correlation coefficient, and is particularly suitable for ordinal variables, which may not meet the assumption of normality of distribution. The correlation analysis was performed by calculating the Spearman's coefficient (rho) and the corresponding p-value determining the statistical significance of the observed relationship.

To test the second hypothesis, which assumed the existence of a difference between age groups in the perception of the impact of digitalisation on environmental behaviour, an independent samples t-test was applied. This test focuses on comparing means between two independent groups and assumes an approximate normal distribution of the dependent variable in each group. The age variable was nominal, with the degree of subjectively perceived impact of digitization as the dependent variable. The test statistic (t-value) and p-value were assessed against a significance level of alpha = 0.05 to decide whether to accept or reject the hypothesis.

The formula used in calculating the t-test was in basic form:

$$t = (M1 - M2) / \text{sqrt}[(s1^2 / n1) + (s2^2 / n2)] \quad (1)$$

where M1 and M2 are the means of each group, s1^2 and s2^2 are their sample variances, and n1 and n2 are the numbers of respondents in each group.

All analyses were performed in Jamovi software, version 2.6.26, and data were coded in MS Excel.

3. Results and Discussion

This section of the paper analyses the data collected from the questionnaire survey, while also offering a discussion of the main findings in the context of the stated objectives aimed at the selected Generation Z.

The questionnaire survey was conducted from May 2025 in the form of an online questionnaire through various digital platforms and social networks, in which the data collected was processed and analyzed using statistical methods. All generational cohorts were reached in the questionnaire, for the purpose of this paper we will focus on the results of Generation Z. The aim of the survey is to identify the factors that fundamentally influence the purchasing behaviour and habits of different generations of customers in their purchase of eco-friendly products or services. The questionnaire also focuses on the perception of sustainability and the impact of digitalisation on purchasing behaviour. A total of 211

respondents participated and Generation Z was represented with 46 respondents Of these, 34 were female and 12 were male. The results of the survey conducted highlight various aspects that are typical for Generation Z. Although they are a generation often described as value-oriented and environmentally conscious, their preferences for purchasing organic products remain largely pragmatic**.** 76% of those surveyed think that price is considered a decisive factor in their purchases. This result reflects the fact that this generation is often still attending various educational institutions or are at the beginning of their working life. In a question aimed at finding out which factors influence their choice of organic, respondents mentioned availability 61% and product quality 61%. Generation Z also looks at composition, origin and also reviews of other customers. The survey results show that this generation actively seeks transparent information before buying organic products and does not settle for superficial product labels. Before buying, Generation Z is most likely to look for the composition and origin of the product 63 %, which we see as a particular interest of this generation to get sufficient information about where the product was produced, what raw materials were used and whether they were sustainable. Equally important to them are reviews from other users 63%. We conclude that for Generation Z, the experiences and opinions of other customers often carry more weight and social feedback is key for this generation. The third most frequently monitored factor was the environmental impact of the product, with 35% of respondents indicating the extent to which the product affects the environment from production, through use, to actual consumption. The majority of the respondents represented by Generation Z see digitalisation as an important tool to promote eco-friendly behaviour, as up to 43% in the questionnaire stated that digital technologies, such as different platforms, apps or media, strongly influence their decision-making and motivation to act in an eco-friendly way. A further 50% described its impact as partial, meaning that digitalisation has a wide reach and shapes environmental awareness, and only 6.5% did not perceive any significant change. After finding out the attitudes of Generation Z towards digitalization, we were interested in what type of ecological content appeals to them the most and motivates them to interact. Personal stories and people's experiences with the environment were the most frequently cited responses, accounting for 14.8%. This is mostly a format that appeals strongly for its authenticity and humanity. Visual communication also has a significant influence, with up to 14.2% of respondents indicating videos (documentaries, interviews and reports on sustainability) which shows the strong influence of visual communication among the surveyed generation. We can also see in the responses that this generation is looking for humorous content which accounts for 13.6%. Furthermore, infographics and visual data were found to account for 12.3% of the responses, confirming the interest in concise but clear visual infomation. Textual formats such as articles on environmental issues reached 7.4% of the cases, from which we can conclude that despite the online space, they still play an important role in building awareness of environmental issues. In addition to content, we also asked what media and platforms Generation Z uses most often to get environmental information. The results showed that social media and visual communication channels are predominant. Instagram scored the highest at 3.98%, recommendations from family and friends at 3.22%, and the Tik Tok platform was identified by 2.91% of respondents.

In order to test hypothesis H1, which hypothesized the existence of a statistically significant relationship between the frequency of use of digital platforms and the perceived impact of digitization on environmental behavior, we used Spearman's correlation. It was chosen due to the ordinal nature of both variables.

Table 1. Verification of the relationship between the use of digital platforms and perceptions of the impact of digitalisation.

Correlation Matrix			
		impact_digitisation	**digital_platforms**
impact_digitisation	**Spearman's rho**	-	
	df	-	
	p-value	-	
	N	-	
digital_platforms	Spearman's rho	0,141	-
	df	44	-
	p-value	0,350	-
	N	46	-

Note. * p < .05, ** p < .01, *** p < .001

Source: own elaboration (2025)

The results of the analysis indicated a weak positive correlation between the variables ($\rho = 0.141$), but this relationship was not statistically significant ($p = 0.350$, $N = 46$). This suggests that although there was a slight trend in the data indicating a relationship between more frequent use of digital platforms and higher perceptions of their impact on environmental behaviour, this relationship is not strong enough to be confirmed as statistically significant. Based on these results, we therefore reject the hypothesis. This is also consistent with the statement made by Kloppenburg et al. (2022).

To test hypothesis H2, we hypothesize that there is a difference in the perception of the impact of digitalization on ecological behavior between different age groups. To test this hypothesis, we used an independent samples t-test, comparing two age groups: younger Generation Z respondents aged 18-30 and older respondents aged 30 and over. The age variable was binary recoded for test purposes.

Table 2. T-test results for comparison of perceptions of the impact of digitization in age cohort Z and other age cohorts.

Independent Samples T-Test				
		Statistic	**df**	**p**
impact_digitisation	**Student's t**	-3.33	209	0.001
Note. H_a $\mu_{(0)} \neq \mu_{(1)}$				

Source: own elaboration (2025)

The results of the analysis showed a statistically significant difference between the groups compared ($t(209) = -3.33$, $p = 0.001$), strongly confirming that the age of the respondents influences their perception of the impact of digitalisation on environmental behaviour. Based on these findings, we can confirm hypothesis H2 that there is a statistically significant difference between younger and older respondents in how they perceive the benefits of digitalization for ecological decision-making. The results also suggest that Generation Z prefers interactive, fast-paced and visually appealing content that they actively consume through various digital platforms, which is basically suggested by Paro et al. (2021).

From the results obtained, we can conclude that although Generation Z perceives sustainability and green activities as an important role in their lives, the purchasing decision for green products is mainly influenced by price, availability and quality. They actively seek information about the origin and composition of products and rely on customer reviews and recommendations. The digital environment is key for this generation and social media and visual content in particular have a strong influence on their behaviour. The survey shows that Generation Z takes a rational but information-conscious approach to green behaviour. Companies should focus their communication on these aspects through various digital tools.

Conclusion

In the light of the growing importance of environmental issues and digitalisation, which are fundamentally influencing the behaviour of green consumers, it proves crucial to understand the specificities of Generation Z. This generation, growing up in a digital environment and shaped by the climate crisis, represents a key market segment. The research carried out shows that, although they tend to value sustainability, their decision-making process is largely influenced by pragmatic factors. From the results we can see that in terms of digital communication, the target group is strongly connected to the online environment, where they actively use various digital platforms, focusing most on social networks (Instagram and TikTok) and also on visual communication formats (videos, infographics, personal stories, etc.). To a large extent, authentic content, the human dimension and the visual appeal of the content can appeal to them. These factors greatly influence the perception of green activities or brands themselves. Brands that can make their communication transparent, interactive and value-consistent have a great chance of success with Generation Z. In this way, they can secure their loyalty and trust in two-way communication. In terms of the hypotheses tested, the research confirmed a statistically significant difference between younger (Generation Z) and older respondents in how they perceive the impact of digitalisation on green decision-making (H2). Generation Z reflected more strongly on the positive impact of digitalisation, indicating the importance of digital tools in shaping their attitudes and behaviour. Conversely, the relationship between frequency of use of digital platforms and perceived impact on ecological behaviour (H1) was not statistically confirmed, suggesting that intensity of use of digital tools may not automatically correspond with higher ecological awareness - rather, the **content, form and quality of communication** is crucial.

The results both highlight and confirm the growing importance of linking environmental issues with digital communication, especially for Generation Z. Effective communication in the digital environment must take into account not only the target group's technological habits, but also their value preferences and the way they perceive societal challenges. Generation Z is a strategically important target group whose loyalty companies can win if they can combine sustainability with meaningful but above all credible digital communication.

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Resources

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Analysis of Brand Awareness Level and Its Relationship with the Determinants of Brand Equity

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Abstract

Research background: The brand plays a crucial role in the consumer decision-making process, with brand awareness representing a fundamental prerequisite for the development of brand equity. Previous research has primarily focused on the relationship between brand equity and purchasing behavior, while less attention has been paid to analyzing the internal relationships among the individual determinants of brand equity.
Purpose of the article: The aim of this study is to identify the level of brand awareness of a selected brand in the giftware industry and to analyze the relationships between brand awareness and four key dimensions of brand equity – perceived value, brand loyalty, perceived quality, and brand trust.
Methods: The research was conducted using a quantitative questionnaire survey on a sample of 417 Slovak respondents. Data collection was carried out online and involved the measurement of latent variables. To analyze the relationships between variables, Spearman's rank correlation coefficient was applied. Brand awareness was assessed through four specific dimensions of brand awareness.
Findings & Value added: The results revealed statistically significant positive relationships between brand awareness and all examined aspects of brand equity. The strongest correlations were observed between brand awareness and loyalty, followed by perceived value, perceived quality, and brand trust. This study contributes to the existing body of knowledge on brand equity by offering insights into its internal structure and provides practical recommendations for brands seeking to strengthen their market position through strategic brand awareness development.

Keywords: Brand awareness, Brand equity, Loyalty, Trust

JEL classification: M31, M37

1. Introduction

The literature indicates that a brand is a unique identifier that functions as a barometer of product performance (Puspitasari & Dwijayanti, 2019), helping to differentiate and protect businesses from their competitors (Putra & Razi, 2020). Furthermore, He et al. (2017) suggest that brand attractiveness facilitates brand communication, which enhances the customer experience. Accordingly, such a positive experience increases the customer's ability to visualize and internalize the product, thereby strengthening brand awareness. Brand awareness, as defined by Bilgin (2018), refers to the ability of customers to recognize and recall a brand that belongs to a specific product category, consistently across various contexts. According to Alexandra & Cerchia (2018), brand awareness plays a crucial role in the consumer decision-making process. This is primarily because it serves as the initial stage during which the brand becomes part of the consumer's consideration set, whether through recognition or recall.

Brand recall and brand recognition are integral components of brand awareness. Brand recall refers to the consumer's ability to accurately remember the brand name upon encountering the product, while brand recognition refers to the consumer's ability to identify the brand whenever its symbol is present (Cheung et al., 2019). Aaker (2020) proposed four levels of brand awareness. In addition to recall and recognition, he identified "Top of Mind" – the situation in which the brand is the first to come to mind when discussing a product category or when prompted – and "Unawareness" – when consumers do not know or have never heard of the brand.

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Previous studies have mainly focused on how brand awareness influences consumer preferences and purchase decision-making (Barreda et al., 2015), the prediction of purchasing behavior (Lee, 2014), brand perception motivation, attitudes, and preferences (Lee, 2014), as well as consumers' attitudes and purchase intentions (Zeqiri et al., 2025; Gburová et al., 2015). Despite the extensive research on brand equity, which largely concentrates on its impact on purchasing behavior, there remains a lack of knowledge regarding the internal relationships between the components of brand equity. Specifically, there is insufficient investigation into how the level of brand awareness affects other determinants such as perceived value of the brand, brand loyalty, perceived brand quality, and brand trust. Identifying these relationships can provide brands with valuable insights for the strategic development of brand equity beyond one-time purchases.

In this study, we therefore pose the following research question:

RQ: How is the level of brand awareness related to the perception of key brand equity determinants?

The aim of this paper is to determine the degree of consumer knowledge regarding a selected brand from the perspective of various dimensions of brand awareness and to examine how brand awareness is associated with selected aspects of consumer brand perception. For the purpose of this paper, the studied brand will be referred to as "XX" to ensure its anonymity. The brand operates in the retail sector, specifically in the giftware segment.

The structure of this paper is divided into several parts. First, we present the development of hypotheses. This is followed by a description of the research methods, including the sample. Subsequently, the research results are presented and further discussed. Finally, the paper outlines theoretical and practical implications, limitations of the study, and recommendations for future research directions.

2. Hypotesis Development

Brand awareness can be defined as a tool that emphasizes the establishment and development of familiarity and recognition of a specific brand among a target audience (Foroudi et al., 2014). Based on the following scientific insights into brand awareness and various aspects of brand perception, we formulate the research hypotheses.

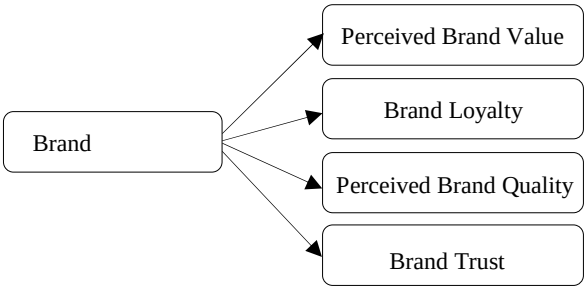

Figure 1. Research framework
Source: own processing

Perceived Brand Value

Perceived value refers to the overall assessment of a product's utility by consumers based on their perception of personal effort and benefit (Chae et al., 2020). More specifically, consumers perceive value when the perceived benefit exceeds the price paid for the product (Sinha & Verma, 2020). Findings from several authors, such as Elsamena (2015), confirm that brand awareness and brand image positively influence perceived value, as a well-known brand reduces the costs and mental effort associated with information processing, thereby enhancing the perceived performance of the brand. As a result, the perceived benefits of the brand outweigh the perceived costs, leading to an overall increase in perceived value. Consistent with these findings, research in the field of technology has also shown that brand image and brand knowledge have a strong positive impact on consumers' perceived value of a given technology (Morgan-Thomas & Veloutsou, 2013). Based on this discussion, we formulate the following hypothesis:

H1: *It is assumed that brand awareness is statistically significantly and positively related to perceived brand value.*

Brand Loyalty

Brand loyalty represents the relational bond between the customer and the brand (Coelho et al., 2018). It reflects the consumer's tendency to remain committed to a brand and indicates an intention to repurchase (Atulkar, 2020). According to Aljumah et al. (2021), brand loyalty begins to develop as consumer preference for a specific brand increases. Lee & Kim (2020) note that at the highest level of brand awareness, consumers experience a sense of ownership and satisfaction, which signals strong brand loyalty. Multiple authors (Kim et al., 2018) have found that brand awareness significantly influences loyalty and serves as a prerequisite for establishing a long-term relationship. Alalwan (2018) emphasizes that when entering a new market or launching a new product, building brand awareness is essential, as it can lead to positive customer loyalty. As Sürücü et al. (2019) argue, a customer's personal experience with a product or brand can evolve into loyalty if the experience is positive and consistent. Based on this discussion, we formulate the following hypothesis:

H2: *It is assumed that brand awareness is statistically significantly and positively related to perceived brand loyalty.*

Perceived Brand Quality

Perceived quality does not represent an objective measure of a product's functional or manufacturing quality; rather, it is a subjective evaluation based on the consumer's perception (Li et al., 2021). Research suggests a significant relationship between brand awareness and perceived quality (García-Fernández et al., 2018). As noted by Yang (2018), higher brand awareness leads to higher quality evaluations by customers. Similarly, Romaniuk et al. (2017) confirm a positive relationship between brand awareness and perceived quality. These findings are further supported by additional studies, which indicate that increased brand awareness directly contributes to enhanced perceived quality (Sürücü et al., 2019; Chi et al., 2020). Based on these findings, we formulate the following hypothesis:

H3: *It is assumed that brand awareness is statistically significantly and positively related to the perceived quality of the brand.*

Brand Trust

Brand trust refers to the consumer's willingness to believe that the brand will fulfill its stated promise (Feng et al., 2023). According to Lee & Rim (2017), high brand knowledge contributes to building customer trust and, consequently, enhances perceived quality. Based on this discussion, we propose the following hypothesis:

H4: *It is assumed that brand awareness is statistically significantly and positively related to brand trust.*

3. Methods

We opted to conduct a quantitative research study. The research instrument was an anonymous questionnaire designed to collect relevant data concerning brand awareness of a giftware brand, which will be referred to as "XX" throughout this paper in order to ensure the protection of its identity.

The questionnaire was structured into three thematic sections. The first section focused on the demographic characteristics of the respondents, which were used to describe the composition of the sample. The second section aimed to assess the level of brand awareness regarding brand "XX." This section included four questions, one of which served as a screening question. If respondents were unable to recognize the brand based on its logo, their participation in the survey was terminated at that stage. The third section examined selected aspects of brand perception – brand awareness, perceived brand value, brand loyalty, perceived quality, and brand trust. The items measuring the latent variables were adapted from validated research studies and tailored to the context of this study.

All items were measured using a five-point Likert scale (ranging from 1 – "strongly disagree" to 5 – "strongly agree"). Data collection was conducted online using a convenience sampling method. The dataset was subsequently tested for normality using the Shapiro-Wilk test. To test the research hypotheses, Spearman's rank correlation coefficient was employed.

Table 1. Latent and manifest variables

Latent variables		Manifest variables	Source
Brand Awareness (BA)	BA-1	When I think of giftware products, brand 'XX' is one of the first that comes to mind.	Sinha & Verma (2018)
	BA-2	Brand 'XX' is a giftware store with which I am very well acquainted.	
	BA-3	I am able to recognize brand 'XX' among other competing giftware retail chains.	
Perceived Brand Value (PV)	PV-1	Brand 'XX' offers good value for money.	Su & Chang (2017); García-Salirrosas (2024)
	PV-2	Considering all factors (price, time, and effort), brand 'XX' is a good choice for purchase.	
	PV-3	Purchasing products from brand 'XX' brings me satisfaction.	
Brand Loyalty (BL)	BL-1	Brand 'XX' is my first choice when I need giftware products.	Quaye et al. (2022)
	BL-2	Overall, I enjoy shopping at the 'XX' retail chain.	
	BL-3	I am willing to recommend brand 'XX' to others who are in need of giftware products.	
Perceived Brand Quality (PQ)	PQ-1	Brand 'XX' is better than other giftware retail chains.	Akoglu & Özbek(2022); Rehman & Elahi (2024)
	PQ-2	Brand 'XX' offers high-quality products.	
	PQ-3	The products of brand 'XX' meet my expectations.	
Brand Trust (PT)	PT-1	I trust brand 'XX'.	Akoglu & Ozbek(2022); Samarah et al. (2021)
	PT-2	Brand 'XX' provides everything I expect from a purchase.	
	PT-3	I can always rely on brand 'XX'.	

Source: own processing

The initial research sample consisted of 432 respondents. However, 15 individuals did not recognize the brand even when presented with its logo and were therefore excluded from further analysis. As a result, the final sample subjected to statistical analysis comprised 417 respondents. The sample was predominantly female, with women representing more than two-thirds (68.8%) of participants, while men accounted for the remaining 31.2%. The average age of respondents was 39 years. In terms of economic activity, the sample encompassed key income-generating segments of the market.

4. Results

4.1 Results of Brand Awareness Testing

Brand awareness of "XX" was assessed using four questions, based on the dimensions of brand awareness as defined by Aaker (2020). All participants who took part in the survey, i.e., a total of 432 respondents, were included in this part of the analysis.

Based on the results of the open-ended question: *"When you hear the term 'giftware products,' which retail brand comes to your mind first?"*, it can be stated that brand "XX" dominates spontaneous brand recall among respondents. Variants of the brand name appeared a total of 196 times in the responses, representing 45.37% of all answers from the original sample of 432 respondents. This outcome indicates that brand "XX" possesses strong mental availability and, according to Aaker's (2020) model of brand awareness dimensions, occupies a *Top of Mind* position in consumers' minds when they think of the giftware category. The second most frequently mentioned brand and its variants appeared in only 4.17% of responses, highlighting the significant dominance of brand "XX" in this segment. Several other brands were mentioned, but with considerably lower frequency.

Responses to the follow-up question: *"If you needed to buy alcohol, a gift basket, gourmet products, etc., for a celebration, which retail brand(s) would come to your mind?"* further confirmed the strong positioning of brand "XX." All recorded variants of the brand name occurred 248 times, accounting for approximately 57.40% brand recall. This result suggests that the brand not only benefits from high spontaneous awareness but is also strongly associated in consumers' minds with specific types of celebratory and gift-related merchandise.

Based on the responses to the question *"Do you know 'XX' as a retail brand selling giftware products?"*, it can be concluded that brand "XX" enjoys high spontaneous recognition among respondents. As many as 91.2% of participants answered "Yes," clearly indicating that the brand is recognizable, well-established, and present in the public consciousness within the target group. Only 8.8% of respondents reported being unfamiliar with the brand, representing a very small proportion of the total sample of 432 survey participants. Regarding the final question *"Do you recognize brand 'XX' based on its logo?"*, results show that 96.53% of respondents—equivalent to 417 individuals out of 432—recognize the brand by its logo. Only 3.47% (15 respondents) indicated that they do not recognize the brand based on its logo.

4.2 Results of Hypothesis Testing

The results of the Shapiro–Wilk test indicate statistically significant deviations from normal distribution in all cases. The values of the test statistic (W) were below 0.9, and all p-values were significantly lower than 0.05, often ranging from 10^{-17} to 10^{-23}. These values provide strong evidence against normality. Therefore, for subsequent analyses, a non-parametric approach was adopted, specifically Spearman's rank correlation coefficient.

Table 2. Relationship between Brand Awareness and Perceived Brand Value

		PV-1	PV-2	PV-3
BA-1	Spearman's coefficient (ρ)	0.563	0.619	0.621
	t(415)	13.893	16.083	16.142
	p-value	<0.001	<0.001	<0.001
BA-2	Spearman's coefficient (ρ)	0.566	0.609	0.626
	t(415)	13.996	15.630	16.360
	p-value	<0.001	<0.001	<0.001
BA-3	Spearman's coefficient (ρ)	0.522	0.555	0.579
	t(415)	12.485	13.590	14.473
	p-value	<0.001	<0.001	<0.001

Source: own processing

According to Table 1, the strongest relationship was observed between spontaneous brand awareness (BA-1) and the belief that shopping for products from brand "XX" brings satisfaction (PV-3), with a Spearman's $\rho = 0.621$. This high correlation coefficient and the corresponding t-value ($t = 16.142$) suggest that if respondents can automatically recall the brand as one of their primary options in the giftware segment, they are also more likely to have had a personally positive shopping experience.

The results for BA-2 and PV-3 ($\rho = 0.626$) indicate a strong positive relationship between well-informed customers and their purchase satisfaction, confirming that brand familiarity increases the likelihood of favorable evaluations. Similarly, the correlations between BA-2 and PV-2 ($\rho = 0.609$) and BA-1 and PV-2 ($\rho = 0.619$) show that consumers who are familiar with the brand or recall it early also perceive it as a good purchasing choice in terms of price, time, and effort. This reflects the perceived efficiency and value of the brand from the consumer's perspective. The relationships between the BA variables and PV-1 range from $\rho = 0.522$ to $\rho = 0.566$, all of which are still strong and statistically significant (with t-values exceeding 12). This indicates that customers who have a well-established memory and identification with the brand are more likely to perceive it as a reasonable and valuable purchase. Based on these findings and the fact that all p-values are below 0.001, we conclude that Hypothesis H2 is accepted.

Table 3. Relationship between Brand Awareness and Brand Loyalty

		BL-1	BL-2	BL-3
BA-1	Spearman's coefficient (ρ)	0.715	0.662	0.675
	t(415)	20.812	18.020	18.766
	p-value	<0.001	<0.001	<0.001
BA-2	Spearman's coefficient (ρ)	0.700	0.705	0.683
	t(415)	19.805	20.267	19.054
	p-value	<0.001	<0.001	<0.001
BA-3	Spearman's coefficient (ρ)	0.655	0.601	0.633
	t(415)	17.678	15.321	16.665
	p-value	<0.001	<0.001	<0.001

Source: own processing

The strongest relationship was recorded between BA-1 and BL-1 with a correlation coefficient of ρ = 0.715. This value indicates a very strong positive correlation, suggesting that respondents who immediately associate brand "XX" with the giftware category also tend to prioritize it in their purchase decisions. The high t-value (t = 20.812) confirms the statistical significance of this relationship. BA-2 (brand awareness) consistently demonstrates strong correlations with all brand loyalty items, especially with BL-2, which measured joy in shopping (ρ = 0.705), and BL-1 (ρ = 0.700). This implies that the more familiar respondents are with the brand, the greater their personal satisfaction and positive attitudes toward it.

Variable BA-3 shows the strongest correlation with BL-3, which assessed the willingness to recommend the brand (ρ = 0.633). This finding suggests that the recognizability and distinctiveness of the brand support the diffusion of positive word-of-mouth and enhance customers' readiness to endorse the brand to others. All correlations are statistically highly significant (p < 0.001), and the t-values (ranging from 15.3 to 20.8) confirm the robustness and strength of these relationships. Based on these results, we conclude that Hypothesis H3 is accepted.

Table 4. Relationship between Brand Awareness and Perceived Brand Quality

		PQ-1	PQ-2	PQ-3
BA-1	Spearman's coefficient (ρ)	0.642	0.604	0.624
	t(415)	17.073	15.460	16.274
	p-value	<0.001	<0.001	<0.001
BA-2	Spearman's coefficient (ρ)	0.645	0.626	0.618
	t(415)	17.198	16.339	16.035
	p-value	<0.001	<0.001	<0.001
BA-3	Spearman's coefficient (ρ)	0.595	0.555	0.579
	t(415)	15.064	13.589	14.476
	p-value	<0.001	<0.001	<0.001

Source: own processing

Table 3 demonstrates a strong positive relationship between brand awareness of "XX" and its perceived quality, with all Spearman correlation coefficients reaching statistical significance (p < 0.001). This indicates that respondents who are familiar with the brand, can recall it spontaneously, or recognize it among competing retail chains also tend to perceive the brand as higher quality and more reliable.

The strongest correlation was observed between BA-2 (brand awareness) and PQ-1, the belief that the brand is superior to its competitors, with ρ = 0.645. This suggests that respondents with greater experience or familiarity with brand "XX" are more likely to consider it of superior quality compared to other brands in the market. The high t-value (t = 17.198) further confirms the reliability of this relationship. BA-1 also showed strong correlations with PQ-1 (ρ = 0.642) and PQ-3 (ρ = 0.624), indicating that high mental availability of the brand is associated with the belief that its products meet consumer expectations. BA-3 yielded slightly lower yet still strong correlations, especially with PQ-3 (ρ = 0.579), suggesting that the brand's visual and identifying features also influence quality perception, albeit to a lesser extent than brand familiarity or mental anchoring. These results allow us to accept hypothesis H4.

Table 5. Relationship between Brand Awareness and Brand Trust

		PT-1	PT-2	PT-3
BA-1	Spearman's coefficient (ρ)	0.620	0.605	0.593
	t(415)	16.111	15.470	14.993
	p-value	<0.001	<0.001	<0.001
BA-2	Spearman's coefficient (ρ)	0.617	0.633	0.610
	t(415)	15.962	16.700	15.686
	p-value	<0.001	<0.001	<0.001
BA-3	Spearman's coefficient (ρ)	0.541	0.529	0.512
	t(415)	13.124	12.704	12.360
	p-value	<0.001	<0.001	<0.001

Source: own processing

The results presented in Table 4 indicate that BA-1 exhibits the strongest correlation with PT-1, suggesting that consumers who spontaneously recall brand "XX" as the first option also perceive it as trustworthy and reliable. The correlations with PT-2, which assessed expectations from purchases (ρ = 0.605), and PT-3 (ρ = 0.593), are likewise strong, reflecting overall satisfaction and positive expectations associated with the brand. BA-2 shows a slightly higher correlation with PT-2 (ρ = 0.633) than other combinations, which may indicate that respondents who are more thoroughly familiar with the brand have actual experience with the brand fulfilling its promises and expectations. Correlations with PT-1 (ρ = 0.617) and PT-3 (ρ = 0.610) further confirm a significant relationship between brand familiarity and consumer trust.

Although BA-3 demonstrates slightly lower correlations (ranging from ρ = 0.541 to ρ = 0.512), these values still reflect moderate to strong relationships, suggesting that visual and identificatory recognition of the brand also contributes to consumer trust. All relationships are statistically highly significant ($p < 0.001$), and the corresponding *t*-values (ranging from 12.3 to 16.7) confirm the reliability and non-random nature of the findings. It can therefore be concluded that respondents who can spontaneously recall the brand, are familiar with it, and can recognize it among competing brands, also report higher levels of trust and satisfaction with purchasing its products. Based on these results, hypothesis H5 is accepted.

5. Discussion

We first examined the level of brand awareness of "XX" according to individual dimensions (Aaker, 2020). The results revealed that 45.37% of respondents recalled the brand at the *Top of Mind* level, 57.40% at the *Brand Recall* level, and as many as 96.53% at the *Brand Recognition* level. Only 3.47% of respondents fell into the *Unaware of Brand* category. These findings indicate that the brand under study has a well-established awareness and can be considered a well-known brand within the giftware retail sector.

This paper subsequently focused on examining the relationship between brand awareness and other brand perception dimensions. The findings consistently confirmed that the higher the level of brand awareness, the more positively customers perceive the brand. It was also shown that the more familiar a respondent is with the brand, the more they perceive it as advantageous, valuable, and satisfying. This aligns with the findings of Ilyas et al. (2020), who demonstrated a positive and significant connection between brand awareness and customer satisfaction.

Respondents who are familiar with the brand are also more likely to perceive it as higher in quality than its competitors. Similarly, the study by Susilowati & Sari (2020) demonstrated a significant positive relationship between brand awareness, brand association, perceived quality, and purchase intention. Strong awareness increases the likelihood that consumers will choose the brand, enjoy shopping with it, and recommend it to others. These findings also align with those of Rubalcava de León et al. (2019), who confirmed the direct positive impact of brand awareness on word-of-mouth communication.

Finally, the results indicated that respondents who can spontaneously recall and recognize the brand are also more likely to trust it and feel confident when making purchases. However, this finding contrasts with the results of Zeng et al. (2019), who found that the relationship between brand awareness and brand trust was insignificant in the context of Chinese smartphone brands among young Chinese consumers. The authors suggest that this may be due to ineffective marketing and advertising campaigns.

In contrast, the brand examined in this study is perceived more favorably across all examined aspects when respondents' level of familiarity is sufficiently high. These findings underscore the critical importance of building brand awareness as a key prerequisite for fostering positive consumer attitudes and behavior. In other words, brand awareness not only serves an informational function but also carries emotional and behavioral implications, as it is closely related to trust, purchase satisfaction, and the willingness to recommend or remain loyal to the brand.

Conclusion

This research has expanded the theoretical understanding of brand equity by demonstrating statistically significant relationships between brand awareness and its key determinants—perceived value, loyalty, quality, and trust. Unlike previous studies that primarily focused on consumer purchasing behavior, this study highlights that brand awareness exerts an intrinsic, reinforcing influence on other elements of brand equity, thereby playing a strategic role in building long-term customer relationships.

From a practical perspective, the findings underscore the importance of investing in brand awareness initiatives, which directly shape positive consumer perceptions and may lead to increased loyalty and brand trust. However, the study is not without limitations and its results should be interpreted with caution. The research focused on a single brand within a specific segment, and the structure of the sample limits the generalizability of the findings.

For future research, it is recommended to validate these relationships across different market segments and to employ structural equation modeling techniques. An interesting direction would also be to explore moderating and mediating variables (e.g., generational differences, level of consumer engagement, or previous brand experience), which may influence the nature and strength of the relationship between brand awareness and brand perception.

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Compulsive Buying in the Context of Socio-Demographic Characteristics

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Abstract

Research background: Compulsive buying represents a specific form of maladaptive consumer behavior that has been increasingly examined within the fields of psychology, marketing, and behavioral economics. While its psychological antecedents are relatively well-documented, less attention has been devoted to the influence of socio-demographic factors, particularly those related to early-life circumstances. Investigating these associations contributes to a more comprehensive understanding of the etiology of compulsive buying.
Purpose of the article: The objective of this study is to explore the relationship between compulsive buying tendencies and selected socio-demographic characteristics, with an emphasis on the educational level of the respondent's parents and the respondent's material conditions during childhood.
Methods: The research was conducted through a structured questionnaire administered to a sample of 154 respondents. The instrument included a validated scale measuring compulsive buying behavior, alongside items capturing a range of socio-demographic variables, such as age, gender, level of education, parental education, and subjective assessment of childhood material security.
Findings & Value added: Statistical analysis revealed significant associations between compulsive buying tendencies and two socio-demographic variables: maternal education level and perceived material well-being in childhood. These findings underscore the relevance of intergenerational and developmental influences in shaping consumer behavior patterns. The study contributes to the existing body of literature by identifying specific socio-demographic predictors of compulsive buying, thereby informing future empirical research and the development of targeted prevention strategies and educational interventions.

Keywords: Compulsive buying, Socio-demographic factors, Consumer behavior

JEL classification: M30, M31

1. Introduction

In today's consumer-driven society, compulsive buying has emerged as a significant behavioral concern that bridges the domains of psychology, marketing, and behavioral economics. Although much research has focused on the psychological mechanisms underlying compulsive buying, less attention has been devoted to the socio-demographic determinants and the role of early-life experiences in shaping such behaviors. Understanding the broader social, economic, and developmental contexts that contribute to compulsive consumption is crucial for forming comprehensive prevention strategies and interventions.

Previous studies have pointed to the importance of socio-demographic factors such as gender, age, income, education, and occupational status in predicting compulsive buying behavior. Furthermore, experiences of material deprivation during childhood and parental educational levels have been increasingly recognized as significant influences. Findings in the existing literature are often mixed, indicating the need for further empirical validation across different cultural and social contexts.

This study seeks to address this gap by investigating the associations between compulsive buying tendencies and selected socio-demographic characteristics, with particular emphasis on parental education

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and perceived material well-being during childhood. By exploring these relationships, the research aims to provide deeper insights into the intergenerational and developmental roots of maladaptive consumer behavior.

2. Theoretical background

Compulsive buying behavior is defined as a chronic, excessive, and uncontrollable urge to purchase goods, often leading to financial and emotional distress. Compulsive buying, also known as oniomania, falls under the category of obsessive-compulsive disorders (OCD). This behavior is characterized by repeated and uncontrollable purchases that serve as a maladaptive strategy for regulating emotions (Faber & O'Guinn, 1992). The phenomenon is associated with anxiety, depression, and low self-esteem, with individuals often feeling unable to control their spending (Ridgway et al., 2008). Compulsive buying is also considered an addiction, which may be linked to other forms of addictive behaviors such as brand addiction, where compulsive purchases are motivated by the need to gain control or alleviate negative emotions, leading to serious personal and social consequences (Mrad & Cui, 2020; Kellett & Bolton, 2009). Compulsive buying is one form of obsessive-compulsive behavior. It occurs in both women and men. The trigger for compulsive shopping is typically a specific impulse. Among the personal and psychological triggers, the most well-known are mental and emotional issues, including loneliness, stress, abandonment, boredom, and lack of recognition. Stimuli related to the product itself affect consumers through external features such as attractive packaging, color design, or fragrance. Similarly, advertisements promoting new, untested, or discounted products can stimulate impulses in consumers (Benkovič, 2007).

According to Heshmat (2018), customers may experience a rush of excitement while making a purchase. The euphoric experience does not stem from owning the product but from the act of buying itself. This rush of excitement often arises when seeing a desirable item and considering whether to buy it. Over time, this sense of excitement may become addictive.

In addition, the interplay between compulsive buying behavior and emotional intelligence has emerged as a critical area of investigation, suggesting that individuals with lower emotional awareness may be more susceptible to maladaptive purchasing patterns. Research indicates that emotional intelligence may serve as a protective factor against compulsive buying, as it enables individuals to better manage their emotional responses and make more informed consumer decisions (Mrad & Cui, 2020). This connection underscores the importance of incorporating emotional intelligence training into preventive strategies aimed at mitigating compulsive buying tendencies, particularly among vulnerable populations. By fostering emotional regulation skills, individuals are less likely to resort to compulsive shopping as a means of coping with negative emotions, thereby potentially reducing the associated financial and psychological burdens (Otero-López & Villardefrancos, 2014).

Social-demographic factors such as gender, age, income, education, and occupation have been found to significantly influence compulsive buying tendencies. In terms of gender differences, women are more likely to exhibit compulsive buying behavior than men. Studies consistently show that women report higher scores on compulsive buying scales (Otero-López & Villardefrancos, 2014). However, male compulsive buyers are more likely to have comorbid psychiatric disorders such as sexual addiction and intermittent explosive disorder (deMattos et al., 2016). In terms of age, younger individuals are more prone to compulsive buying behavior. Studies conducted in Malaysia and Spain found that younger adults are more likely to engage in compulsive buying compared to older populations (Shah et al., 2023).

Lower income levels and lower education attainment are associated with higher compulsive buying tendencies. For instance, a study in Brazil found that individuals with fewer years of formal education were more likely to exhibit compulsive buying behavior. However, some studies suggest that income alone may not be a significant predictor of compulsive buying, as individuals with low incomes may still engage in compulsive buying due to psychological factors (Leite & Silva, 2015). Unemployed individuals and those with lower occupational status are more likely to display compulsive buying behavior as a coping mechanism for stress and anxiety (Potrich et al., 2016).

Family status has shown mixed effects, with some studies suggesting that single individuals may be more vulnerable to compulsive buying due to emotional vulnerability (Bhattacharya & Basak, 2016). Parental upbringing and material conditions during childhood play a crucial role in shaping compulsive buying tendencies. Higher levels of parental education are associated with lower compulsive buying tendencies in offspring. This may be attributed to better financial literacy and healthier consumption

habits passed down to children (Baker et al., 2013). Individuals who experienced material deprivation during childhood are more likely to develop compulsive buying behavior in adulthood. This is often viewed as a compensatory mechanism for feelings of inadequacy (Baker et al., 2013).

Anxiety, depression, and low self-esteem are strongly associated with compulsive buying behavior. Compulsive buyers often exhibit higher levels of anxiety and depressive symptoms. A study conducted in Germany found that individuals with compulsive buying behavior reported more depressive symptoms compared to non-compulsive buyers (Mueller et al., 2010). Anxiety and depression may lead individuals to use shopping as a coping mechanism, resulting in a cycle of compulsive buying (Otero-López & Villardefrancos, 2014; Leite & Silva, 2016).

Low self-esteem is a significant predictor of compulsive buying behavior. Individuals with lower self-esteem may use shopping as a means of enhancing their self-image (Yurchisin & Johnson, 2004). Materialistic values, which emphasize the importance of possessions, are also strongly associated with compulsive buying behavior (Yurchisin & Johnson, 2004; Tarka & Kukar-Kinney, 2022).

Moreover, the intersection of compulsive buying behavior with digital consumerism represents a modern layer of complexity surrounding this phenomenon. The rise of e-commerce and social media marketing has created an environment in which impulsive purchases are not only facilitated but actively encouraged through targeted advertisements and time-limited offers. This digital landscape may exacerbate pre-existing compulsive tendencies, particularly among younger consumers, who are more susceptible to online influences and peer pressure (Shah et al., 2023).

The Compulsive Buying Scale is a widely used instrument for assessing this behavior, measuring factors such as impulsive buying, emotional shopping, and post-purchase guilt (Otero-López & Villardefrancos, 2014; Mueller et al., 2010).

Valence, d'Astous, and Fortier (1988) conceptualized and developed the Compulsive Buying Scale (CBS) as an assessment tool designed to identify compulsive buying behavior. The original scale contained 16 items. Subsequently, d'Astous (1990) revised the instrument by reducing it to 13 items, eliminating those related to family influences. CBS remains one of the oldest and most widely used instruments for measuring compulsive buying.

The scale assesses three dimensions (Yüncü & Kesebir, 2014; Tarka & Babaev, 2021):

- Tendency to spend,
- Reactive aspect of shopping (e.g., buying in response to negative emotions),
- Post-purchase guilt.

The scale has demonstrated good reliability and validity across various populations. For instance, the Turkish adaptation of the CBS showed an internal consistency of 0.80 and effectively distinguished individuals with compulsive buying tendencies from those without (Yüncü & Kesebir, 2014). The CBS is widely used in both clinical and non-clinical settings to assess the severity of compulsive buying behavior and to evaluate treatment outcomes (deMattos et al., 2019).

3. Methods

The objective of this study is to explore the relationship between compulsive buying tendencies and selected socio-demographic characteristics.

Based on previous theoretical knowledge and empirical research, the following hypotheses were formulated:

H1: There is a statistically significant correlation between the respondent's gender and the level of compulsive buying.

H2: There is a statistically significant correlation between the respondent's age and the level of compulsive buying.

H3: There is a statistically significant correlation between the respondent's level of education and the level of compulsive buying.

H4: There is a statistically significant correlation between the respondent's net monthly income and the level of compulsive buying.

H5: There is a statistically significant correlation between lower parental education and the level of compulsive buying.

H6: There is a statistically significant correlation between the respondent's subjectively perceived material conditions during childhood and the level of compulsive buying.

The survey was conducted using a structured questionnaire administered to a sample of 154 respondents. The sample was selected using convenience sampling. To measure compulsive buying behavior, the Compulsive Buying Scale (CBS) developed by Valence, d'Astous, and Fortier (1988) was used. This scale includes a series of statements rated on a Likert-type scale and allows for the identification of the level of compulsive buying as a form of maladaptive consumer behavior.

In addition to the CBMS, the questionnaire also included questions focused on socio-demographic characteristics such as age, gender, education, economic activity, income, number of siblings, parental education, and subjective evaluation of material security during childhood.

To test the hypotheses, Spearman's rank-order correlation coefficient was applied, considering the ordinal nature of some variables and the assumption of non-normal data distribution.

Sample Description

The research sample consisted of 154 respondents, of whom 59.1% were women and 40.9% were men. The mean age of participants was 34.1 years (SD = 12.94), with ages ranging from 18 to 74 years, indicating a demographically diverse adult population. In terms of educational attainment, the majority of respondents had achieved at least secondary education. Specifically, 33.1% reported secondary education without a degree, while 10.4% had completed higher vocational education. A substantial portion held university degrees: 18.8% held a bachelor's degree, 32.5% a master's degree, and 3.9% had completed doctoral studies. Only 1.3% of respondents had only primary education.

Regarding economic activity, most participants were employed (72.1%), followed by those on parental leave (11.0%) and students (11.7%). A small proportion were retired (3.9%) or unemployed (1.3%) at the time of data collection. Respondents' monthly net income varied across categories, with 24.0% reporting an income of up to 500 EUR, 22.7% earning 501–1000 EUR, and the largest group (35.7%) falling into the 1001–1500 EUR range. Higher income groups were less represented, with 9.1% earning between 1501–2000 EUR and 8.4% earning above 2000 EUR.

A large majority (87.7%) reported growing up with both parents, while 5.2% lived with their mother after parental divorce, 3.9% with mother only, 1.3% with father only, and 1.3% without either parent. In terms of number of siblings raised in the same household, the most common responses were one (33.8%) or two siblings (33.8%). Some respondents reported larger families, including 10.4% with three, and smaller proportions (under 2% each) indicating as many as eight or more siblings. Only 3.9% of participants indicated they were only children.

The mother's education was most commonly reported as secondary education with graduation (53.2%), followed by no graduation (18.2%), and university degree at the second stage (16.9%). Father's education followed a similar pattern: 44.8% had completed secondary education with graduation, 24.7% had no graduation, and 20.8% had a university degree at the second stage.

Finally, respondents were asked to evaluate their material well-being during childhood. Nearly half (45.5%) reported a state of constant material sufficiency, 46.8% experienced occasional shortages, and 7.8% reported living in constant material deprivation.

4. Results

To examine the relationship between compulsive buying behavior and selected socio-demographic variables, Spearman's rank-order correlation was applied due to the non-parametric distribution of several variables and the ordinal nature of the data. The results of the correlation analysis are summarized in Table 1.

A statistically significant negative correlation was found between age and compulsive buying tendencies ($\rho = -0.234$, $p = .004$), indicating that younger individuals reported higher levels of compulsive buying behavior. This finding aligns with existing research suggesting that younger consumers are more vulnerable to impulsive and maladaptive consumption patterns.

Another statistically significant result emerged for perceived material well-being during childhood, which showed a negative correlation with compulsive buying ($\rho = -0.228$, $p = .004$). Participants who reported frequent or permanent material deprivation in childhood tended to score higher on the compulsive buying scale. This supports the hypothesis that early-life material insecurity may lead to compensatory consumption behaviors in adulthood.

A positive correlation was also observed between the mother's level of education and compulsive buying tendencies ($\rho = 0.206$, $p = .010$). Surprisingly, individuals whose mothers had higher educational

attainment were more likely to engage in compulsive buying. Although parental education is typically viewed as a protective factor, this result may point to more complex mechanisms such as elevated expectations, social comparison, or intergenerational modeling of consumer values.

Table 1. Spearman's correlations between compulsive buying and socio-demographic variables

Variable	ρ	p
Gender	-.080	.327
Age	**-.234****	**.004**
Education level	-.045	.581
Net monthly income	-.036	.657
Number of siblings	-.058	.478
Economic activity	-.097	.232
Mother's education	**.206***	**.010**
Father's education	.088	.280
Family structure	-.009	.910
Perceived childhood material well-being	**-.228****	**.004**

*p < .05, **p < .01
Source: own processing

Other variables—including gender, education level, net monthly income, number of siblings, economic activity, father's education, and family structure—did not show statistically significant relationships with compulsive buying behavior.

These findings support the hypothesis that early life conditions - particularly perceived material (in)security - play a role in shaping maladaptive consumer behavior. An interesting result is the positive association with higher maternal education, which may reflect more complex mechanisms of socialization or psychological factors that go beyond conventional socioeconomic explanations.

5. Discussion

The results of this study indicate significant associations between compulsive buying and various socio-demographic factors. The most prominent finding is the negative correlation between age and the tendency toward compulsive buying, suggesting that younger individuals are more susceptible to this type of behavior.

Another significant finding is the negative relationship between perceived material conditions during childhood and compulsive buying tendencies. Individuals who experienced material deprivation in childhood may engage in shopping behavior in adulthood as a compensatory mechanism. This phenomenon was also observed in a study that identified a link between low socio-economic status in childhood and an increased vulnerability to compulsive buying in adulthood (Grougiou, Moschis & Kapoutsis, 2015).

An interesting result is the positive correlation between maternal education level and compulsive buying tendencies. Although higher parental education is often considered a protective factor, some studies suggest that higher maternal education may be associated with increased expectations and performance pressure, which can lead to greater vulnerability to compulsive buying in children (Singh & Nayak, 2016).

On the other hand, variables such as gender, income, the respondent's level of education, economic activity, and father's education did not show significant associations with compulsive buying in this study. These findings suggest that compulsive buying may be more influenced by individual psychological and developmental factors than by current socio-demographic characteristics.

The study by Otero-López and Villardefrancos (2014) identified that women and younger individuals are more prone to compulsive buying, with psychological factors such as anxiety, depression, and passive avoidant coping strategies increasing the risk of this behavior. In contrast, active problem-solving strategies and cognitive restructuring functioned as protective factors.

Another study (Huang & Guo, 2023) highlights that loneliness, which intensified as a result of the COVID-19 pandemic, may contribute to increased compulsive buying tendencies, particularly among young adults. These individuals may use online shopping as a way to escape negative emotions and social isolation.

Research from Poland (Tarka & Kukar-Kinney, 2022) showed that among young consumers, compulsive buying is associated with low self-esteem, high levels of materialism, depression, anxiety, and stress. These findings underscore the important role of psychological factors in the development of compulsive buying behavior.

A study by Nanda, Banerji, and Singh (2023) found that excessive use of social media and hedonic shopping experiences can lead to a higher susceptibility to compulsive buying, with gender playing a moderating role in these relationships.

Overall, these results support the hypothesis that compulsive buying is a complex phenomenon influenced by a combination of developmental experiences, family influences, and individual characteristics. For effective prevention and intervention, it is important to focus not only on current socio-economic factors but also on the deeper psychological and developmental aspects that may contribute to the emergence of this behavior.

Conclusion

The findings of this study confirm that compulsive buying behavior is significantly influenced by specific socio-demographic variables, particularly age, maternal education level, and perceived material well-being during childhood. Younger individuals exhibited a greater tendency toward compulsive buying, supporting previous findings regarding the vulnerability of youth to impulsive consumer behaviors.

The positive association between higher maternal education and compulsive buying tendencies suggests that the impact of parental education may be more complex than previously assumed, possibly reflecting factors such as parental expectations or values surrounding consumption. Meanwhile, the negative correlation between perceived childhood material well-being and compulsive buying reinforces the theory that early experiences of material deprivation contribute to maladaptive coping mechanisms later in life.

On the other hand, factors such as gender, the respondent's education level, income, economic activity, and father's education did not show statistically significant relationships with compulsive buying. These results highlight the critical role of developmental and psychological influences over purely economic factors in the formation of compulsive buying tendencies.

In sum, compulsive buying appears to be a multidimensional phenomenon shaped by a combination of individual, familial, and early environmental factors. Future research and preventive interventions should therefore integrate not only financial literacy education but also emotional regulation training and strategies addressing the psychological roots of compulsive behavior.

Despite offering valuable insights, this study has several limitations that should be acknowledged. First, the use of a convenience sample limits the generalizability of the findings to the broader population. The sample may not be representative in terms of geographic, cultural, or socio-economic diversity. Second, the study relied exclusively on self-reported data, which may be influenced by social desirability bias or inaccuracies in recall, particularly in questions regarding childhood experiences. Third, the cross-sectional design of the research prevents any conclusions about causality. While correlations were identified, it is not possible to determine the direction or underlying mechanisms of the observed relationships. Fourth, although the study included several socio-demographic factors, it did not incorporate psychological constructs such as impulsivity, materialism, or emotional regulation, which are known to significantly contribute to compulsive buying behavior.

Finally, cultural norms around consumption and family roles may also shape compulsive buying in ways not captured in this study. Future research would benefit from more diverse sampling, inclusion of psychological measures, and longitudinal designs to better understand the developmental pathways of compulsive buying behavior.

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Marketing Tools for Increasing the Export Potential of Agricultural Enterprises

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Abstract

Research background: In modern conditions of globalization and growing competition in international markets, agricultural enterprises are faced with the need to actively use marketing tools to increase their export potential. The relevance of the study is due to the need to form effective strategies for promoting agricultural products outside the country, taking into account modern challenges and trends in world trade.
Purpose of the article: The purpose of the paper is to identify and analyze effective marketing tools that can help strengthen the positions of agricultural enterprises in foreign markets, as well as to formulate recommendations for their implementation in export activities.
Methods: The research methodology is based on the use of a systematic approach, analysis of secondary statistical data, expert survey of representatives of the agricultural sector, as well as SWOT analysis methods and comparative analysis of promotion practices in international markets.
Findings & Value added: The results of the research showed that the most effective tools in increasing export potential are digital marketing, product branding, and participation in international exhibitions. At the same time, insufficient digital literacy and limited access to financial resources remain key barriers to their application. The added value of the research lies in the formation of a comprehensive approach to the use of marketing tools in agricultural exports and the provision of practical recommendations for enterprises seeking to expand their presence in the international market.

Keywords: Marketing tools, Export potential, Agricultural enterprises, Ukraine, Slovakia

JEL classification: Q13, Q17 , F18, M31

1. Introduction

In today's conditions of globalization and growing competition in international agri-food markets, agricultural enterprises are faced with the need to develop and implement effective international marketing strategies. Changing trends in international activity, increasing requirements for the quality of agri-food products, digitalization of trade operations and transformation of communication channels between the producer and the consumer - all this requires a deeper understanding of marketing tools as mechanisms for creating added value and increasing the competitiveness of the agricultural sector.

This problem is of particular importance for countries where agricultural production is one of the key sectors of the economy, in particular for Ukraine. At the same time, studying the experience of European Union countries, such as Slovakia, allows us to identify successful practices of adapting agricultural business to the conditions of an open market and effective positioning at the international level. Given the European integration vector of Ukraine's development, a comparative analysis of approaches to marketing support for agricultural exports in Ukraine and Slovakia is of particular relevance. Ukraine has significant export potential in the agricultural business, as confirmed by the production volumes of grains, oilseeds, meat and other products. However, the potential is often not fully realized due to weak positioning in international markets, the lack of clear marketing strategies, a low level of digital transformation of business, as well as

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limited access to financial and educational resources. In contrast, Slovakia, despite the smaller volumes of agricultural production, demonstrates examples of successful institutionalization of marketing functions in the agricultural sector, effective interaction between the state and business, as well as the active involvement of digital promotion tools and international branding. In this context, research into the specifics of the use of marketing tools by agricultural enterprises in both countries, as well as identifying those elements that can be effectively adapted to Ukrainian realities, is of particular importance. That is why the purpose of this work is to identify and analyze marketing tools that have the potential to increase the export capacity of agricultural enterprises, as well as to formulate practical recommendations for their implementation.

Thus, the scientific and practical value of the study lies in the integration of an analytical approach to evaluating marketing strategies with applied conclusions that can be used by agricultural enterprises, industry associations, and government agencies to form an effective policy to support agricultural exports.

The use of marketing tools to increase the export potential of agricultural enterprises is studied by scientists in various aspects. First of all, the global context of the formation of marketing strategies of agricultural businesses is considered. A significant part of the research is devoted to the digitalization of marketing activities in agribusiness. Also an important contribution to the theory and practice of international marketing is the study of branding issues, etc. Scientific sources indicate that marketing strategies play a key role in the process of internationalization of agricultural businesses (Sitnicki et al., 2024). Studies of European practices (Izakovičová et al., 2022) show that state support, agricultural clusters and active participation in international fairs are important factors of success.

The theoretical foundations of marketing strategies are based on the works of Porter (1980) on competitive advantage and Kotler (Kotler et al., 2016), which emphasize the importance of segmentation, positioning and differentiation. In the context of agricultural exports, special attention is paid to adaptive marketing, which takes into account the cultural, economic and regulatory characteristics of the market (Masud et al., 2022). Also, Ravi Kumar et al. (2024) emphasizes the importance of strategic management of marketing channels in agriculture and the need to form partnerships to reduce costs and increase export efficiency. In the context of globalization, agricultural enterprises are faced with the need to implement effective marketing strategies to ensure competitiveness in international markets. Research emphasizes the importance of adapting the marketing mix (4P) to the specifics of the agricultural sector and target markets (Kucher et al., 2025). In particular, the emphasis is on brand development, digital marketing, and participation in international exhibitions as key tools for product promotion. Successful participation in global value chains allows for the application of niche marketing strategies and access to new markets (Velychko et al., 2023).

Digitalization of agribusiness opens up new opportunities for promoting products to foreign markets. The introduction of digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and big data, helps to increase the effectiveness of marketing campaigns and optimize logistics processes (Kanellos et al., 2024, Parkhomenko et al., 2024). The use of digital technologies (electronic platforms, CRM systems, data analytics) allows agricultural exporters to respond more quickly to market changes and expand the geography of sales (Puma-Flores & Rosa-Díaz, 2024).

Branding of agricultural products is an effective tool for increasing added value and differentiation in the market. Research by Parkhomenko & Vilčeková (2025) shows that consumers are willing to support brands that declare environmental and social responsibility, which influences the marketing strategies of agricultural exporters, which are increasingly implementing ESG approaches. Participation in international exhibitions is an important element of the marketing strategy of agricultural enterprises, allowing them to establish direct contacts with potential buyers, study market trends and present their products to a wide audience. Research emphasizes that regular participation in such events contributes to increasing brand awareness and expanding sales markets (Janšto et al., 2019).

Ukrainian agricultural enterprises demonstrate high potential for export development, particularly in the organic products segment. However, there are certain barriers, such as limited access to financing, weak state support (Kvasova et al,, 2023). The introduction of digital technologies and the development of branding are key areas for increasing the competitiveness of farmers in the international market. Slovak agricultural companies are actively implementing digital technologies and effectively using marketing tools to promote their products. Studies indicate a high level of participation of Slovak enterprises in international exhibitions and the presence of a developed infrastructure to support exports (Moravčíková et al., 2021). In addition, state support and access to European funding programs contribute to the development of the agricultural sector in Slovakia.

The literature review shows that the effective use of marketing tools, such as digital marketing, branding, and participation in international exhibitions, is a key factor in increasing the export potential of agricultural enterprises. Comparing the experiences of Ukraine and Slovakia allows us to identify strengths and areas for improvement, which can be useful for shaping agricultural export development strategies in both countries.

2. Methods

The methodological basis of the paper is based on a comprehensive approach that combines both quantitative and qualitative methods of analysis. The main goal is to identify effective marketing tools that contribute to the growth of the export potential of agricultural enterprises, as well as to formulate practical recommendations for their implementation.

Initially, secondary statistical data were collected and processed, which relate to the volumes, structure and dynamics of agricultural exports of Ukraine and Slovakia in the period 2018–2023. The data sources were the State Statistics Service of Ukraine, the National Statistical Institute of Slovakia, as well as analytical reports of international organizations as Eurostat, FAO. The information collected will allow us to assess the main export positions, key sales markets, growth or decline trends, as well as institutional factors affecting export activity.

After that, an expert survey was conducted among representatives of the agricultural business of the two countries. In total, 48 experts were interviewed, 32 from Ukraine and 16 from Slovakia. The sample included: heads of enterprises, marketing specialists, analysts and consultants of the agricultural industry. The survey was conducted in the form of an online questionnaire. Its purpose is to determine the list of marketing tools that are already used in export activities, as well as the most effective ones, identify barriers that prevent the expansion of presence in foreign markets; outline trends that are most relevant for agricultural exports. The results of the survey were qualitatively processed and categorized using the thematic analysis method.

Based on the collected statistical and expert data, a SWOT analysis of the export activities of agricultural enterprises in Ukraine and Slovakia was conducted to identify strengths and weaknesses, as well as opportunities and threats. A comparison of SWOT profiles made it possible to identify specific problems and advantages of each country.

A separate stage of the research is the study of marketing practices of leading agricultural companies, namely the Ukrainian holding "MHP" (Myronivskyi Hliboproduct) and the Slovak company "Agro Tami" based on the analysis of open sources, annual reports, marketing campaigns, participation in exhibitions, digital presence. Attention is paid to the following marketing tools, such as branding, participation in international agro-industrial exhibitions, digitalization of marketing activities, the presence of strategic partnerships with international distributors, which allowed us to analyze the tools used and compare the results of their implementation in two different economic, cultural and institutional environments.

3. Results

The study analyzed data for the period 2018–2023 on agricultural exports of Ukraine and Slovakia. The sources of information were official data from the State Statistics Service of Ukraine, the National Statistical Institute of Slovakia, as well as analytical reports from Eurostat and FAO. The analysis of agricultural export volumes, commodity and regional structure of exports of both countries was carried out, and institutional factors affecting the efficiency of export activities were also identified.

Ukraine's agricultural exports experienced significant fluctuations, driven by both market trends and foreign policy factors. At the same time, Slovakia's exports were more stable with moderate growth (Table 1).

Table 1. Agricultural export volumes of Ukraine and Slovakia (2018–2023), billion USD / euro

Country	2018	2019	2020	2021	2022	2023
Ukraine (billion USD)	22.0	22.4	22.2	24.3	18.6	20.8
Slovakia (billion euros)	1.9	2.0	2.1	2.2	2.3	2.2

Source: Statistical office of Slovak Republic (2025), Ukrstat (2025), Eurostat (2025), FAO (2025)

As can be seen from Table 1, Ukraine's agricultural exports increased until 2021, after which they declined due to military operations. Slovakia, on the other hand, maintained stable positive dynamics without sharp changes.

In the period 2018–2021, Ukraine experienced a steady growth in agricultural exports, amounting to about 22–24 billion USD annually, accounting for over 40% of the country's total exports. The highest figure was reached in 2021 is 24.3 billion USD, however, in 2022, due to a full-scale war, there was a decrease to 18.6 billion USD, with a partial recovery in 2023 ($20.8 billion). Slovakia's agricultural exports are significantly smaller in volume compared to Ukraine and amounted to 1.9–2.3 billion EUR per year, which is about 8–10% of total exports. In 2020–2023, the trend of moderate growth continued, with peak values in 2022 (2.3 billion EUR).

Analysis of sales markets indicates a different export orientation of the two countries. Ukraine traditionally exports to countries in Asia, Africa and Europe, while Slovakia is focused on the EU domestic market. The summarized data is presented in Table 2.

Table 2. Main markets for agricultural products (share of total exports, %)

Country / Market	EU	China	India	Middle East	Other
Ukraine (2023)	45%	14%	9%	12%	20%
Slovakia (2023)	91%	—	—	—	9%

Source: Statistical office of Slovak Republic (2025), Ukrstat (2025), Eurostat (2025), FAO (2025)

The above data confirm the high level of regionalization of Slovakia's exports, while Ukraine demonstrates a more diversified geographical structure. Until 2022, the main sales markets for Ukraine were China, India, Egypt, Turkey, as well as the EU (primarily the Netherlands, Italy, Spain). After the outbreak of the war, geography changed and logistics routes were reloaded through the ports of Romania, Poland, Germany, and the share of exports through the western borders increased. The share of exports within the Free Trade Area with the EU increased from 34% (2021) to over 45% (2023). Slovakia is focused mainly on the EU domestic market. The main importers are the Czech Republic, Hungary, Germany, and Austria. The share of exports outside the EU does not exceed 7–9%, which indicates a high level of integration into the European market.

A comparative analysis of the commodity structure showed that Ukraine's exports are predominantly raw materials, while Slovakia focuses on finished products. Table 3 presents a typical structure of agricultural exports of both countries.

Table 3. Main categories of agricultural exports (share in the structure, %)

Country / Category	Commodities	Oil	Processed products	Organics
Ukraine	75%	15%	7%	3%
Slovakia	20%	10%	60%	10%

Source: Statistical office of Slovak Republic (2025), Ukrstat (2025), Eurostat (2025), FAO (2025)

These data indicate the need for deeper processing of agricultural products in Ukraine to increase added value and competitiveness in international markets.

The main export categories in Ukraine are grain crops (wheat, corn), oilseeds (sunflower, rapeseed), oil, and poultry meat. Ukraine's exports are characterized by a high dependence on raw materials is about 75% of exports are unprocessed products. The share of finished products is small, but shows growth in niches: organic products, honey, berries, poultry meat. The main export products of Slovakia are dairy products, meat, processed food products, seeds and fodder. The structure of Slovakia's agricultural exports is dominated by value-added products. Compared to Ukraine, Slovak exports are smaller in volume, but more focused on branded products.

Thus, Ukraine faces infrastructure and logistical problems, exchange rate instability, high dependence on weather conditions and geopolitical risks, which today affects the dynamics and structure of agricultural exports. Slovakia, as an EU member, has stable access to subsidies under the common agricultural policy, but suffers from a limited domestic raw material base.

The comparison results show that Ukraine's agricultural exports have significantly greater potential in terms of volume, but are characterized by a raw material orientation and high risks. Slovakia demonstrates stability and high integration into European value chains. These differences should be taken into account when developing marketing strategies and recommendations for strengthening the export presence of both countries.

The second stage of the study involved conducting an expert survey among representatives of agrarian business in Ukraine and Slovakia in order to understand the state of application of marketing tools in the practice of export activities. The survey was conducted in the format of an online questionnaire during December 2024 - February 2025. The total sample consisted of 48 respondents, including 32 representatives from Ukraine and 16 from Slovakia. The experts included specialists from agricultural enterprises.

In the answers of experts regarding the use of marketing tools in exports, there is a significant differentiation between the two countries. Ukrainian respondents most often indicated participation in international exhibitions (87%), digital marketing through social networks (63%), and searching for partners through B2B platforms (41%). Slovak experts focused on product branding (75%), cooperation with EU distributors (68%), and product certification in accordance with the requirements of European standards (56%). This indicates that Ukrainian enterprises are actively seeking access to foreign markets, while Slovak companies operate in the conditions of an already integrated EU market.

When assessing the effectiveness of marketing tools, experts from both countries identified three main areas. 71% of experts identified digital marketing as the most effective tool, as a tool that allows attracting new partners and increasing product recognition. Branding and geographical marking were especially noted among experts from Slovakia (62%) as a tool for creating added value. Participation in exhibitions and trade missions as a means of direct access to potential customers was noted by 69% of respondents from Ukraine.

When assessing the barriers to expanding presence in foreign markets, the following were noted as the most critical by experts as insufficient level of digital literacy of personnel is 58% among Ukrainian experts; limited access to financing for marketing campaigns is 53% in both countries; high competition in European markets is 46%, mainly Slovak respondents; regulatory and logistical difficulties is especially relevant for Ukraine in conditions of war and blockade of sea routes.

During the survey on current trends in agricultural exports, the most noticeable trends were identified, which, according to experts, have the greatest impact on export activity as demand for organic and niche products (berries, honey, legumes) is 63%; the growing role of sustainable production and ESG communications is 59%; integration of e-commerce and direct online sales is 44%; use of data analytics to personalize communications is 37%.

The results were processed using thematic analysis, which allowed grouping responses into key areas. It was found that both countries recognize the growing importance of digital technologies and branding, but existing barriers, in particular financial and institutional, hinder the effective implementation of international marketing strategies. Thus, the survey confirmed the need to develop differentiated marketing approaches to agricultural exports, focused on the specifics of regional markets, available resources and the level of digital transformation of enterprises.

The systematization of the results of the expert survey with a comparison of indicators for Ukraine and Slovakia, as well as with basic statistical processing (mean and standard deviation) is presented in Table 4.

Table 4. Systematization of expert survey results

Indicator	Ukraine (%)	Slovakia (%)	Average (%)	Standard deviation
Participation in international exhibitions	87	56	71.5	21.92
Using digital marketing	63	69	66.0	4.24
Demand for organic products	61	65	63.0	2.83
Product branding	38	75	56.5	26.16
Limited access to financing	53	53	53.0	0.00
Role of E-Commerce in sales	44	48	46.0	2.83

Certification according to EU standards	35	56	45.5	14.85
Low level of digital literacy	58	22	40.0	25.46
Competition in the EU market	32	46	39.0	9.90
Using B2B platforms	41	30	35.5	7.78

Source: authors' own research

Thus, the most consistent assessments are observed for limited access to finance (zero deviation), which indicates a common problem for both countries. The largest discrepancies are observed in the issues of branding and digital literacy, where Slovakia shows higher standards of brand strategy, and Ukraine has greater problems with digital skills. The smallest deviation is observed for indicators of organic products and digital marketing, which indicates the global nature of these trends.

An extended statistical analysis of the results of the expert survey is presented in Table 5.

Table 5. Statistical analysis of the results of the expert survey

Indicator	Ukraine (%)	Slovakia (%)
Average value	51.2	52.0
95% confidence interval	[39.21; 63.19]	[40.18; 63.82]
Standard error of the mean	≈ 6.0	≈ 5.8

Source: authors' own research

The results of the t-test for independent samples are as follows t-statistics is −0.108, p-value (two-sided) is 0.916. The difference in the mean scores between experts from Ukraine and Slovakia is not statistically significant ($p > 0.05$). This indicates that despite some differences in individual scores, both groups demonstrate similar assessments in the overall perception of the use of marketing tools. The width of the confidence intervals indicates moderate variability of the responses, but the limits for both countries overlap significantly, which reinforces the conclusion that there is no statistically significant difference.

Based on the processed statistical data and expert assessments, a SWOT analysis of the export potential of agricultural enterprises in Ukraine and Slovakia was carried out. This approach allowed for a comprehensive assessment of internal (strengths and weaknesses) and external (opportunities and threats) factors that affect the effectiveness of foreign economic activity in both countries. Comparative SWOT profiles of agricultural enterprises in Ukraine and Slovakia are presented in Table 6.

Table 6. Comparative SWOT profiles of agricultural enterprises in Ukraine and Slovakia

Category	Ukraine	Slovakia
Strengths	High competitiveness of products; Certification according to EU standards; Variety of export destinations	ntegration into EU markets; Advantageous geographical location; CAP support program
Weaknesses	Low level of digital transformation; Limited funding; Lack of international marketing specialists	Small scale of production; Dependence on the EU market; Low flexibility of marketing strategies
Opportunities	Demand for organic products; Expansion of Asian and Middle Eastern markets; Development of B2B platforms	Demand for ecological products; Support for digital transformation within the EU; Development of e-commerce
Threats	Political instability; Volatility of world prices; Logistical risks	Increased competition in the EU; Price risks; Regulatory barriers

Source: authors' own research

The comparative analysis revealed that, despite the differences in the scale of the economy and geopolitical situation, both countries have a number of common threats (price instability, high level of competition) and opportunities (environmental trends, new markets). At the same time, Ukrainian enterprises have significant scaling potential, but face greater risks and technological limitations. Slovak

companies, on the contrary, demonstrate higher stability, but smaller export volumes and lower international visibility outside the EU. The results obtained indicate the need to adapt the marketing strategies of each country, taking into account the identified strengths and opportunities, as well as systematically overcoming weaknesses and minimizing threats.

The final stage of the study was a comparative analysis of marketing practices based on the case study method of two leading agricultural enterprises of the Ukrainian agro-industrial holding MHP (Myronivskyi Hliboproduct) and the Slovak dairy company Agro Tami.

The research analyzed annual reports, public sources of information, digital marketing tools (official websites, social networks, online stores), and participation in international exhibitions.

Regarding the branding of the products of the two companies, the following can be noted. MHP actively promotes its own brands (“Nasha Ryaba”, “Skott Smeat”, “Ukrainian Chicken”), paying significant attention to adapting the labeling to the requirements of specific markets. A defining feature is the emphasis on quality, safety and origin of the product, which allows Ukrainian products to be positioned as competitive even in demanding European and Asian markets. In contrast, Agro Tami focuses on origin labeling (“Made in Slovakia”, “EU Milk Standard”), which allows using European geographical positioning as an element of the brand. The company is also actively working on creating the image of a “natural” and “local” producer.

Regarding such a marketing tool as participation in international exhibitions. Both companies regularly participate in key industry exhibitions, in particular SIAL (Paris), ANUGA (Cologne), Green Week (Berlin). MHP uses exhibitions as a platform for demonstrating innovations, promoting new product lines and establishing B2B contacts, especially in the Middle East and Asian markets. Agro Tami uses exhibition activity with a focus on strengthening its position in the countries of Central and Eastern Europe. Presence at international events is accompanied by tastings, presentations of the company's history and demonstration of quality.

Regarding the integration of digital marketing as an effective marketing promotion tool. MHP demonstrates a high level of digital activity, as it has active pages on social networks (Facebook, Instagram, LinkedIn), optimized brand sites, as well as the use of SEO and content marketing. The company focuses on interaction with the end consumer, strengthening trust through production transparency. Agro Tami also has a presence on social networks, but its digital strategy is less aggressive. The main emphasis is on cooperation with distributors through B2B platforms, as well as on partner mailings within retail chains.

Strategic partnerships help increase the export potential of agricultural companies. MHP actively forms international alliances, in particular through subsidiaries in the EU, the Middle East and North Africa. Strategic cooperation with distributors allows for the implementation of the “farm to shelf” model with quality control at all stages. Agro Tami focuses on distribution through a network of partners within the EU, with a special focus on the markets of the Czech Republic, Hungary and Austria. The company’s main strategy is to build stable long-term contracts without large-scale entry into global markets. Table 8 provides a comparative analysis of the marketing practices of MHP (Ukraine) and Agro Tami (Slovakia).

Table 8. Comparative analysis of marketing practices of MHP (Ukraine) and Agro Tami (Slovakia)

Marketing tool	MHP (Ukraine)	Agro Tami (Slovakia)
Branding	Active use of brands ("Nasha Ryaba", "Skott Smeat"); adaptation to markets	European labeling ("Made in Slovakia", "EU Milk Standard"); image of a local producer
Participation in international exhibitions	Participation in SIAL, ANUGA, Green Week; focus on the Middle East and Asia	Participation in European exhibitions; focus on CEE (Czech Republic, Hungary, Austria)
Digital Marketing	SMM, SEO, content marketing, optimized websites; direct communication with the consumer	Social media presence; focus on B2B platforms, less activity
Strategic partnerships	Network of subsidiaries; farm-to-shelf model	Distribution through stable contracts in the EU; no global expansion

Source: authors' own research on based AGRO TAMI, a.s. (2025), MHP is an international food and agri-tuch company (2025).

Comparative analysis shows that both companies use different marketing models, adapted to their own goals and external economic conditions. MHP applies an aggressive multi-level export strategy that

combines branding, digitalization and extensive logistics. In turn, Agro Tami chooses a moderate model of European integration, betting on the stability and image benefits of EU membership. Both approaches demonstrate effectiveness in their respective market contexts, but require different levels of investment and managerial flexibility.

Thus, the main effective tools used in both countries are digital marketing, product branding, participation in international exhibitions. Digital marketing (websites, SEO, social networks) is more actively used in Slovakia, where most agricultural companies have English-language websites and CRM systems. Regarding product branding, in Ukraine only large enterprises have a stably developed brand strategy, in Slovakia even medium-sized farms are actively developing regional brands. As for participation in international exhibitions, for Ukrainian companies, participation often depends on state or donor grants, while Slovak companies use European support programs.

Key barriers in Ukraine are the low level of digital literacy in the rural sector, limited funding for marketing activities, lack of knowledge about international markets, and in Slovakia, high competition in the European market and dependence on EU subsidies.

4. Discussion

Comparative analysis showed that the Slovak agricultural business has more stable conditions for marketing expansion thanks to state and European support. Ukrainian companies demonstrate high adaptability and creativity, but need targeted assistance in the field of digital technologies and brand positioning. Digital marketing allows Ukrainian enterprises to overcome logistical barriers.

The SWOT analysis confirmed that one of the main threats for both countries remains global logistics risks, in particular those associated with geopolitical instability. An interesting fact is that despite better institutional conditions, Slovak companies act more conservatively in choosing new markets and promotion channels. Ukrainian companies, on the contrary, are forced to take risks and develop non-traditional markets, which gives them competitive advantages in the field of marketing innovations.

Thus, the results of the study both confirm and complement existing scientific findings. They indicate the need for differentiated strategies to support agricultural exports as in Ukraine, with an emphasis on the development of digital infrastructure, in Slovakia, on expanding market activity outside the EU through the modernization of marketing approaches.

Conclusion

Marketing tools are crucial for increasing the export potential of agricultural enterprises. The greatest effect is provided by digital promotion platforms; branding of products with an emphasis on quality and origin; active participation in exhibitions and fairs. At the same time, country specificities significantly influence the implementation of such strategies. Ukraine should use the experience of Slovakia in the field of cooperation and state support for marketing.

For Ukrainian agribusiness, it is advisable to develop programs for the digitalization of agricultural marketing, support the creation of industry brands and the promotion of regional products. At the same time, for Slovak agribusiness, in terms of the implementation of marketing tools, the first priority is to deepen cooperation with Eastern European countries to expand sales markets and strengthen the innovative component of agricultural marketing through new generation digital tools (AI, big data).

The study showed that the effective use of marketing tools is a key factor in increasing the export potential of agricultural enterprises in both Ukraine and Slovakia. Analysis of secondary statistical data, expert survey, SWOT analysis and case studies allowed us to identify both general trends and country specificities in the use of marketing strategies.

The most effective marketing tools that contribute to entering foreign markets include digital promotion platforms, which are especially relevant for Ukrainian companies; product branding, in particular with indication of origin, quality certificates and environmental standards, which increases competitiveness in the premium segment; active participation in international exhibitions, which allows you to establish direct contacts with buyers, distributors and investors.

The limitations of the study are the sample size in the expert survey (48 people), which may affect the generalizability of the results, the focus on only two cases does not allow extrapolating all the revealed patterns to a wider range of enterprises. That is, the prospects for further research are to conduct an expanded quantitative study with a representative sample of enterprises, and to analyze the economic efficiency of individual marketing strategies using the example of specific products or export destinations.

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Gender Perspective on Perception of Healthy Food Advertisement by Entrepreneurs

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Abstract

Research background: Entrepreneurs, who often lead demanding lifestyles, are increasingly looking for convenient yet nutritious meal options. Healthy food advertising for entrepreneurs is a growing niche within health marketing. Entrepreneurs, especially those in fast-paced, high-stress environments, are increasingly concerned with wellness and productivity factors directly linked to their eating habits.
Purpose of the article: The main goal of this article was to examine how male and female entrepreneurs perceive healthy food advertisements.
Methods: For statistical analysis, given the established hypothesis and the nature of the data, we used the Mann-Whitney U-test for two independent samples and comparation of middle values – median and mean. We performed the statistical analysis in the SPSS 22 program.
Findings & Value added: Based on the research we found that how male and female entrepreneurs perceive food advertisement has no effect on their eating habits. Most women claim to try to eat healthy, so we assumed that they would perceive healthy food advertisements more positively than men. From our research, we can conclude that there is no statistically significant difference between men and women in the degree to which healthy food advertisements are positively perceived. However, research shows that while entrepreneurs may be aware of healthy food advertising, this awareness does not always translate into healthier eating habits due to time constraints, stress, and convenience-based choices.

Keywords: Entrepreneurs, Gender, Advertisement, Healthy food

JEL classification: M31, I12, L26

1. Introduction

Over the past two decades, there has been a noticeable shift in consumer preferences toward healthier lifestyles, with food choices being a primary domain of transformation. In tandem with these changes, food advertising has evolved to emphasize attributes such as nutritional value, sustainability, and ethical sourcing. Entrepreneurs, as both consumers and strategic intermediaries, play a central role in disseminating and adapting these narratives.

Advertising is not a one-size-fits-all endeavor. Studies have shown that gender plays a significant role in shaping how audiences perceive and respond to advertising messages. For entrepreneurs often working with limited resources the effectiveness of advertising can directly impact product success and brand reputation. This makes it imperative to understand how men and women may interpret messages differently, thereby influencing not only purchasing behavior but also brand loyalty and trust. Responses to such advertisements are not uniform.

Among the variables that mediate this relationship, gender has emerged as a significant factor in determining how advertising messages are received, processed, and acted upon (Meyers-Levy & Loken, 2015). Despite an increase in gender research within consumer behavior studies, there is limited work that focuses on how entrepreneurial men and women perceive health-oriented advertisements differently and how this perception informs their business models and branding strategies.

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1.1 Gender Differences in Advertisement Perception

Multiple studies suggest that women process advertising content in a more detailed and emotionally driven manner, while men often rely on heuristic and information-based cues. Birknerová et al. (2018) conducted empirical research revealing that female respondents exhibited higher expectations from advertisements in terms of creativity, memorability, and emotional resonance. They also showed stronger preference for aesthetically pleasing visuals and meaningful narratives. Conversely, male respondents emphasized clarity, factual information, and direct calls to action. These findings align with prior cognitive studies indicating that males are more outcome-oriented in decision-making contexts, while females engage more thoroughly with contextual and emotional stimuli. Research shows that men and women process advertising content differently due to variations in cognitive and emotional engagement (Meyers-Levy & Loken, 2015).

Women are generally more detail-oriented and emotionally responsive, while men tend to process messages more analytically and focus on the overall utility (Lord et al., 2023). These differences significantly affect how they perceive healthy food messages. Female entrepreneurs are more likely to resonate with health-related advertising that emphasizes emotional appeals, family well-being, and long-term benefits (Dittmar & Isham, 2022). In contrast, male entrepreneurs may prefer ads that highlight performance enhancement, productivity, or convenience attributes linked with their often goal-oriented behavior (Darley & Luethge, 2019). Female entrepreneurs often pursue business for reasons tied to personal fulfillment, social impact, or work-life balance, whereas male entrepreneurs are typically more driven by financial goals and risk-taking (Brush et al., 2022). This affects not only how they build businesses but also how they interpret consumer messages, including those related to health.

Research has shown that entrepreneurs tend to exhibit higher stress levels and less favorable health profiles compared to non-entrepreneurs (Gardiner et al., 2024). However, women entrepreneurs are more likely to implement health-conscious decisions in both personal and professional realms. Powell and Eddleston (2013) found that female entrepreneurs incorporated health into the mission and vision of their businesses more often than their male counterparts. Research suggests that men tend to process advertising messages more selectively, focusing on heuristic cues and salient details, while women engage in more elaborate processing, considering a broader spectrum of informational and emotional content (Goodrich, 2014). This difference means that advertisements emphasizing factual information and efficiency may appeal more to men, whereas emotionally rich and relational messages tend to resonate more with women (Zavodny, Pospisil & Zavodna, 2022).

Emotional engagement also varies by gender. Women generally exhibit higher emotional involvement with advertisements that evoke warmth, empathy, and social connectedness, enhancing brand attitudes and purchase intentions (Kosakowska-Berezecka et al., 2024). Conversely, men show stronger positive responses to ads emphasizing achievement, independence, or status. Such emotional divergence influences the design of advertisements tailored to male and female entrepreneurial consumers. Gender stereotypes embedded in societal norms further influence ad reception. Ads conforming to traditional male roles (assertive, competitive) or female roles (nurturing, communal) often enjoy higher acceptance among their target gender. However, challenging these stereotypes can yield mixed reactions but may foster progressive brand images (Åkestam, 2021). For example, advertisements portraying women in nontraditional occupational roles can either positively affect perceptions of empowerment or create resistance among certain demographics (Gentry & Harrison, 2010).

1.2 Entrepreneurs as Consumers

Entrepreneurs do not only shape the market they are also key participants within it. Their purchasing behaviors are often forward-looking and innovation-centric, signaling preferences that trickle down to wider consumer bases. As creative consumers, entrepreneurs are frequently the first to engage with, adapt, and improve upon existing products. For example, entrepreneurs often experiment with emerging digital tools and platforms such as AI-based productivity software or sustainable packaging long before they are adopted by mainstream consumers. These actions influence early-stage product feedback and iterative innovation (da Fonseca et al., 2023).

Moreover, platforms like Instagram, LinkedIn, and YouTube increasingly blend content consumption with entrepreneurial education and branding. As such, entrepreneurs occupy a hybrid space where they consume and simultaneously shape product narratives and cultural norms (Guiñez-Cabrera & Aqueveque, 2022).

Entrepreneurs are typically viewed through the lens of business creation and innovation, yet they also represent a distinct consumer segment. As individuals who actively engage in the market both professionally and personally, entrepreneurs exhibit unique consumption behaviors influenced by their lifestyle, work demands, and psychological traits (Chatterjee et al., 2022). Their consumption decisions often intertwine with their entrepreneurial identity, reflecting both their business orientation and personal values.

Entrepreneurs are known for being highly time-constrained and efficiency-oriented, which affects their preferences for products and services that save time, increase productivity, or offer convenience. This trait often leads them to adopt digital tools, health-oriented food products, and functional goods more readily than average consumers. In fact, entrepreneurs may view certain purchases not only in terms of personal benefit but also in terms of their potential to enhance business performance or networking potential (Obschonka et al., 2023).

From a psychological standpoint, entrepreneurs tend to be more open to new experiences and exhibit higher levels of risk tolerance (Zhao & Seibert, 2006). This disposition translates into greater willingness to try new products, engage with innovative brands, or respond to non-traditional marketing tactics. Therefore, entrepreneurs as consumers may respond more favorably to novel or aspirational advertising approaches, especially those aligned with themes of autonomy, leadership, health, and performance (Fauchart & Gruber, 2011).

Moreover, the social identity of entrepreneurs plays a significant role in shaping their consumer choices. Entrepreneurial self-concept—how they view themselves in relation to their professional roles—can influence everything from clothing and transportation to food and technology consumption (Navis & Glynn, 2011). For instance, entrepreneurs who perceive themselves as innovative leaders may be more inclined to choose premium, healthy, or sustainable food products, reflecting an alignment between their personal image and the values projected by such products.

1.3 Healthy Food Advertisement

Healthy food advertising plays a critical role in shaping consumer perceptions, dietary choices, and overall public health outcomes. It encompasses a range of promotional strategies that aim to influence consumer attitudes toward nutritionally beneficial products, such as fruits, vegetables, whole grains, and low-fat alternatives. Unlike traditional food advertising which has historically prioritized indulgent, energy-dense products, healthy food advertising seeks to align product appeal with health-related values and lifestyle aspirations (Hawkes, 2009).

Effective healthy food advertisements influence not only consumer attitudes but also behavioral intentions and actual purchasing patterns. When advertisements communicate clear, credible health benefits and align with consumer values, they increase product appeal and purchase likelihood (Haws, Winterich, & Naylor, 2014). Studies indicate that messages emphasizing the positive impact of healthy eating on personal well-being and longevity resonate strongly across demographic groups, especially among women and health-conscious individuals. Healthy food advertisements contribute to shaping social norms around diet and wellness. By normalizing healthy choices and associating them with aspirational identities, advertisements can promote sustainable behavior change. However, effectiveness depends on avoiding “health halo” effects where consumers overestimate the healthiness of products based on advertising cues alone (Chandon & Wansink, 2007). Despite its benefits, advertising healthy food faces several challenges. Regulatory scrutiny over health claims varies widely by region, requiring marketers to carefully navigate legal standards to avoid misleading consumers (Campos et al., 2011).

Additionally, consumers are increasingly skeptical of health claims due to past experiences with deceptive marketing, necessitating transparency and third-party validation to maintain trust. Another challenge is overcoming entrenched taste preferences and cultural habits. Healthy food advertisements must balance promoting nutritional benefits without alienating consumers by implying inferior taste or convenience. Gender differences add complexity, as males and females respond differently to taste, health messages, and convenience appeals, demanding tailored marketing approaches (Garcia-Burgos & Zamora, 2015).

One of the major challenges of healthy food advertising lies in overcoming taste-related perceptions. Consumers often associate healthy foods with poor taste or lower satisfaction. To counteract this bias, effective marketing strategies often combine health claims with sensory appeal.

For instance, visually rich advertisements that emphasize freshness, flavor, and pleasure rather than just nutritional value have been found to enhance the persuasive power of health-related food marketing (Raghunathan et al., 2006).

Another critical dimension of healthy food advertising is the use of social and cultural cues. Advertisements that incorporate relatable role models, peer influence, or aspirational lifestyles tend to resonate more strongly with health-conscious audiences, especially younger consumers. Furthermore, endorsements by health professionals, celebrities, or influencers with a credible personal brand in wellness can amplify the perceived legitimacy of health claims (Puhl & Heuer, 2010).

2. Methods

The goal of the article is to to examine how male and female entrepreneurs perceive healthy food advertisements. Based on the theoretical background and the goal of the research, one hypothesis is established:

Hypothesis: We assume that there are gender differences in the perception of advertising for healthy food.

The research sample consisted of 146 respondents (98 male entrepreneurs (67%) and 48 female entrepreneurs(33%)) from Eastern part of Slovakia. The average age of the respondents was 41 years. Participants were recruited through professional entrepreneur networks and social media platforms using purposive sampling. Data were collected via an online survey distributed between January and March 2025. The questionnaire included Likert-scale items measuring attitudes toward healthy food advertisements.

For statistical analysis, given the established hypothesis and the nature of the data, we used the Mann-Whitney U-test for two independent samples and comparation of middle values – median and mean. We performed the statistical analysis in the SPSS 22 program.

3. Results

The results from the survey and analysis indicate (in Table 1) a generally high level of positive perception toward healthy food advertising among female entrepreneurs. A majority of the participants expressed that they view such advertisements as informative, empowering, and aligned with values of well-being and sustainability. Female entrepreneurs, particularly those in sectors related to health, wellness, and lifestyle, often resonated with the messages of promoting a healthier lifestyle and making nutritious food more accessible.

Table 1. Level of positive perception of healthy food advertising - Female Entrepreneurs

N	**48**
Mean	**4.7765**
Median	**5.0000**
Standard Deviation	**2.07260**
Skewness	**-.303**
Kurtosis	**-.501**
Range	**8.00**
Minimum	**.00**
Maximum	**8.00**

Source: own processing (2025)

In Table 2 we can see that the results reveal that male entrepreneurs generally hold a moderately positive perception of healthy food advertising, with a notable distinction in the type of messaging that resonates with them. While a majority appreciate the focus on health and wellness, they are more selective in their responses to the way these advertisements are framed, with a preference for messaging that is practical, clear, and performance-oriented.

Table 2. Level of positive perception of healthy food advertising - Male Entrepreneurs

N	**98**
Mean	**4.2419**
Median	**4.0000**
Standard Deviation	**2.29348**
Skewness	**.079**
Kurtosis	**-.489**
Range	**8.00**
Minimum	**.00**
Maximum	**8.00**

Source: own processing (2025)

When we look at the figure 1, we can see that the average value of the level of positive perception of healthy food advertising on a scale from 0 - maximum negative perception to 8 - maximum positive perception was 4.7765 for female and 4.2419 for male.

Overall, female entrepreneurs perceive healthy food advertising positively, particularly when the messages are authentic, informative, and aligned with values of transparency, health, and sustainability. There is a notable opportunity for brands to capitalize on this perception by developing marketing strategies that emphasize genuine health benefits, ethical sourcing, and social responsibility. Male entrepreneurs demonstrate a moderately positive perception of healthy food advertising, with a strong preference for practical, transparent, and scientifically-backed messaging. They value advertisements that highlight tangible benefits and align with their values of efficiency, performance, and sustainability, though they remain wary of exaggerated health claims. For brands, this insight provides an opportunity to craft messaging that balances health benefits with credibility and authenticity, while emphasizing real-world functionality.

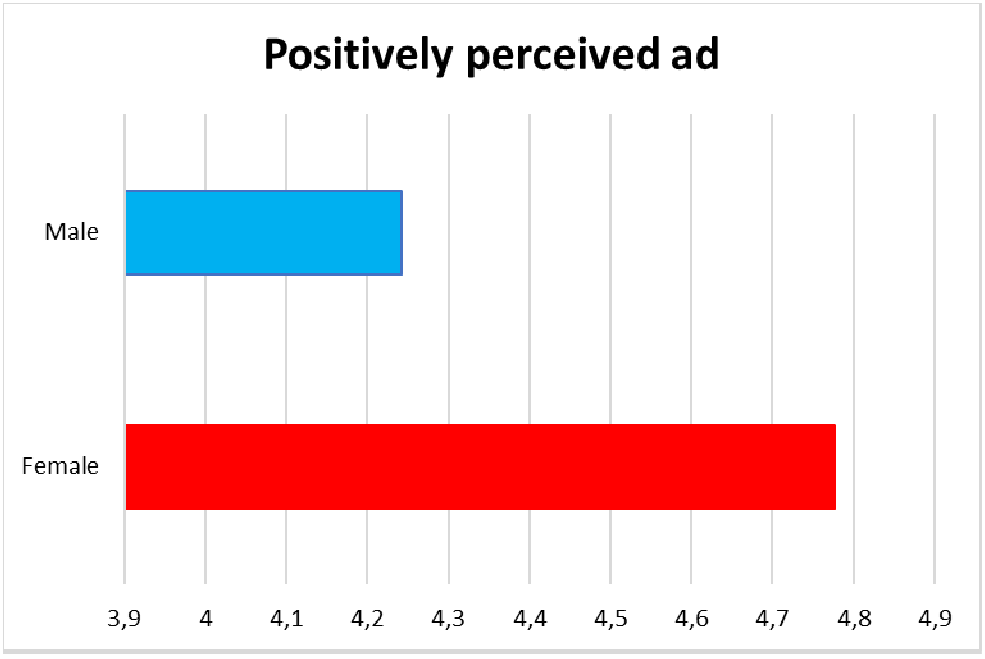

Figure 1. Positively perceived ad
Source: own processing (2025)

Table 3. Mann-Whitney U-test

	Rate of positively perceived advertising for healthy food
Mann-Whitney U	**3621.500**
Wilcoxon W	**4039.500**
Z	**-1.278**
Asymp. Sig. (2-tailed)	**.183**

Source: own processing (2025)

We tried to find out whether there is a statistically significant difference in the level of positively perceived advertising for healthy foods based on gender. Based on the results presented in Table 3, we can conclude that there is no statistically significant difference in the level of positively perceived advertising for healthy foods based on gender. Based on these results, we can conclude that our ***hypothesis was not confirmed***.

4. Discussion

In a global marketplace increasingly driven by health consciousness and ethical consumption, the intersection of gender and entrepreneurial response to healthy food advertising presents an underexplored yet significant area of study. To strengthen the description and comparison of results with existing literature, it would be helpful to integrate findings from research that explores the perceptions of healthy food advertising among entrepreneurs, particularly gender differences, and the effectiveness of different messaging strategies. Several studies have noted that there are significant gender-based differences in how people perceive and respond to health-related advertisements, including those for healthy food.

Research by Cramphorn (2011) shows that less than 15% of ads are directed specifically to women and less than 5% are intended just for men. The remaining 80% are apparently targeted to everyone. This presumes very little difference in overall response between genders, which is strange, given that fundamental gender differences do exist. For example, women typically respond more positively to ads than men. Women are generally more responsive to emotional and aspirational health messages, while men tend to prefer more factual, performance-oriented messaging. This aligns with the findings in the comparison between male and female entrepreneurs in the present study. Female entrepreneurs gravitated toward health advertising that emphasized well-being, lifestyle, and sustainability, reflecting their more holistic and values-driven approach to wellness. In contrast, male entrepreneurs preferred practical messaging focused on functional benefits, such as energy and productivity, which matches the research indicating that men tend to be more goal-oriented in their consumption decisions (McIntyre et al., 2018).

Female entrepreneurs generally demonstrate a more holistic and values-driven approach to health messaging. They are more likely to resonate with advertising that emphasizes well-being, sustainability, community health, and ethical consumption. This aligns with findings from Adalı et al. (2024), who noted that women are more emotionally engaged with wellness-oriented marketing, especially when it connects to family or environmental concerns. In contrast, male entrepreneurs tend to evaluate advertisements through a more pragmatic and functional lens. They show greater interest in marketing that highlights performance benefits, such as increased energy, focus, or productivity (Gentry & Harrison, 2010). For male entrepreneurs, the effectiveness of advertising is often tied to its ability to convey practical utility, supported by scientific evidence or measurable outcomes.

Another dimension where gender differences emerge is in how entrepreneurs see healthy food advertising as a business opportunity. Female entrepreneurs, particularly those involved in wellness or lifestyle industries, often view alignment with healthy food brands as a way to promote shared values and social impact. Conversely, male entrepreneurs are more likely to evaluate such partnerships in terms of market potential, consumer demand, and profitability (Åkestam et al., 2021). These different motivations inform how each gender approaches brand collaborations and business development in the healthy food sector.

Conclusion

Gender differences significantly shape how entrepreneurs perceive and react to healthy food advertisements. These differences not only influence personal consumption choices but also impact

business practices and marketing strategies. Recognizing and leveraging these gendered patterns can enhance both advertising effectiveness and health outcomes.

Understanding gender perspectives on the perception of healthy food advertising is essential in today's increasingly segmented and health-conscious marketplace especially when considering the influential role of entrepreneurs, who not only consume but often promote and co-create brand messages. This analysis reveals that male and female entrepreneurs differ markedly in how they interpret, engage with, and value advertising related to healthy food, with these differences rooted in broader gender-based psychological, social, and business motivations. Gender significantly influences advertisement perception through cognitive, emotional, and socio-cultural mechanisms. Understanding these differences is vital for crafting inclusive and impactful advertising strategies, particularly for entrepreneurial markets where gender diversity continues to grow.

While gender is only one of many intersecting factors influencing advertising perception, it remains a critical dimension for understanding consumer behavior in the entrepreneurial space. Brands that are attuned to these nuanced gender differences are better positioned not only to engage entrepreneurial consumers, but also to leverage their influence as trendsetters, business leaders, and community voices in the evolving healthy food market. Future research may further explore how these gender-based perceptions intersect with other variables such as age, culture, business sector, and digital platform use, offering even more refined insights for targeted communication in the health and wellness industry.

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Marketing Research in the Age of Industry 5.0: Insights from a Bibliometric Analysis

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Abstract

Research background: In the current context of digital transformation, it is increasingly important to align marketing activities with the principles of Industry 5.0, which emphasizes a human-centric approach, personalization, and technological integration. Despite dynamic developments in digital marketing, there is a lack of systematic knowledge regarding research trends that connect these domains.
Purpose of the article: The aim of this study is to assess the current state of the theoretical foundation linking marketing research and Industry 5.0 through a bibliometric analysis of scientific publications indexed in the Web of Science database.
Methods: The study applied bibliometric and text mining techniques to analyze a dataset of 390 articles published between 2020 and 2024. The analysis included descriptive statistics, thematic mapping, keyword co-occurrence networks, and frequency and bigram association analysis.
Findings & Value added: The results revealed two dominant research streams: a behavioral stream (consumer behavior, trust, satisfaction) and a technological-managerial stream (AI, personalization, performance). Although the volume of explicitly marketing-focused studies remains modest, their citation impact suggests high relevance and quality. The study addresses a notable research gap by bridging marketing research with Industry 5.0, offering a clear overview of prevailing themes. It contributes a conceptual framework for future research directions and pedagogical innovation in marketing research education, particularly in areas of personalization, digital analytics, and human-technology integration.

Keywords: Marketing Research, Industry 5.0, Bibliometric Analysis, Web of Science, Consumer Behavior, Research Trends

JEL classification: M31, Q56

1. Introduction

In the current era, marked by rapid digitalization and societal transformation, data have become a critical asset. As early as 2017, The Economist highlighted this shift with the headline "The world's most valuable resource is no longer oil, but data," emphasizing the growing importance of information. This evolution has created increasing demand for digital, technical, and analytical skills—competencies that are also crucial in the field of marketing research. Today, marketing research plays a strategic role in understanding the rapidly changing behavior of consumers, their expectations for personalization, and the rising importance of digital services. It equips organizations with tools for data-driven decision-making, effective market trend analysis, and the development of customer-oriented strategies. As noted by Judijanto, Risdwiyanto, and Suroso (2024), contemporary digital marketing is increasingly adopting data- and technology-based philosophies, thereby strengthening a culture of evidence-based decision-making. Furthermore, Rosário and Dias (2022) emphasize that the principles of Industry 4.0 have significantly shaped marketing approaches and laid the groundwork for the transition toward Industry 5.0, which emphasizes a human-centric approach and technological synergy aligned with customer needs.

While previous industrial revolutions primarily focused on technologies and engineering, Industry 5.0 introduces a paradigm shift by emphasizing human involvement in production processes. According to Madsen et al. (2024), the concept of Industry 5.0 emerged in the mid-2010s and gained significant

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traction during the COVID-19 pandemic, attracting increased attention not only from the business sector but also within academic circles. Akundi et al. (2022) identify frequently cited driving forces behind Industry 5.0, such as artificial intelligence (AI), big data, supply chain optimization, digital transformation, machine learning, and the Internet of Things (IoT). In a bibliometric study, Tunji-Olayeni et al. (2023) outlined key areas of Industry 5.0 applications in the construction sector, including health and safety, collaborative work, waste management, environmental monitoring (e.g., indoor air quality, atmospheric pressure, noise, humidity, and temperature), and the forecasting of environmental, social, or financial outcomes. These insights suggest that data-related competencies are both highly relevant and transdisciplinary in nature an important advantage for the practical employability of future graduates.

As early as 2019, Paas emphasized that marketing research education should increasingly focus on transactional data and Big Data. Marketing analysts are expected to convert raw data into actionable insights for managerial decision-making, which requires the development of analytical competencies not only among researchers but also among non-technical managers. In alignment with this view, Guha et al. (2024) argue that employers expect marketing graduates to be well-versed in contemporary topics such as sustainability, digital marketing, big data, analytics, and the role of artificial intelligence (AI) in both traditional and emerging marketing domains. Consequently, students should acquire the knowledge and skills necessary to operate effectively within a marketing environment shaped by the principles of Industry 5.0.

The presented research addresses the lack of a systematic overview linking marketing research with the Industry 5.0 concept, which emphasizes personalization, sustainability, and human-centric innovation. Most current studies focus separately on either marketing or technological advancements, lacking an integrated perspective. The added value of this study lies in the identification of research trends, thematic focal points, and methodological approaches that can serve as a foundation for future interdisciplinary research projects, as well as for the modernization of educational curricula in the field of marketing research.

2. Methods

The aim of the presented research is to assess the current state of the theoretical foundation linking research areas focused on marketing research and Industry 5.0 through a bibliometric analysis of publications indexed in the Web of Science database.

All data were obtained from the Web of Science – Core Collection database (Clarivate, 2025). The dataset consisted of scientific articles for which complete bibliometric indicators were available (all information excluding the full text of the articles). The search was conducted using the following keywords:

"Industry 5.0" OR "human-centric" OR "human-machine collaboration" OR "personalization" OR "resilience" OR "circular economy"

AND

"marketing research" OR "consumer behavior" OR "digital marketing" OR "market analysis" OR "marketing innovation"

Only journal and conference articles were included in the analysis, while book chapters, reviews, and other types of documents were excluded. As a result, the bibliometric analysis comprised a total of 390 documents published between 2020 and 2024.

The study employed multiple bibliometric and text-analytical techniques to comprehensively explore the intersection of marketing research and the Industry 5.0 concept. A foundational descriptive bibliometric analysis (Aria and Cuccurullo, 2017) was conducted to provide an overview of key publication metrics. A thematic map was used to identify thematic clusters and research domains based on keyword co-occurrences, allowing for the detection of mature, emerging, and marginal topics. Co-word analysis revealed the structure and intensity of relationships between frequently co-occurring terms within the publications. To complement this, word frequency analysis was applied to determine the most commonly used terms and their significance within the corpus. Finally, bigram word association analysis identified frequent word pairs and their semantic connections, offering deeper insights into linguistic patterns and thematic contexts within the literature. The calculations were performed via the R programming language (v. 4.4.2) (R Core Team, 2025).

3. Results

This section presents the main findings of the bibliometric analysis, which aimed to identify developmental trends, key research areas, and thematic clusters within publications related to marketing research and the concept of Industry 5.0. The analysis initially focuses on the broader connection between Industry 5.0 and selected marketing concepts—primarily marketing research—and subsequently narrows its scope to studies explicitly containing the term "marketing research".

3.1 Selected Areas of Marketing and Industry 5.0

The analysis results reveal a growing research trend at the intersection of marketing and Industry 5.0, with dominant themes including circular economy, consumer behavior, personalization, and digital marketing. Frequently occurring keywords such as "consumer behavior," "digital marketing," and "resilience" indicate an increasing emphasis on sustainability, customer experience, and adaptability in a changing environment. The most cited publications appear in prestigious journals such as the Journal of the Academy of Marketing Science and Sustainability. Notably, international collaboration is strong (31.28%), with China, the USA, Italy, and the United Kingdom being the most active countries. This development highlights the interdisciplinary and global nature of research in this field.

Figure 1. Word cloud of the titles of the analyzed studies
Source: own processing (2025)

Figure 1 presents the frequency of the most common terms found in the analyzed text, specifically in the titles of research studies. Dominant words such as consumer, behavior, marketing, circular, sustainable, economy, COVID, and analysis indicate that the research in the examined area primarily focuses on consumer behavior, sustainability and the circular economy, digital technologies, marketing strategies, and the impacts of the COVID-19 pandemic. However, a more in-depth view is offered in the following section, which examines the most frequently occurring words in titles in greater detail.

In the titles of the analyzed research studies, the term “customer” most frequently appeared in connection with “behavior” (36) and “consumers” (35), indicating a strong research focus on customer behavior and perceptions across various contexts. Sustainability also emerged as a prominent theme, as reflected in co-occurrences such as “circular” (22), “sustainable” (16), and “economy” (14), suggesting an

increasing interest in linking customer behavior to the principles of circular and sustainable economies. In response to broader societal challenges, terms like “COVID” (11) and “waste” (9) were also present, signaling researchers’ efforts to address shifting consumer patterns during and after the pandemic. Other frequent terms such as “food” (11), “product” (11), and “study” (10) further highlight that the research often focuses on specific application areas and empirical evaluations of customer behavior.

In the titles of the analyzed publications, the term “circular” most frequently appeared in combination with “economy” (43), confirming the central role of the circular economy in the research. Common co-occurrences also included “circular consumer” (17), “behavior” (13), and “consumption” (6), indicating a strong focus on consumer behavior within this context. Associations such as “circular product” (7) and “business” (5) reflect attention to sustainable products and business models. Terms like “analysis” (6), “economic” (5), “fashion” (5), and “models” (5) suggest a broader analytical and sectoral scope of the research.

In the titles of the analyzed publications, the word “marketing” most frequently appeared in combination with “digital” (24), confirming the dominance of digital marketing in current research. Notable associations also included “strategies” (8), “COVID” (7), “AI” (6), “consumer” (6), “research” (6), and “analysis” (6), indicating a strong link between marketing, technological innovations, changes in consumer behavior, and research methodologies. Additionally, “marketing” was commonly paired with “artificial” (5), “data” (5), and “green” (5), reflecting growing interest in artificial intelligence, data-driven marketing, and environmental dimensions of marketing strategies.

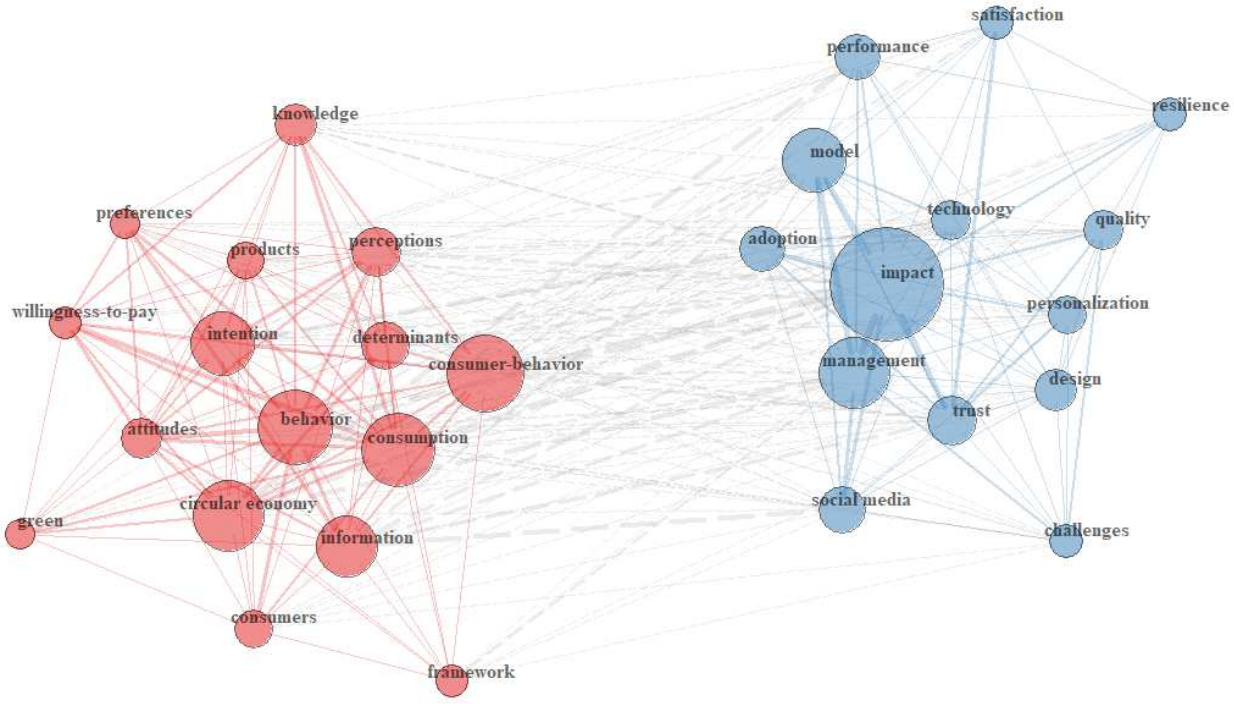

Figure 2. Keyword co-occurrences
Source: own processing (2025)

Figure 2 illustrates the network of keyword co-occurrences in the analyzed scientific literature. The nodes (circles) represent key terms, with their size reflecting frequency of occurrence, while the thickness of the connecting lines indicates the strength of co-occurrence between terms. Colors distinguish thematic clusters. The red cluster focuses on consumer behavior in the context of the circular economy and includes terms such as behavior, consumption, consumer behavior, attitudes, intention, and circular economy. The blue cluster is more related to technology, performance, and management, containing keywords like technology, impact, performance, management, and personalization. These findings point to two dominant research domains: a consumer-oriented approach and a techno-managerial framework. The analysis thus reveals a clear polarization between human-centric and technology-driven paradigms within marketing research.

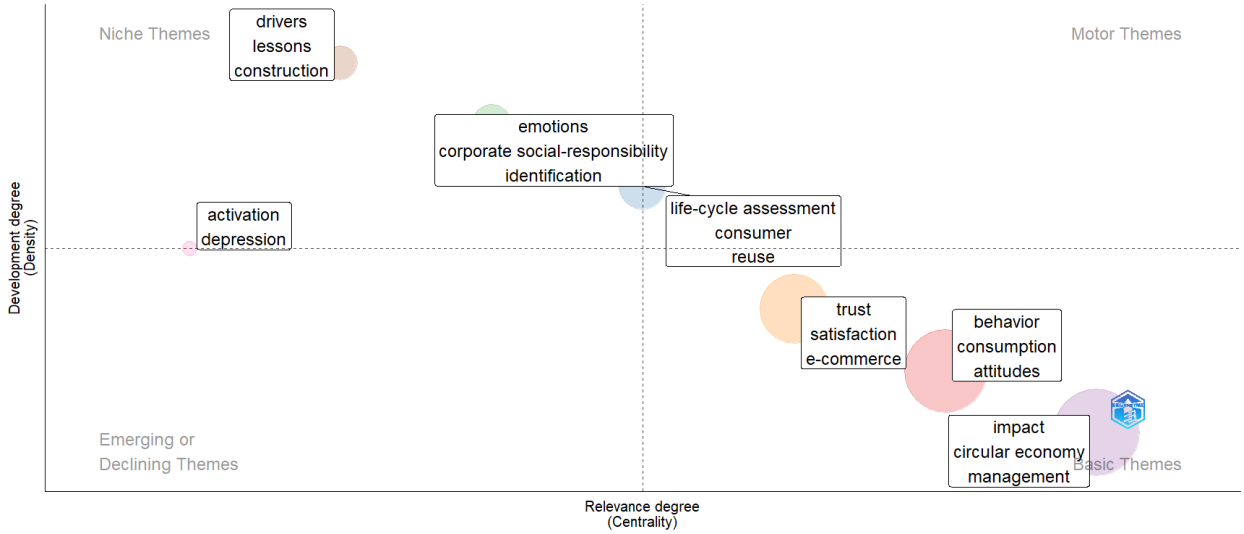

Figure 3. Thematic Map of Selected Research Areas
Source: own processing (2025)

Figure 3 presents a thematic map based on keyword co-occurrence analysis. Each bubble represents a research theme, positioned according to its relevance (centrality) and level of development (density). In the bottom-right quadrant (Basic Themes), we find foundational but less developed topics such as impact, circular economy, and management, which are central to the field but require further elaboration. The top-right quadrant (Motor Themes) includes well-developed and highly connected themes like trust, satisfaction, e-commerce, behavior, consumption, and attitudes, representing the driving forces of the field. The top-left quadrant (Niche Themes) shows specialized topics such as drivers, lessons, and construction, which are well-developed but marginal in relevance. The bottom-left quadrant (Emerging or Declining Themes) captures underdeveloped and weakly connected topics like activation and depression.

Although circular economy is recognized as a frequently discussed and central theme in alignment with the human-centric and sustainable principles of Industry 5.0, its placement in the Basic Themes quadrant suggests a gap in methodological or applied depth in marketing research. This highlights a promising direction for future interdisciplinary socio-economic research.

3.2 Marketing Research and Industry 5.0

To deepen the analysis, a specific subset of publications was created by selecting only those that explicitly included the term “marketing research” in the title, abstract, or keywords. The goal of this focused analysis was to identify the core body of research that directly addresses marketing research within the context of trends related to Industry 5.0. Through this selective approach, a total of 20 documents published between 2020 and 2024 were isolated, offering a representative overview of the direction, key themes, and scholarly output in this specialized area.

A bibliometric analysis of a subset of 20 publications focused on marketing research in the context of Industry 5.0 revealed a compact yet citation-intensive and internationally diverse corpus. Most documents were scientific articles published between 2020 and 2024, involving 60 authors with a strong degree of collaboration (3.05 authors per article) and 40% international co-authorship. The research focus primarily revolved around topics such as personalization, artificial intelligence, digital marketing, and consumer behavior, which align with the human-centric principles of Industry 5.0. Key terms such as “marketing research”, “AI”, “app”, “consumer”, or “personalization” confirm the technological-behavioral character of the studies. The most cited work is the article by Huang & Rust (2021) with 491 citations, while other authors such as Astvansh and Gao also show notable citation performance. Geographically, China, the United Kingdom, and the United States dominate, while the most relevant published outputs are dispersed across prestigious journals such as the European Journal of Marketing or the Journal of the Academy of Marketing Science. Despite the limited number of studies, the corpus represents highly valuable outputs with interdisciplinary reach that shape the emerging domain of marketing research reflecting the challenges of Industry 5.0.

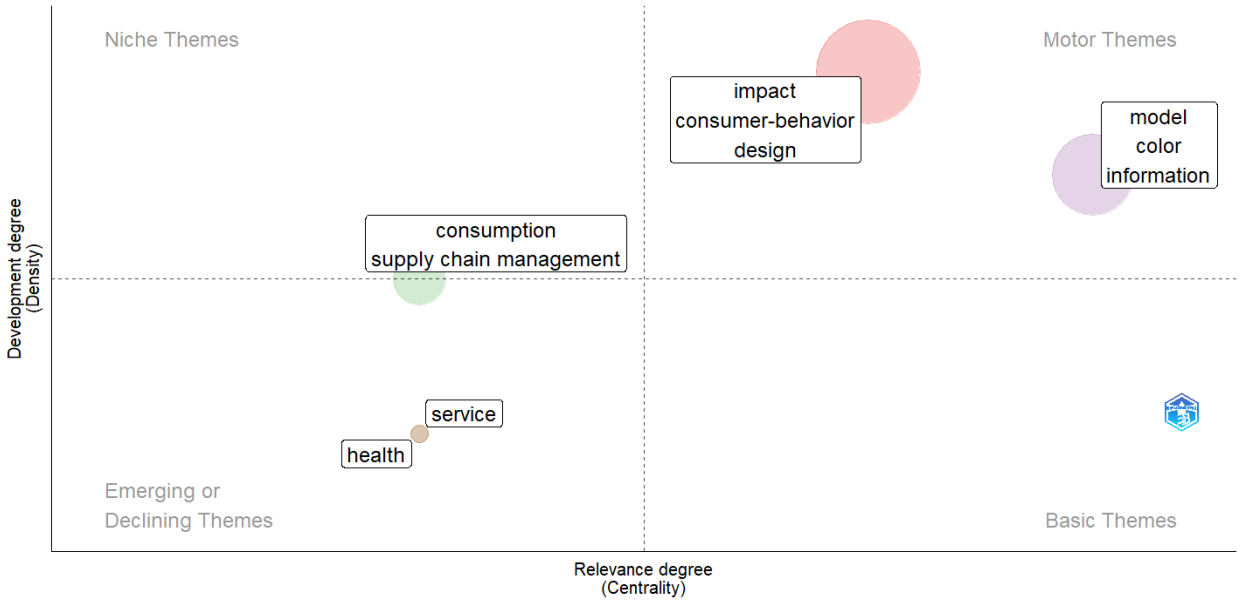

Figure 4. Thematic Map of Selected Research Areas within the Marketing Research Subset
Source: own processing (2025)

The thematic map in Figure 4 shows that consumer behavior and research design are the most developed and influential areas of marketing research in the context of Industry 5.0. At the same time, it reveals the untapped potential of themes such as health and service, which may represent promising opportunities for future research.

Figure 5. Word Cloud of Abstracts from Analyzed Studies in the Specification of Marketing Research
Source: own processing (2025)

Figure 5 presents a word cloud visualizing the most frequent terms in publications focused on marketing research in the context of Industry 5.0. Dominant terms such as research, marketing, study, and paper confirm the strong academic anchoring of the field. Technologically oriented terms like AI, app, ads, and based highlight the growing intersection of marketing with artificial intelligence, personalization, and digital tools. Concurrently, terms like attention, customer, communication, and consumer reflect a continued emphasis on consumer behavior and interaction. The word cloud captures the current research orientation that blends technological innovation with a behavioral approach to marketing.

In the analyzed publications, the term marketing most frequently co-occurred with research (59), indicating a strong emphasis on the research framework in this domain. This is followed by terms such as study (23) and paper (21), reflecting the academic nature of the contributions. Notably, there is a high frequency of associations with artificial intelligence (AI – 22) and applications (app – 19), confirming the technological dimension of current marketing research. Terms like business (20), attention (18), and customer (15) suggest a focus on consumer experience and the effectiveness of marketing communication. The presence of terms like based (16) and ads (15) further illustrates the model- and data-driven approaches prevalent in the analyzed studies.

The word research most frequently co-occurred with marketing (67), confirming the central role of marketing research within the analyzed corpus. It is followed by terms such as study (23), paper (22), and business (20), reflecting both the academic and applied nature of the research. Strong associations with technical terms like AI (22), app (19), based (17), and ads (15) highlight the growing intersection of research with technological innovation and digital marketing. Additionally, terms such as attention (18) and consumer (16) indicate a focus on consumer behavior and the effectiveness of marketing interventions. Overall, this field represents a convergence of scientific inquiry, technological advancement, and customer orientation.

4. Discussion

The earliest study in the dataset is by Rybanský and Janos (2020), who argue that marketing must respond to contemporary global changes by shifting its focus toward maximizing consumer value and enhancing the alignment between offerings and customer needs. The human-centric principles of Industry 5.0 are further explored in the study by Kaabachi, Ben Mrad, and Fiedler (2020), which investigates how the structure of e-banking models affects trust and loyalty highlighting behavioral aspects of marketing research in the digital landscape of Industry 5.0. Notably, the impact of personalization and interactivity varies by platform type, confirming the necessity of segmented approaches in digital marketing strategies. Jánošová, Sádecká, and Labudová (2021) expand the discussion by emphasizing the importance of effective communication between SMEs and public administration, adding a regional and institutional dimension to marketing research—essential for sustainable governance and innovation within Industry 5.0. Collectively, these studies demonstrate a shift in marketing from traditional sales-centric models toward a nuanced understanding of trust, consumer experience, and value-based relationships. They underscore the rising importance of personalization, interactivity, and inter-institutional collaboration, which enhance both the effectiveness of marketing communication and its broader social and innovation impact across various contexts.

Consumer behavior and customer value are central concepts in both marketing research and the Industry 5.0 framework. In this context, Industry 5.0 emphasizes a human-centric approach, personalization, and human–technology collaboration, making customer experience and value creation essential. Yu, Liang, and Choi (2023) highlight the active role of customers as co-creators of value in highly personalized service environments, such as hospitality, through behaviors like feedback, recommendations, and assistance. This aligns with the need to understand customer motivations, satisfaction, and values to shape effective marketing strategies in Industry 5.0—where success depends on co-creating value with rather than for customers. Similarly, Wooley et al. (2022) stress the importance of understanding visual attention in dynamic digital environments, revealing that consumers' behavioral responses to visual content are nuanced and context-dependent. This insight reinforces the relevance of advanced, personalized, and technologically driven communication strategies. Istudor et al. (2022) further support this by demonstrating the increasing importance of integrating sustainability and marketing on digital platforms—a theme closely linked to consumer behavior in the Industry 5.0 era. Finally, Carlini and Robertson (2022) emphasize the importance of involving consumers, particularly vulnerable groups,

as active research partners. Their work advocates for empathy, inclusion, and co-creation in marketing research—values that deeply resonate with the core principles of Industry 5.0.

Jung and Kim (2023), in their bibliometric study, found that research at the intersection of sustainability and marketing has significantly shifted over the past decade—from general theoretical discussions to practical applications in environmental and technological contexts reflecting evolving market and societal demands. Astvansh and Fridmanski (2023) further highlighted how artificial intelligence is transforming marketing research, identifying four major thematic areas: consumer behavior, big data, personalization, and ethical challenges. Their study underscores AI's potential to enhance customer understanding and decision-making but also stresses the need for responsible data use and privacy protection. Building on this, Vanharanta and Wong (2023) introduced the concept of "laminated resilience" in B2B marketing systems, emphasizing that resilience in Industry 5.0 stems from the interaction of individuals, teams, organizations, and networks. Their work advocates for a complex, systems-oriented research perspective that can better address uncertainty, risks, and disruptions in an increasingly interconnected and technologically advanced environment. Collectively, these studies show how marketing research is evolving to address both technological transformation and human-centric values in line with Industry 5.0 principles.

One of the most prominent current trends is the broad application and adaptation of artificial intelligence (AI). Huang and Rust (2021) argue that AI is fundamentally transforming the marketing paradigm by shifting from traditional, reactive approaches to proactive, autonomous decision-making across the entire value chain. In the context of marketing research and Industry 5.0, their study emphasizes the importance of integrating technological sophistication with a human-centric perspective, aiming to create systems that not only enhance efficiency but also respect customer values, experiences, and trust. These insights are essential for developing ethically grounded, intelligent marketing in a digitized society. The significance of AI is further highlighted by Gao and Liu (2023), who explore both the opportunities and limitations of AI in interactive marketing along the consumer purchase journey.

Conclusion

The objective of the study to assess the current state of the theoretical foundation linking marketing research and Industry 5.0 through bibliometric analysis was successfully achieved. The analysis identified relevant research domains, dominant themes (e.g., personalization, AI, consumer behavior), as well as key trends and influential authors in the field. The findings provide a comprehensive overview of the research landscape and highlight opportunities for further development at the intersection of marketing and the techno-humanistic principles of Industry 5.0.

The research findings indicate that while the intersection of marketing research and the Industry 5.0 concept currently represents a relatively narrow segment of academic literature, it is marked by high research quality. The analysis of publications from the Web of Science revealed a strong focus on themes such as personalization, artificial intelligence, digital marketing, and consumer behavior underscoring the growing importance of human-centric approaches and technological innovations in this domain. Furthermore, significant links to sustainability and the circular economy key pillars of Industry 5.0—were identified. Keyword mapping revealed two dominant research streams: behavioral and techno-managerial, with consumer behavior, trust, satisfaction, and interactivity emerging as central concepts. Despite the limited volume of publications, the selected corpus demonstrates strong citation impact, reflecting its scholarly relevance and potential to guide the future development of marketing research aligned with Industry 5.0 principles.

Based on the research findings, a key recommendation for planning future research activities is to focus on deepening knowledge about personalization and customer experience in digital environments especially in relation to the use of artificial intelligence and ethical data processing. These areas appear to be the most progressive and strongly aligned with the principles of Industry 5.0, as they merge technological advancement with a human-centric approach. Therefore, when designing research, it is advisable to closely examine the interactions between technology and consumer behavior, and to apply both qualitative and quantitative methods. This mixed-methods approach will enable a deeper understanding of personalization, trust, satisfaction, and customer value as core research variables.

The results of this study suggest clear implications for teaching courses such as Marketing Research or related subjects. Specifically, greater emphasis should be placed on principles such as personalization and customer experience, digital technologies and artificial intelligence, research ethics and data

protection, as well as data visualization and interpretation. While methodological aspects like sampling remain important, current teaching often lags behind the pace of practical developments, making innovation in curricula essential. Marketing research is no longer limited to traditional survey-based approaches it now requires the ability to respond to complex and dynamic environments through the use of advanced technologies, interdisciplinary thinking, and a strong focus on the practical relevance of research outcomes.

One key limitation of the present research lies in the ambiguity of marketing taxonomy "marketing research" may be interpreted both as basic and applied research, which is difficult to distinguish in large-scale bibliometric analyses. A further limitation is the relatively small number of publications explicitly linking marketing research with the Industry 5.0 concept, reflecting the early stage of integration between these domains. Additionally, the study focused exclusively on the Web of Science database, which may have resulted in the omission of relevant sources from other databases (e.g., Scopus, Google Scholar). The analysis was also limited to metadata (titles, abstracts, keywords), without in-depth assessment of full-text content. Future research should expand the data sources and apply more comprehensive evaluation techniques, including full-text analysis and qualitative synthesis.

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Resources

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The Impact of Loyalty Programs on Consumer Behavior: A Multivariate Analysis from Croatia

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Abstract

Research background: Loyalty programs have become a central marketing tool in retail strategies aimed at enhancing customer retention and long-term engagement. While their prevalence continues to grow globally, understanding how consumers perceive and respond to such programs remains context specific. In Croatia, where retail dynamics are rapidly evolving, it becomes crucial to assess how demographic variables influence consumer attitudes toward loyalty programs.
Purpose of the article: This paper aims to investigate the effects of gender and age on consumers' awareness, satisfaction, and loyalty toward retail loyalty programs. The study also explores the interrelationships among these three constructs, proposing that awareness and satisfaction play a key role in fostering customer loyalty. Through this approach, the research seeks to contribute to a better understanding of how demographic factors shape consumer responses to loyalty marketing efforts.
Methods: The research was conducted via an online survey distributed through social media platforms using random sampling across Croatia. Data collected from 450 respondents were analysed using MANOVA and regression techniques. Gender and age were treated as fixed factors, while awareness, satisfaction, and loyalty served as dependent variables. The study tested several hypotheses, including demographic impacts and correlation analyses between key constructs.
Findings & Value added: Results show that gender significantly influences all three dependent variables, while age significantly impacts awareness and satisfaction, but not loyalty. Furthermore, strong positive correlations were found between awareness and satisfaction, satisfaction and loyalty, and awareness and loyalty. These findings highlight the importance of tailoring loyalty programs based on demographic profiles and support the notion that increasing consumer awareness and satisfaction can directly enhance brand loyalty. The study adds value by offering empirical insights from the Croatian market, contributing to the broader field of consumer behavior in retail loyalty strategies.

Keywords: Consumer loyalty, Loyalty programs, Customer satisfaction, Demographic analysis, Retail marketing

JEL classification: M31, M37

1. Introduction

In the context of increasingly saturated markets and evolving consumer expectations, the ability of supermarkets to cultivate and retain consumer loyalty has emerged as a critical factor for sustained business success. Consumer behavior is constantly influenced by various factors (psychological, cultural, personal, and social), while market crises (such as the COVID-19 pandemic and wars) serve as triggers for changes in consumer behavior patterns (Šostar and Ristanović, 2023a.; Šostar and Ristanović, 2023b.) Once Loyalty programs, were viewed as simple transactional incentives, have evolved into sophisticated marketing tools aimed at fostering deeper, long-term relationships between retailers and their customers. Academic literature underscores that modern consumer loyalty is no longer driven solely by proximity,

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routine, or low prices; instead, it is shaped by an intricate interplay of factors such as trust, satisfaction, perceived value, and emotional engagement.

Research highlights the pivotal role of consumer awareness as a foundational step in the effectiveness of loyalty programs. Studies indicate that informed consumers are more likely to engage with program features and derive satisfaction from them. Satisfaction, in turn, is positively correlated with trust in the brand and long-term loyalty. Furthermore, the design and implementation of loyalty program features such as ease of use, reward relevance, and personalization significantly influence consumer perceptions and behaviors. Several studies also point to the role of active promotional monitoring, suggesting that consumers who frequently engage with loyalty promotions are more likely to remain loyal over time.

At the same time, demographic characteristics such as gender and age play a pivotal role in shaping how individuals perceive, engage with, and derive satisfaction from these programs. Understanding these patterns is essential for developing loyalty strategies that are both inclusive and effective across diverse consumer segments. Recognizing the impact of demographic variables on consumer engagement with loyalty programs is therefore essential for businesses aiming to foster long-term customer relationships and adapt to the increasingly nuanced expectations of today's marketplace.

2. Literature Review

2.1. Analysis using VOSviewer

The bibliometric analysis of the co-occurrence keyword map generated using VOSviewer provides a detailed view of the intellectual structure and thematic orientation of research in the area of customer loyalty and loyalty programs. This map visualizes how frequently keywords appear together in academic literature and clusters them into thematic groups based on their relational strength, emphasizing various elements of the advancement of scientific literature and finding 32 clusters .

Table 1. Clusters and Keywords

Sl. No	Clusters	Mapped colour	Keywords
1	Cluster – 1	Green	Satisfaction, Customer Loyalty, Customer behaviour, Brand experience, Consumer perceptions etc
2	Cluster – 2	Red	Program, Incentives, Reward, Relationship marketing, Competition, Innovation etc
3	Cluster – 3	Yellow	Loyalty program, Incentives, Reward, Competition, Innovation etc
4	Cluster – 4	Blue	Loyalty, Consumer response, Customer service, Competition
5	Cluster – 5	Pink	Behaviour, Trust, Consumer, Communication

Source: Authors elaboration

The colored clusters surrounding the core indicate thematic groupings. The green cluster emphasizes consumer behavior-related concepts such as word-of-mouth, social media, and adoption, suggesting that scholars often explore how external influences and personal experiences shape loyalty. The red cluster includes keywords like incentives, competition, game theory, and pricing, highlighting a more strategic and economic perspective on loyalty programs, including their structure and market competitiveness. The blue cluster, which includes keywords such as program, trends, and innovation, reflects attention on the design and evolution of loyalty programs themselves. Meanwhile, the yellow and orange clusters focus on emotional and experiential aspects such as customer experience, emotions, and service failure, illustrating the importance of affective responses and service recovery in loyalty formation (Table 1 and Figure 1). The co-occurrence keyword map Figure 1, generated using VOSviewer offers a visual representation of the thematic structure within the research field of customer loyalty and loyalty programs. At the center of the map, the most dominant keywords - "customer loyalty" and "satisfaction" - appear in large font and are densely connected to numerous other terms. This indicates their central role in the literature and frequent co-occurrence with other key concepts. Closely linked to these central terms are keywords such as "behavior," "consumer," "relationship quality," and "brand loyalty," reflecting a strong research focus on understanding the behavioral and psychological drivers of loyalty, as well as the outcomes tied to customer satisfaction.

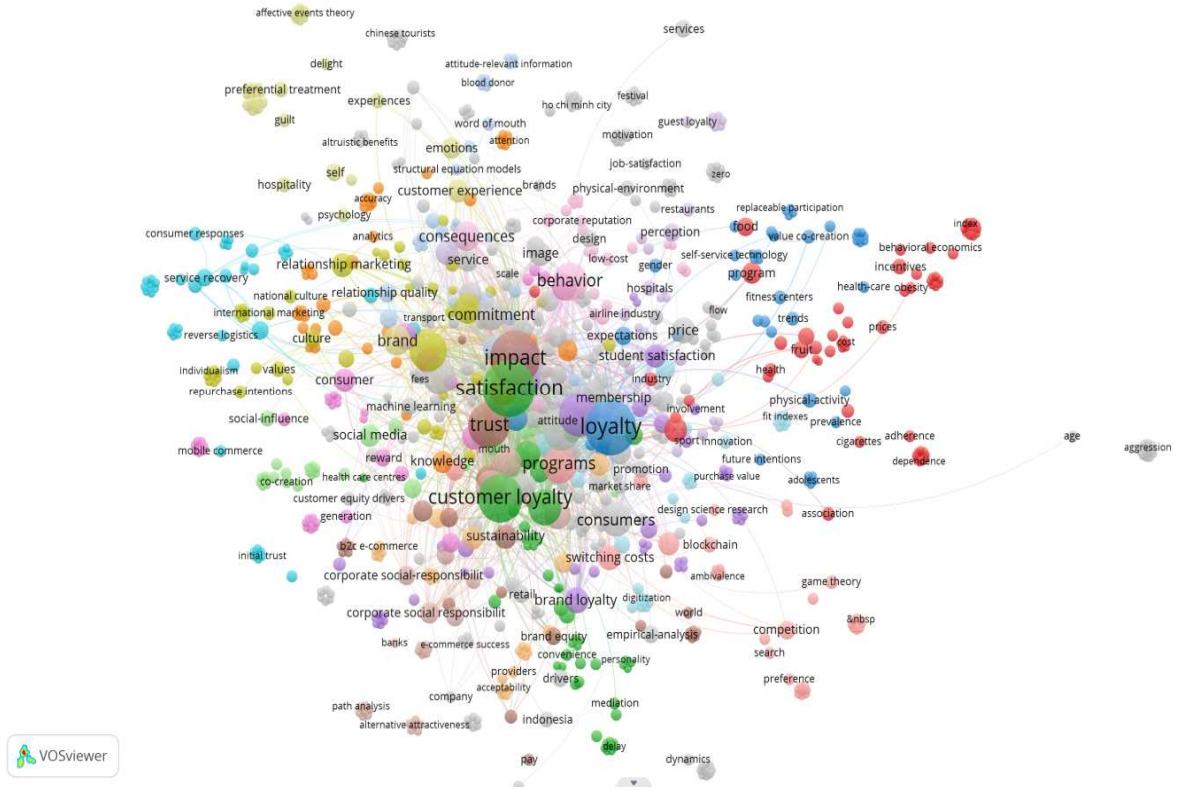

Figure 1. Network based on Co-occurrence Keywords Map
Source: Authors elaboration

The green cluster occupies a central position on the map and brings together core concepts such as customer loyalty, satisfaction, trust, impact, programs, and consumers. This group of terms reflects the main theme present in most studies in the field, an emphasis on the emotional, cognitive, and behavioral aspects of loyalty. Particular importance is placed on satisfaction and trust as key components of a long-term relationship between consumers and brands. The density and centrality of this cluster underscore its significance within the overall body of scientific literature. The red cluster is thematically focused on incentives, rewards, competition, innovation, program design, and relationship marketing. This group of terms illustrates the operational and strategic dimension of loyalty programs, specifically how rewards and incentives are used to achieve differentiation and increase market commitment. The connection between reward system design and competitive advantage highlights the importance of innovation and strategic planning. The yellow cluster contains terms that partly overlap with the red cluster but with a focus on loyalty programs, rewards, promotion, and market share. This cluster shows interest in the business and market outcomes of loyalty, particularly in the context of the effectiveness of various reward models. The link to promotional strategies and market share measurement indicates a quantitative and evaluative approach to the topic. The blue cluster includes terms such as consumer response, customer service, involvement, and switching costs. The focus here is on consumer reactions and their perception of service, as well as barriers that affect switching behavior. This cluster points to the importance of customer experience and service quality in shaping loyalty, particularly in service-oriented industries. The pink cluster is fundamentally built around terms like behavior, trust, communication, and consumer. It emphasizes the psychological and communicative aspect of the topic, how communication, perception, and interpersonal relationships shape consumer behavior. This cluster highlights the significance of the interpersonal dimension of loyalty, as well as the role of trust in shaping long-term preferences (Figure 1).

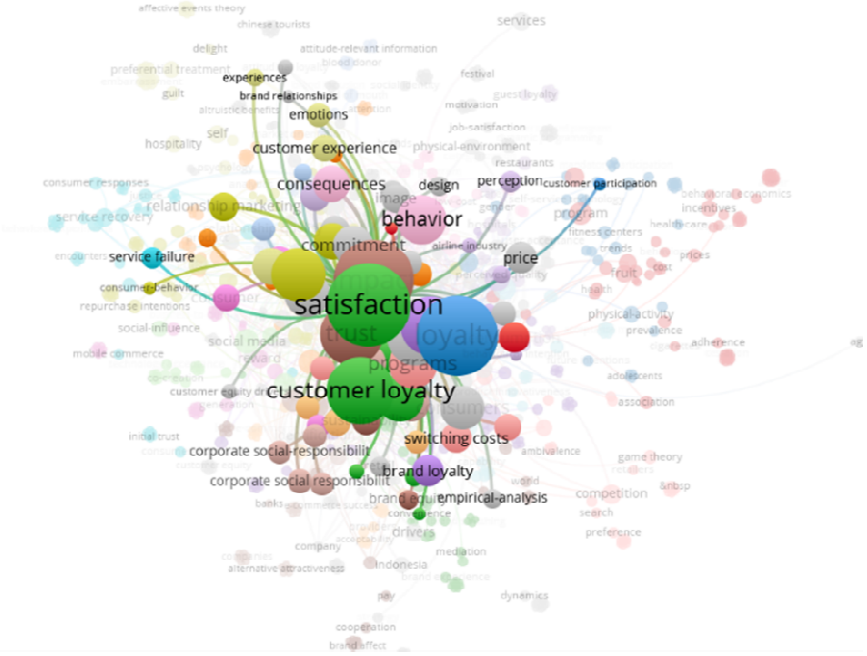

Figure 2. Keyword Co-Occurrence Network: Customer Satisfaction
Source: Authors elaboration

Figure 2 centers around the concept of satisfaction, which emerges as the most prominent and highly connected node. Its size and the number of links indicate that customer satisfaction is the most frequently examined outcome in the context of consumer loyalty. It is surrounded by key terms such as trust, customer loyalty, programs, behavior, customer experience, and consequences. The visual proximity and strength of these connections suggest that satisfaction and trust serve as critical mediating components in the relationship between customer experience and ultimate loyalty. The emphasis is clearly placed on the psychological and emotional dimensions of the consumer–brand relationship, where loyalty and satisfaction appear almost inseparable.

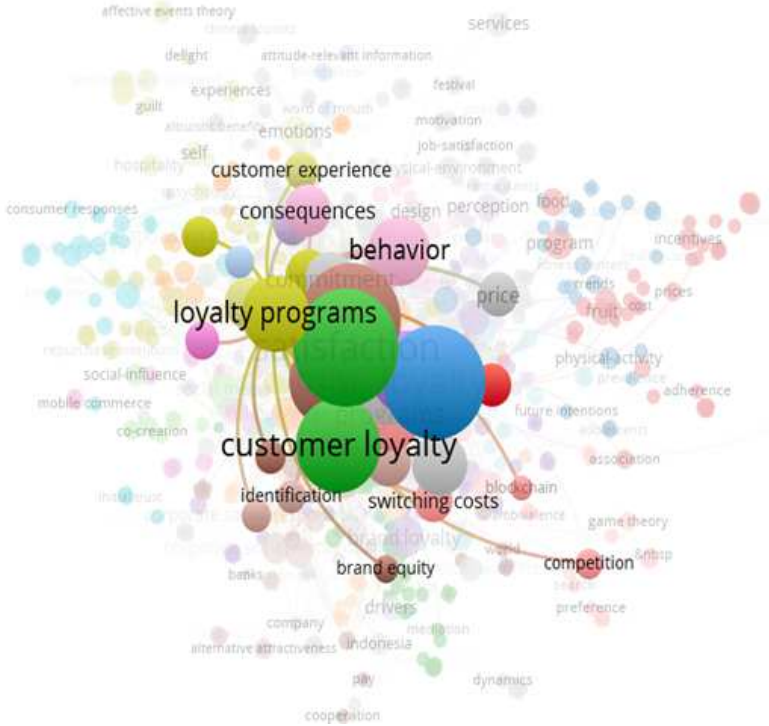

Figure 3. Keyword Co-Occurrence Network: Loyalty Programs
Source: Authors elaboration

Figure 3 shifts the focus from psychological to structural aspects — the term loyalty programs dominates and occupies the central position. Here, strong associations are observed with terms such as customer loyalty, switching costs, brand equity, competition, and reward. This network configuration suggests that loyalty programs are primarily analyzed as marketing tools designed to retain consumers and reduce their sensitivity to competition. Prominent terms like identification and incentives further underscore the role of personalization and reward mechanisms in shaping loyalty.

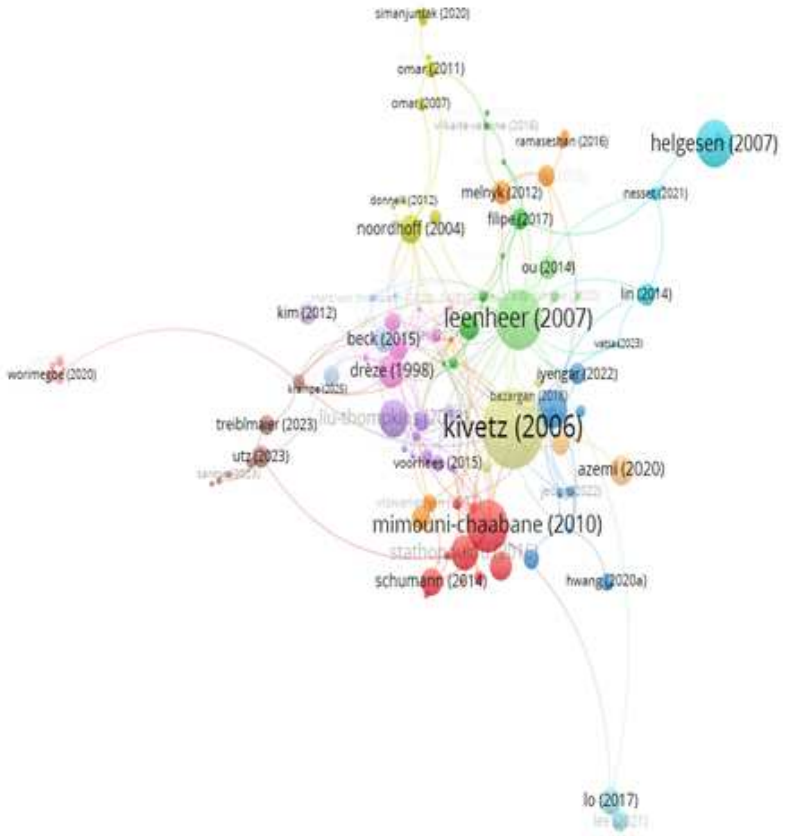

Figure 4. Network Based on Co-authorship Documents
Source: Authors elaboration

The bibliometric network map (Figure 4) based on Web of Science data visualizes co-authorship and citation linkages among prominent authors in the field of consumer loyalty and loyalty programs. The map displays 32 clusters, each color-coded to represent a group of closely related researchers who frequently cite or collaborate with one another. Central figures such as Leenheer (2007), Kivetz et al., 2006, and Mimouni-Chaabane and Volle, 2010 appear as large nodes, indicating their high citation impact and centrality within the research network. Leenheer et al., 2007 and Kivetz et al., 2006 form the intellectual backbone of the network, serving as major hubs that connect to various other clusters, suggesting their foundational role in shaping loyalty program theory and practice. Leenheer's connections span multiple clusters, reflecting the multidisciplinary influence of his work, particularly in the context of customer loyalty program effectiveness and consumer response. Kivetz, known for contributions on reward preferences and motivation, shows strong ties with both psychological and marketing-focused authors. Mimouni-Chaabane and Volle, 2010 and other authors, in the red cluster, are part of a group examining emotional, relational, and commitment-based aspects of loyalty. Meanwhile, the green cluster appears to focus on strategic management and service marketing perspectives, emphasizing loyalty within broader business performance frameworks. The blue cluster, including authors like Azemi, points toward more recent and possibly digital-era loyalty dynamics.

2.2. Structure and Characteristic of Loyality Programs

Shahzad and Norazah, 2022 explore how relational benefits like confidence, altruism, and self-expression positively influence relationship quality, which then mediates customer citizenship behavior.

In the study conducted by them,it is said that relational benefits and relationship quality play a key role in promoting favorable consumer behavior. This highlights how loyalty program elements can shape deeper relational loyalty, going beyond transactions to foster voluntary customer advocacy.

Stourm and Bradlow, 2023 examine point currency devaluation in coalition programs, revealing cross-reward effects where rewards from one store influence loyalty at another. Popular stores face higher risks from devaluation, emphasizing the need for consistent reward value to retain consumer trust and engagement. Hwang et al., 2020 examined recovery strategies in loyalty programs and found that customers prefer dollar-based compensations over miles when faced with service failures. The study highlights the importance of aligning financial recovery options with consumer expectations to maintain loyalty and trust.

Song et al., 2021 explore how perceived value influences consumers' willingness to pay in the context of bike-sharing programs in China. Their study applies perceived value theory and structural equation modeling to show that customers' perceived value of a service directly impacts their willingness to engage with it, even in low-cost or subsidized markets. This research is relevant to loyalty programs, as perceived value, whether through discounts, rewards, or exclusivity, can significantly influence consumer behavior and enhance program effectiveness.

Söderlund, 2019 explores the psychological impact of labeling customers as "members" in loyalty programs. The study finds that the mere act of membership labelling significantly boosts customer satisfaction by enhancing perceived exclusivity and belonging. This emotional benefit, coupled with financial perks, increases program engagement. While not directly financial, the satisfaction induced by psychological factors like recognition and group identity plays a vital role in program success, especially when paired with tangible rewards.

Nesset et al., 2021 provides empirical evidence from the Norwegian grocery market, showing that loyalty programs are critical to building chain loyalty. Key findings indicate that financial incentives (discounts, reward points) and emotional engagement both contribute to long-term loyalty. Importantly, consumer satisfaction is directly tied to their understanding and perceived fairness of the program, reinforcing that awareness and transparency are foundational for loyalty program success. Building on earlier work, this paper by Viswanathan et al., 2022 quantifies how status tiers influence engagement and perceived value in loyalty programs. Higher tiers lead to significantly greater financial benefits and emotional satisfaction, increasing customer loyalty. The findings stress the importance of making tier progression and rewards highly visible and understandable, ensuring that customers are aware of how to move up and what they stand to gain. The event study analysis by Faramarzi and Bhattacharya, 2021 quantifies the financial impact of loyalty programs on firms, showing a positive stock market reaction upon program announcements. From a consumer perspective, programs that offer clear, measurable financial benefits such as discounts or cash-back rewards are more likely to enhance satisfaction and loyalty. Reiblmaier and Petrozhitskaya, 2023 proposes that blockchain technology is redefining B2C relationship management by promoting transparency, security, and decentralization in loyalty programs. It argues for a paradigm shift where consumers gain greater control and awareness over their rewards. The trust fostered by blockchain enhances satisfaction, while its cost-efficiency and traceability deliver tangible financial benefits. This sets the stage for more equitable and engaging loyalty mechanisms aligned with emerging digital expectations.

Bies et al., 2021 in the empirical study examines the effect of push notifications on spending and reward redemption in loyalty programs. The findings show that timely and targeted messages increase consumer awareness, leading to higher redemption rates and increased basket sizes. Satisfaction improves as consumers feel guided and recognized, while financial benefits are maximized through strategic prompting that aligns with purchase intent. It demonstrates that awareness is not just about knowledge but also real-time engagement.

Bombaij, Gelper and Dekimpe, 2022 explores short-term or temporary loyalty initiatives, examining effectiveness across countries and retailer types. Surprisingly, short-term programs can be highly effective if well-publicized and aligned with customer needs. Awareness campaigns are crucial - without them, even attractive financial offers fail. Satisfaction is driven by the perceived urgency and exclusivity of the offer, while financial incentives (e.g., limited-time discounts or bonus points) are key motivators. Górajski and Machowska, 2019 examines how loyalty programs affect brand goodwill over time. A loyalty program that maintains high consumer awareness and financial attractiveness increases brand value. However, overuse or poor design can lead to diminishing returns. Programs must strike a balance

between investment in customer rewards and long-term brand equity, with satisfaction acting as a mediating factor.

Worimegbe et al., 2020 explore the effect of gamification on customer experience in the hospitality industry. The integration of game-like elements into loyalty schemes significantly boosts consumer engagement and awareness. Gamification enhances satisfaction by making participation enjoyable and financially rewarding, especially when users are continuously informed of their progress and upcoming benefits, thereby reinforcing a sense of achievement. Xu and Meng, 2021 explore the strategic dynamics of paid membership programs. Unlike free loyalty schemes, paid programs demand a higher level of consumer commitment and hence require stronger financial benefits and clearer value propositions. The study finds that awareness of benefits and trust in long-term gains are critical in justifying the upfront cost, reinforcing the importance of transparency and ongoing satisfaction.

Krampe, et al., 2025 introduce the concept of "green loyalty", examining consumer preferences in sustainable temporary loyalty programs. Consumers are increasingly aware of the ethical implications of their purchases, and programs that promote sustainability alongside financial rewards receive higher engagement and satisfaction scores. The authors conclude that financial benefits must be balanced with ethical messaging, and awareness must be raised through transparent and values-driven marketing. Nishio and Hoshino, 2022 use joint modeling to evaluate tier-based loyalty programs, finding that customers in higher tiers tend to spend more and stay longer. However, the study also finds that these outcomes are conditional on consumers' awareness of the benefits associated with each tier. Satisfaction arises when customers perceive a just correlation between loyalty status and rewards, reinforcing the necessity of clear tier communication. Lee et al., 2021 explore the psychological aftermath of double deviation incidents - when both the service and its recovery fail. Their findings suggest that loyalty program members are particularly sensitive to such failures due to high expectations tied to membership status. However, transparent apology and compensatory financial rewards can partially restore satisfaction and trust, suggesting that consistent program integrity is key to maintaining loyalty. Lo et al., 2017 investigate the role of loyalty programs in building brand relationship quality among hotel guests. Their research highlights that when loyalty members perceive emotional and functional value from program rewards, their satisfaction and brand attachment significantly increase. This underscores the need for loyalty initiatives that combine financial incentives with affective experiences to foster consumer retention. Ozuem et al., 2021, focusing on millennials in the fashion sector, show that online brand communities play a crucial role in reinforcing loyalty by increasing brand-related awareness and satisfaction. The study finds that community engagement boosts members' emotional connection and perceived exclusivity, which are essential for sustaining brand loyalty - especially when rewards are tied to active participation.

2.3. Perceive Value and User Experience

Loyalty programs (LPs) have been considered a key determining factor for the performance of many companies. It is one of the nonverbal way to communicate with the customers which can make a difference at customers mind (Šostar, et al., 2022). Limberger et al., 2021 analyze the role of customer involvement in airline loyalty programs, revealing that satisfaction and perceived functional value mediate the loyalty relationship. Importantly, consumer involvement acts as a moderator, suggesting that awareness and engagement are critical for maximizing program effectiveness. Xu and Hu (2022) explore how loyalty programs combined with virtual communities and social media enhance perceived value and customer loyalty in convenience stores. Their study suggests that emotionally resonant program structures and timely rewards significantly improve consumer response and loyalty behavior.

Zhang, 2020 investigates the role of ongoing trust in tourism O2O platforms, identifying that trust in both offline and online elements - reinforced by loyalty benefits and quality confirmations, supports continued platform use. The study highlights the importance of perceived benefits and trust-building features in maintaining customer engagement and loyalty over time. Aydin, 2022 reveals that hedonic and symbolic value in mobile multi-brand loyalty programs (CMLPs) are as influential as monetary benefits in driving satisfaction. Personalization through digital data analytics significantly enhances perceived value and customer retention. Končar et al., 2019; Šostar et al., 2024. state that expected benefits such as discounts, special offers, and point accumulation shape consumers' decisions to use loyalty cards. The effectiveness of loyalty cards depends on clearly communicated financial advantages. The study highlights key indicators influencing customer expectations from loyalty cards, such as price discounts, personalized communication, efficient service, and rewards, based on a sample from Central and

Southeast Europe. These indicators form the basis for a regression model that retail managers can use to optimize loyalty programs in line with customer expectations.

Behl and Pereira, 2021 explored the role of gamification in mobile apps and found that features like digital scratch cards enhance customer engagement and loyalty through an interactive user experience. Their experimental design confirmed that gamified rewards positively influence behavioral intentions and user satisfaction with loyalty applications. Jeong et al., 2022 investigated how personalized recommendations and rewards influence customer behavior, finding that personalization significantly enhances emotional engagement and loyalty. Their S-O-R model demonstrated that well-tailored loyalty stimuli can strongly drive positive customer responses and repurchase intentions. Liu et al., 2021 evaluated "Buy X, Get One Free" schemes and demonstrated that these programs are highly effective in stimulating short-term purchases and increasing customer retention. Their quantitative model revealed that reward timing and product type influence perceived value and redemption behavior.

Nishio and Hoshino, 2024 examined birthday rewards and identified both short- and long-term loyalty enhancements from personalized promotional incentives. Their findings showed that emotionally significant and financially valuable rewards strengthen customer-brand attachment and repeat purchase behavior. Farhan et al., 2020 extended the concept of brand loyalty to political branding, revealing that relationship quality and emotional engagement significantly influence voter loyalty and advocacy behavior. Although in a political context, their findings underline the universal role of trust and satisfaction in driving loyalty, applicable across sectors.

Simanjuntak et al., 2020 focus on enhancing customer retention using a customer relationship management (CRM) approach in the car loan business. They show that CRM strategies, which are often embedded in loyalty programs, significantly contribute to customer retention. By focusing on personalized relationships and understanding customer needs, businesses can improve their retention rates. This approach ties into the broader concept that customer satisfaction, particularly through customized loyalty offerings, enhances loyalty and leads to repeat business. Fourie et al., 2022 discuss the design of effective loyalty programs in the financial services industry. Their study identifies key design elements, such as reward structure and ease of use, that are critical to the success of financial service loyalty programs. They emphasize that offering clear financial benefits, such as cashback or preferential rates, can significantly boost consumer satisfaction and loyalty. This is particularly relevant in industries where financial transactions and customer loyalty are intricately linked. Voorhees et al., 2015 assesses the impact of airline loyalty programs on brand equity perceptions and share of wallet. It concludes that loyalty programs positively influence consumer spending and brand perceptions only when the perceived value is high. Consumers who see financial advantages and status-related rewards are more likely to consolidate their purchases with a single brand. The findings reinforce that consumer awareness of tiered benefits and the financial attractiveness of rewards are key drivers of satisfaction and loyalty.

Vatsa et al., 2023 explore how loyalty programs integrated into digital wallets enhance customer experience. Their research confirms that financial benefits like cashback and point accumulation significantly increase satisfaction and retention. Moreover, consumers who understand and frequently use these features are more likely to remain loyal. The study emphasizes the need for consumer education and feature visibility, ensuring that users are aware of their benefits and can easily access them.

Albarq, 2023 investigates how Customer Knowledge Management (CKM) and satisfaction affect loyalty in the banking sector. The study reveals that satisfaction mediates the relationship between CKM and loyalty, and that trust also plays a central role. Loyalty programs that clearly communicate benefits and manage customer information effectively result in higher perceived value, increased trust, and long-term loyalty. Santos et al., 2023 proposes a blockchain-based framework for loyalty management that enhances interoperability, trust, and user experience. The system allows consumers to exchange or aggregate points across multiple vendors, increasing the perceived financial benefit. Additionally, the use of smart contracts ensures fair and automated reward delivery, contributing to consumer satisfaction. Tu, Hsu and Wu, 2022 in their paper introduces a blockchain-based loyalty system integrated with call auction mechanisms, allowing customers to bid for rewards in a dynamic system. This novel approach increases consumer interaction and perceived value through competitive reward access. It enhances consumer awareness by making point utility and redemption values visible and dynamic. Financially, it increases perceived fairness and potential gains, boosting satisfaction and long-term engagement.

Wu et al., 2020 focuses on item-based loyalty programs, where consumers are rewarded for buying specific products. These short-term initiatives boost sales and alter purchase patterns in the short run,

especially when well-promoted. Financial benefits are immediate and visible, leading to short bursts of satisfaction and engagement. Awareness is driven by in-store signage and digital prompts. Ou et al., 2014 delve into the role of consumer confidence in fostering loyalty. The authors find that customer trust and satisfaction in loyalty programs stem largely from confidence in the brand and the perceived stability of rewards. Clear communication and financial predictability, such as guaranteed points or cashback, are essential to building confidence, which in turn strengthens awareness and loyalty.

2.4. Contextual Factors and Implementation Streategies

de Souza Junior and Sarfati, 2020 show that mobile loyalty program adoption increases purchase frequency and basket value, proving financial benefits for both firms and consumers. Their analysis supports the digital transformation of retail loyalty programs. This study provides empirical evidence that implementing a mobile loyalty platform significantly enhances customer loyalty and spending in the Brazilian retail sector. Customers using the mobile app had an 11.4% higher average ticket, and mobile sales were nearly four times higher than physical store sales. The findings emphasize that mobile loyalty programs, when well-integrated with store operations, can effectively drive both new customer acquisition and retention of existing customers. The research suggests that small and medium-sized supermarkets can benefit from investing in mobile platforms to strengthen customer loyalty.

The study by Balakrishnan et al., 2020 explores how coupons, online memberships, and peer influence affect repurchase intentions in online marketplaces, focusing on their psychological impacts. Findings show that while coupons and memberships effectively drive revenue and encourage purchases, they can also lead to post-purchase psychological discomfort. Offering after-purchase coupons may help reduce cognitive dissonance, though it may not fully address emotional dissatisfaction, highlighting the importance of managing both functional and emotional aspects of loyalty tools.that retail coupons and membership-based loyalty schemes foster a sense of belonging, enhancing satisfaction and psychological disposition toward the brand. Strategic labeling and membership awareness increase emotional loyalty. Lee-Anant, 2022 conducted an in-depth analysis of frequent flyer programs and emphasized their strategic importance in increasing brand commitment and market share in the airline industry. The study concluded that personalized rewards and elite tier benefits are key drivers of consumer loyalty.

Kwiatek and Thanasi-Boçe, 2019 examine the effects of loyalty program activity on B2B customer behavior. Their findings indicate that B2B loyalty programs that offer targeted incentives can increase purchasing behavior and deepen customer relationships. The study suggests that in business-to-business contexts, the value of loyalty programs is enhanced when businesses tailor rewards to meet specific customer needs, leading to higher levels of engagement and repeated transactions. In their study, Johan, et al., 2022 analyses how specific e-wallet features, including integrated loyalty programs, affect continued use in Indonesia. The authors find that financial rewards such as cashback and loyalty points strongly drive continued usage, especially when consumers are made aware of these benefits. Program transparency and user awareness are critical; when users clearly understand how they benefit from using the e-wallet (e.g., real-time points accumulation), satisfaction and continued engagement rise. On the other hand, Rybaczewska & Sparks, 2020 investigates how local identity and emotional attachment to places interact with loyalty schemes. Although focused on place-based marketing, the study finds that combining financial incentives with emotional value (such as supporting local economies) leads to higher consumer engagement. The research suggests that awareness campaigns emphasizing both financial and community benefits of loyalty programs can improve satisfaction and loyalty, especially in smaller or community-oriented markets.

Mastilak et al., 2023 explores the use of blockchain for developing sustainable and transparent loyalty systems. Consumers benefit from improved tracking, secure redemption, and transparent point management, which enhances trust and satisfaction. Financially, decentralized reward management reduces fraud and inefficiencies, while program transparency increases consumer engagement. Utz et al., 2023 ocus on consumer trust in blockchain-powered loyalty programs, tracing the evolution from initial skepticism to trust via user education, transparency, and operational reliability. As consumers gain awareness of the system's integrity, their satisfaction grows. Financially, reduced fraud and frictionless transactions increase the efficiency and value of programs.

Program awareness, such as understanding terms and redemption policies, correlates with satisfaction and participation. This suggests the need for culturally adapted communication strategies to increase loyalty outcomes. Gubíniová et al., 2023 analyse on the hospitality sector in China, identifying

what drives customer loyalty in hotels. Key drivers include clear communication, visible and flexible rewards, and status recognition. Consumers are more satisfied when they feel informed and in control of their rewards, and financial benefits such as room upgrades or cashback are most valued. The study reinforces the importance of program design transparency and cultural relevance.

Kimura, 2021 investigates how customer segments evolve over time through loyalty program participation. The study highlights that effective loyalty programs not only retain existing customers but facilitate transitions between low- and high-value segments, provided that consumers are fully aware of the potential rewards and benefits. Consumer satisfaction is closely tied to this upward transition, as customers perceive financial benefits and status upgrades as validation of their loyalty. Edirisinghe et al., 2020 contribute a psychological dimension by examining female consumers' emotional connections with small- and medium-sized clothing retailers. Loyalty programs that cater to emotional satisfaction and social bonding—alongside financial rewards, lead to stronger customer-retailer relationships. The research emphasizes that awareness campaigns should extend beyond technical benefits to also communicate emotional and identity-based advantages, thus deepening satisfaction.

Kanakaratne et al., 2020 assess how national culture and retail structure influence grocery customer loyalty. The study finds that in collectivist societies, emotional and social loyalty benefits are more persuasive, while in individualist cultures, financial incentives and transparency take precedence. Consumer awareness of program mechanics and reward certainty plays a central role in shaping loyalty behavior across different environments. Thompson and Tuzovic, 2020 critically examine the limits of organizational loyalty programs in preventing customer switching. Their study reveals that awareness alone is insufficient when customers perceive loyalty schemes as lacking in personalization or meaningful benefits. When satisfaction from service delivery does not align with loyalty incentives, even well-known programs fail to secure long-term commitment, emphasizing the need for integrated satisfaction strategies alongside financial perks. In a follow-up study, Bazargan, et al., 2018 analyze the profitability of "Buy n, Get 1 Free" loyalty cards using game theory. They show that such offers can be successful in competitive markets only if consumers fully understand and value the reward structure. Misalignment between perceived value and actual cost to the consumer often results in underperformance, suggesting that awareness and perceived fairness of financial rewards are essential for loyalty success.

Ding et al., 2021 study how non-member customers perceive the freedom-restricting nature of loyalty programs. The research reveals that when non-members feel excluded or manipulated, they develop negative perceptions of the brand. However, when programs are presented as flexible and financially advantageous, overall brand perception and future participation likelihood improve. This highlights the need for inclusive communication strategies to build program awareness and convert non-members.

Dudek et al., 2021 investigate consumer switching behavior in Poland's energy market, focusing on loyalty in traditionally non-competitive sectors. The study emphasizes that financial incentives are insufficient without trust and awareness of alternatives. Loyalty programs that inform and empower consumers are more effective at retaining them, even when price-based switching is tempting. Laškarin et al., 2020 offers a tourism-focused perspective, identifying emerging trends and challenges in loyalty program research. They stress the importance of experiential and emotional satisfaction alongside financial incentives. The study recommends that hospitality firms prioritize program visibility and communication, especially in digital platforms, to enhance awareness and long-term consumer connection. Lee et al., 2022 study the effectiveness of direct booking incentives for loyalty program members in the hospitality industry. They find that when hotels offer exclusive prices or perks to members booking directly, perceived value and brand loyalty increase. This demonstrates the potential of clearly communicated, tangible financial benefits in influencing consumer decision-making and reinforcing loyalty.

Boukis, 2024 introduces a modern dimension by exploring tokenized rewards in loyalty programs. The research indicates that blockchain-based tokens, when perceived as transparent and valuable, enhance trust and financial satisfaction, particularly among tech-savvy consumers. Tokenization adds an innovative layer to the financial benefit structure, increasing engagement through digital ownership and flexibility.

Gorlier and Michel, 2020 delve into the psychological depth of loyalty by examining how special or personalized rewards create self-expansion, thereby strengthening consumer-brand relationships. Their

study reveals that such rewards enhance emotional satisfaction and boost awareness of personal value alignment with the brand, showing that non-monetary benefits can rival financial ones in impact.

In a parallel study by Ozuem et al., 2021 published in a different outlet, further support is provided for the notion that interactive and socially engaging loyalty platforms heighten brand loyalty through millennials' sense of digital belonging, confirming the importance of awareness and community-based value delivery in loyalty marketing. Todea et al., 2022 apply loyalty analysis in a higher education context, demonstrating that emotional connection, trust, and perceived program quality are fundamental determinants of loyalty, even outside traditional commerce. The structural model confirms that both awareness of institutional benefits and satisfaction with academic services drive continued engagement, findings transferable to commercial loyalty programs. Nikolajenko-Skarbalė and Viederytė-Žilienė, 2023 offer a conceptual overview of modern loyalty transformation, emphasizing personalization, data-driven engagement, and cross-channel coherence. They argue that programs must now evolve beyond transactional offers to include value-based, emotionally resonant experiences that improve both awareness and satisfaction with long-term program participation. Krafft et al., 2021 discuss the consumer-firm data exchange dynamic in loyalty settings, finding that when consumers understand and feel in control of how their data is used (awareness), they are more willing to engage in loyalty programs and perceive greater value and fairness in personalized financial rewards. Transparency, therefore, becomes a loyalty driver in itself. Laškarin et al., 2020 revisited in this batch, further emphasize emerging loyalty trends in tourism, noting the increasing demand for customized, meaningful, and emotionally satisfying program offerings. They suggest that future loyalty programs must fuse clear communication, flexible financial incentives, and experiential rewards to remain relevant.

3. Methods

The Systematic Literature Review (SLR) approach is used in this study to assess the areas under consideration. According to the theoretical framework offered, an exact SLR generally assists in generating a solid understanding of what is known in a subject field, detecting research trends and trajectories, and setting a research plan. The growth of evidence-based practice has resulted in an increasing variety of review types. A pool of academic contributions was obtained by conducting a keyword search of Web of Science-indexed papers. Web of Science was chosen as the database because it offers complete scientific, technological, and sociological content from all relevant scientific publications.

After a detailed literature review, the research hypotheses were formulated, followed by the implementation of a survey questionnaire and subsequent statistical data analysis using Multivariate Analysis of Variance (Figure 5). The survey was conducted in 2025 in the Republic of Croatia on a random sample of 450 respondents via social media platforms.

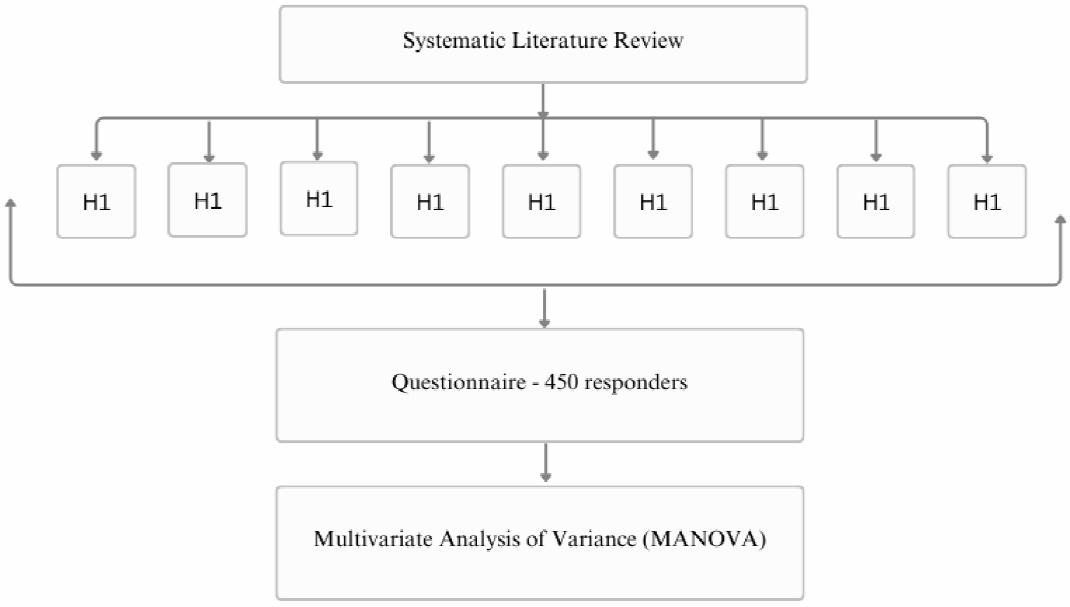

Figure 5. Research Design and Methodology Framework
Source: Authors elaboration

Note: H1: There is a significant impact of gender on overall consumer awareness of loyalty programs; H2: There is a significant impact of gender on consumer satisfaction with loyalty programs; H3: There is a significant impact of gender on consumer loyalty toward retail stores; H4: Age group significantly influences awareness of loyalty programs; H5: Age group significantly influences satisfaction with loyalty programs; H6: Age group significantly influences consumer loyalty; H7: There is a strong positive correlation between awareness and satisfaction; H8: There is a strong positive correlation between satisfaction and loyalty; H9: There is a strong positive correlation between awareness and loyalty.

Table 2. Demographic Structure of Responders

Gender of responders		**Age of responders**				**Total**
Male	**Female**	**Up to 25**	**26-40**	**41-55**	**56+**	**/**
152	298	103	197	110	40	450

Source: Authors elaboration

Looking at the demographic structure of the respondents (Table 2), it is evident that, traditionally, more women participated in the research (298 responders), and that the largest portion of respondents were between 26 and 40 years of age (197 responders), while the smallest group consisted of older individuals aged 56 and above (40 responders).

4. Results

In order to examine the effects of gender and age on consumer attitudes toward loyalty programs, as well as the relationships between awareness, satisfaction, and loyalty, a series of statistical analyses were conducted. The results of MANOVA, ANOVA, assumption checks, and correlation analyses are presented in the following tables.

Table 3. Multivariate Analysis of Variance (MANOVA) Results Using Pillai's Trace for the Effects of Gender and Age on Consumer Awareness, Satisfaction, and Loyalty

Cases	**df**	**Approx. F**	**Trace $_{Pillai}$**	**Num df**	**Den df**	**p**
(Intercept)	1	1972.928	0.931	3	440.000	< .001
Gender	1	8.613	0.055	3	440.000	< .001
Age	3	2.587	0.052	9	1326.000	0.006
Gender ✻ Age	3	1.061	0.021	9	1326.000	0.389
Residuals	442					

Source: Authors elaboration

Table 3 presents the results of the MANOVA analysis using Pillai's Trace criterion, which is considered one of the more robust tests in cases where the assumptions of normality and homogeneity of covariance matrices are slightly violated. The analysis was conducted to examine the joint effects of gender and age, as well as their interaction, on three dependent variables: consumer awareness, satisfaction, and loyalty. The results show that gender has a statistically significant effect on the combination of these three variables, as indicated by the Pillai's Trace value of 0.055 and the associated F-test ($F = 8.613$, $p < .001$). Age also emerged as a significant factor, with a Pillai's Trace value of 0.052 and a p-value of 0.006. In contrast, the interaction between gender and age was not statistically significant, suggesting that their effects on the dependent variables operate independently. These findings indicate that both gender and age are relevant factors in understanding consumer attitudes toward loyalty programs.

Table 4. Multivariate Analysis of Variance (MANOVA) Results Using Wilks' Lambda for the Effects of Gender and Age on Consumer Awareness, Satisfaction, and Loyalty

Cases	**df**	**Approx. F**	**Wilks' Λ**	**Num df**	**Den df**	**p**
(Intercept)	1	1972.928	0.069	3	440.000	< .001
Gender	1	8.613	0.945	3	440.000	< .001
Age	3	2.591	0.949	9	1070.995	0.006
Gender ✻ Age	3	1.060	0.979	9	1070.995	0.390
Residuals	442					

Source: Authors elaboration

Table 4 presents the results of the same model using an alternative test – Wilks' Lambda – which serves to validate the findings from the previous analysis. The results align closely with those from the Pillai's Trace test. Gender has a significant effect on the set of dependent variables, with a Wilks' Lambda of 0.945 and F-value of 8.613 ($p < .001$), confirming that there is a difference between men and women when it comes to awareness, satisfaction, and loyalty. Similarly, age is again shown to be a significant predictor, with a Wilks' Lambda of 0.949 and a p-value of 0.006. The interaction between gender and age remains non-significant. These results reinforce the previous analysis and suggest that gender and age independently influence consumer behavior in the context of loyalty programs.

Table 5. One-Way ANOVA Results for the Effect of Gender and Age on Consumer Awareness of Loyalty Programs

Cases	Sum of Squares	df	Mean Square	F	p
(Intercept)	4783.724	1	4783.724	3888.960	< .001
Gender	7.782	1	7.782	6.326	0.012
Age	13.498	3	4.499	3.658	0.013
Gender ✻ Age	5.301	3	1.767	1.437	0.231
Residuals	543.694	442	1.230		

Source: Authors elaboration

Table 5 analyzes the effect of gender and age on consumer awareness of loyalty programs using a one-way ANOVA. The results indicate a statistically significant effect of gender, with men and women differing significantly in their level of awareness ($F = 6.326$, $p = 0.012$). Age is also a significant factor ($F = 3.658$, $p = 0.013$), suggesting differences in awareness among age groups. The interaction between gender and age is not statistically significant, indicating that the joint effect of these two factors is not greater than their individual effects. These findings support the notion that demographic characteristics such as gender and age play an important role in shaping consumers' awareness of loyalty programs.

Table 6. One-Way ANOVA Results for the Effect of Gender and Age on Consumer Satisfaction with Loyalty Programs

Cases	Sum of Squares	df	Mean Square	F	p
(Intercept)	5837.761	1	5837.761	5481.105	< .001
Gender	24.313	1	24.313	22.828	< .001
Age	14.734	3	4.911	4.611	0.003
Gender ✻ Age	1.150	3	0.383	0.360	0.782
Residuals	470.761	442	1.065		

Source: Authors elaboration

Table 6 examines the influence of gender and age on consumer satisfaction with loyalty programs. The results reveal a strong and statistically significant effect of gender on satisfaction ($F = 22.828$, $p < .001$), indicating a clear difference in how men and women perceive satisfaction with such programs. Age is also significant ($F = 4.611$, $p = 0.003$), confirming that different age groups experience satisfaction in diverse ways. The interaction between gender and age is not significant, again confirming that these demographic factors act independently rather than synergistically. These findings highlight the importance of tailoring loyalty programs to various demographic groups in order to enhance customer satisfaction.

Table 7. One-Way ANOVA Results for the Effect of Gender and Age on Consumer Loyalty Toward Retail Stores

Cases	Sum of Squares	df	Mean Square	F	p
(Intercept)	5185.693	1	5185.693	4356.506	< .001
Gender	17.019	1	17.019	14.298	< .001
Age	6.935	3	2.312	1.942	0.122
Gender ✻ Age	3.266	3	1.089	0.915	0.434
Residuals	526.127	442	1.190		

Source: Authors elaboration

Table 7 explores how gender and age affect consumer loyalty to retail stores offering loyalty programs. Gender once again emerges as a significant predictor ($F = 14.298$, $p < .001$), indicating that

there is a statistically significant difference in loyalty between genders. However, age does not have a significant effect on loyalty (F = 1.942, p = 0.122), suggesting that consumer loyalty is not determined by age. The interaction between gender and age is also not significant. These results imply that while gender plays an important role in shaping loyalty, age does not appear to be a decisive factor in consumers' inclination to remain loyal to stores.

Table 8. Box's M Test for the Homogeneity of Covariance Matrices Across Gender and Age Groups

χ^2	df	p
64.874	42	0.013

Source: Authors elaboration

Table 8 presents the results of Box's M test, which assesses the assumption of homogeneity of covariance matrices across groups. A statistically significant result (χ^2 = 64.874, p = 0.013) indicates that this assumption is violated, which poses a potential threat to the validity of the MANOVA results. Nevertheless, since Pillai's Trace is relatively robust in such situations, the results can still be considered reliable, although they should be interpreted with caution. This means that the observed effects of gender and age should ideally be confirmed with additional analyses or interpreted acknowledging this limitation.

Table 9. Shapiro–Wilk Test of Multivariate Normality for Dependent Variables

Shapiro-Wilk	p
0.991	< .001

Source: Authors elaboration

Table 9 presents the results of the Shapiro–Wilk test, which is used to check the assumption of multivariate normality. The test result (W = 0.991, p < .001) indicates a statistically significant deviation from normal distribution. Although this technically violates one of the key assumptions of MANOVA, it is worth noting that such deviations are more acceptable in studies with larger sample sizes, such as the present one, which included over 400 respondents. Therefore, despite the lack of perfect normality, the results can still be considered valid within the robustness of the MANOVA framework.

Table 10. Pearson's Correlation Coefficients Between Consumer Awareness, Satisfaction, and Loyalty

		Awareness	Satisfaction	Loyalty
Awareness	n	-	-	-
	Pearson's r	-	-	-
	p-value	-	-	-
	Lower 95% CI	-	-	-
	Upper 95% CI	-	-	-
Satisfaction	n	450	-	-
	Pearson's r	0.718***	-	-
	p-value	< .001	-	-
	Lower 95% CI	0.669	-	-
	Upper 95% CI	0.760	-	-
Loyalty	n	450	450	-
	Pearson's r	0.694***	0.703***	-
	p-value	< .001	< .001	-
	Lower 95% CI	0.643	0.654	-
	Upper 95% CI	0.739	0.747	-

Source: Authors elaboration

Table 10 presents the results of Pearson's correlation analysis among the three key dependent variables: awareness, satisfaction, and loyalty. The results show a strong positive correlation between awareness and satisfaction (r = 0.718, p < .001), meaning that as consumers' awareness increases, so does their satisfaction with loyalty programs. Additionally, satisfaction and loyalty are also strongly correlated (r = 0.703, p < .001), supporting the assumption that satisfied consumers are more likely to remain loyal to a given store. Finally, there is a strong correlation between awareness and loyalty as well (r = 0.694, p < .001), indicating that more informed consumers are more likely to remain loyal to retailers offering

loyalty programs. These correlations provide robust empirical support for the theoretical assumption that the interconnection of these variables plays a key role in shaping customer loyalty.

Table 11. Overview of Hypotheses and Their Outcomes

Hypothesis Code	Hypothesis Statement	Outcome
H1	There is a significant effect of gender on consumer awareness of loyalty programs.	Accepted
H2	There is a significant effect of gender on consumer satisfaction with loyalty programs.	Accepted
H3	There is a significant effect of gender on consumer loyalty to retail stores.	Accepted
H4	Age group significantly affects awareness of loyalty programs.	Accepted
H5	Age group significantly affects satisfaction with loyalty programs.	Accepted
H6	Age group significantly affects consumer loyalty.	Rejected
H7	There is a strong positive correlation between awareness and satisfaction.	Accepted
H8	There is a strong positive correlation between satisfaction and loyalty.	Accepted
H9	There is a strong positive correlation between awareness and loyalty.	Accepted

Source: Authors elaboration

Table 11 present a overview of research hypothesis and their outcomes. The first hypothesis proposed that gender significantly influences consumer awareness of loyalty programs. This was confirmed through the ANOVA analysis, which showed a statistically significant difference between men and women ($F = 6.326$, $p = 0.012$). These results suggest that gender plays a meaningful role in shaping how informed consumers feel about such programs. The second hypothesis stated that gender affects consumer satisfaction with loyalty programs. The analysis supported this claim, revealing a strong and statistically significant difference between male and female respondents ($F = 22.828$, $p < .001$). It can therefore be concluded that gender differences are also present in how consumers evaluate their satisfaction with loyalty programs. The third hypothesis give focus on whether gender impacts consumer loyalty toward stores offering loyalty programs. The results showed a significant effect ($F = 14.298$, $p < .001$), indicating that men and women differ in the way they express brand or store loyalty, which confirms the third hypothesis. The fourth hypothesis tested whether age influences awareness of loyalty programs. The findings ($F = 3.658$, $p = 0.013$) point to significant differences between age groups, suggesting that consumer awareness tends to vary depending on which age group individuals belong to. The fifth hypothesis proposed that age affects satisfaction with loyalty programs. The ANOVA results ($F = 4.611$, $p = 0.003$) confirmed that satisfaction levels do indeed vary across different age groups. This suggests that generational differences might shape how loyalty initiatives are experienced and perceived. The sixth hypothesis—that age significantly impacts consumer loyalty—was not supported by the data. The analysis yielded a non-significant result ($F = 1.942$, $p = 0.122$), indicating that loyalty does not differ meaningfully between age groups. As such, age does not appear to be a determining factor when it comes to store loyalty. The seventh hypothesis suggested a strong positive correlation between awareness and satisfaction. The Pearson correlation coefficient ($r = 0.718$, $p < .001$) confirmed a strong and statistically significant relationship, meaning that more informed consumers also tend to be more satisfied. The eighth hypothesis explored the link between satisfaction and loyalty. The analysis revealed a robust correlation ($r = 0.703$, $p < .001$), showing that satisfied customers are more likely to remain loyal. This supports the broader marketing theory that satisfaction is a key driver of loyalty. The ninth hypothesis stated that there is a strong positive relationship between awareness and loyalty. This was also confirmed ($r = 0.694$, $p < .001$), suggesting that consumers who are more knowledgeable about loyalty programs tend to develop stronger loyalty toward the brand or store.

5. Discussion

The results of this research reveal a multi-layered relationship between consumers' demographic characteristics and their attitudes toward loyalty programs. Gender emerged as a statistically significant predictor for all three key variables – awareness, satisfaction, and loyalty. These findings align with previous research indicating gender-based differences in consumer behavior, where women are often more active in following promotional activities and more engaged in using loyalty programs. At the same time, the results suggest that men exhibit different patterns of loyalty, which are not always directly linked to perceived benefits but are instead influenced by a more rational approach to evaluating advantages. The study by Melnyk and Osselaer (2012) explores how men and women respond differently

to psychological rewards within loyalty programs. The results show that men respond more positively to programs that emphasize status, particularly when that status is visible to others. On the other hand, women prefer personalization, but in private settings. This suggests that the design of loyalty programs should take gender differences in reward perception into account. Maryanti et al. (2022) investigated the differences in satisfaction and loyalty between male and female consumers in the Alfamart retail chain in Indonesia. By analyzing the data using a MANOVA test, the authors concluded that there were no statistically significant differences in satisfaction and loyalty between male and female consumers. This suggests that gender is not a decisive factor in the perception of loyalty programs in this context.

Age structure also influenced the level of awareness and satisfaction, but not loyalty itself. This points to an interesting phenomenon: while younger and middle-aged groups show a greater willingness to interact with loyalty programs, older groups may maintain loyalty based on habit or relationships with sales staff, rather than solely due to the benefits of the program. The absence of a significant age-related impact on loyalty opens the door for further research into latent factors that shape consumer habits, such as value orientations, digital literacy, or the degree of attachment to a particular brand. The consumer behavior report by Stephens et al. (2024) highlights that younger generations, such as Generation Z and Millennials, have different expectations from loyalty programs compared to older generations. Younger consumers value personalized offers and digital interactions, which affects their awareness and satisfaction with loyalty programs. On the other hand, the same study states that consumers of all age groups value the product or service's quality above all, not necessarily their age group. This implies that age may not be the key factor in determining consumer loyalty. The PricewaterhouseCoopers (2022) study shows that Generation Z and Millennials exhibit a greater preference for loyalty programs that offer fast services and a sense of community. These preferences differ from those of older generations, indicating a significant influence of age on the perception and satisfaction with loyalty programs. The analysis by Kyguoliene et al. (2024) shows clear generational differences in preferences regarding loyalty programs. Younger age groups are more inclined towards digital and personalized programs, while older generations prefer traditional approaches, which affects their awareness and satisfaction. Conversely, a study conducted in Croatia analyzed the influence of education, gender, and age on consumer loyalty. The results showed that age did not have a statistically significant impact on consumer loyalty, suggesting that age group may not be a decisive factor in determining loyalty.

Further analysis revealed strong positive correlations between awareness, satisfaction, and loyalty. This relationship supports theoretical assumptions that satisfaction acts as a mediator between awareness and loyalty. Consumers who are more familiar with how loyalty programs operate are more likely to perceive fairness and transparency, which directly influences their perception of value and long-term commitment. Given the competitive environment in the retail sector, it is clear that brands must invest in communication strategies that foster user understanding and engagement. Interestingly, the results suggest no significant interaction between gender and age, meaning that each of these factors independently contributes to variations in consumer attitudes. This finding further underscores the importance of market segmentation based on individual characteristics rather than generic combinations of demographic groups. In the study by Sasikumar and Sundaram (2024), the authors found that customer awareness of banking services, including digital innovations and social responsibility, significantly influences their satisfaction. Using PLS-SEM analysis, a strong positive correlation between awareness and customer satisfaction was confirmed. Through a systematic review of 200 scientific papers, Utami et al. (2023) concluded that there is a consistent and strong positive relationship between customer satisfaction and their loyalty, regardless of the industry sector. The study by Myftaraj and Trebicka (2023) confirms the strong positive correlation between awareness of loyalty programs, customer satisfaction, and their loyalty, supporting the proposed hypotheses. Consumers who are aware of the program's existence and satisfied with the offered benefits - such as discounts and points accumulation, are more likely to make repeat purchases and maintain long-term loyalty to stores.

Conclusion

The obtained results confirm the relevance of loyalty programs as one of the key tools of modern marketing, particularly in the retail sector. The empirical analysis conducted on a sample of Croatian consumers clearly demonstrates that demographic factors, such as gender and age, have a measurable impact on consumers' perception of the value of loyalty programs. Specifically, gender significantly influences all aspects of the user experience, while age primarily affects the levels of awareness and satisfaction.

A particularly important contribution of this research lies in the identification of strong interrelations between awareness, satisfaction, and loyalty. This relationship suggests that long-term consumer loyalty does not rely solely on the size of rewards or financial benefits, but also on the degree of understanding, transparency, and emotional engagement that the program manages to establish with its users. In this context, a clear recommendation emerges for business practice: investing in consumer education, simple user interfaces, and personalized communication may have a greater impact than simply increasing material rewards. Moreover, the results show that loyalty is not universally defined nor equally stimulated across all age groups, which indicates the need to tailor loyalty programs to the needs of specific target segments. The digital transformation and the increasing use of mobile applications present additional opportunities for personalization and interactivity, especially among younger consumers, while simplicity and system reliability remain crucial for older customers.

The conclusions of this study confirm the importance of a comprehensive approach to designing loyalty programs that incorporates both the functional and emotional dimensions of the consumer experience. Programs that successfully balance clear benefits, a sense of fairness, and emotional connection hold far greater potential for retaining customers and generating long-term competitive advantage.

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Neuromarketing as a Tool for Optimizing Multimedia Communication in the Tourism Sector

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Abstract

Research background: The tourism and hospitality sector increasingly relies on multimedia communication to shape consumer behavior. However, traditional research methods often fail to capture the subconscious emotional and cognitive mechanisms that influence decision-making. Neuromarketing, which combines neuroscientific tools with marketing approaches, offers new possibilities for understanding these underlying processes and for optimizing communication strategies.
Purpose of the article: This article aims to synthesize the state of knowledge on neuromarketing in tourism and hospitality through a systematic meta-analysis. It seeks to identify the main methods applied, evaluate their contributions and limitations, and highlight future research directions.
Methods: A systematic review was conducted across major academic databases using keywords related to neuromarketing, neuroscience, and tourism. Out of 142 initially identified articles, eight core peer-reviewed studies were selected based on predefined inclusion criteria. Content analysis was applied to extract themes, methodological patterns, and theoretical contributions, resulting in five thematic clusters: authenticity, message congruence, virtual reality applications, subliminal stimuli, and pricing psychology.
Findings & value added: The review shows that neuromarketing provides unique insights into subconscious consumer reactions, complementing traditional self-report methods and enriching tourism research. Applications such as EEG, fMRI, eye-tracking, and biometric measures reveal how authenticity, framing, and digital immersion affect consumer responses. The study also identifies challenges, including small sample sizes, lab-based settings, and ethical concerns, while highlighting opportunities in AI-driven personalization and real-world applications. The article contributes a structured overview of neuromarketing in tourism and hospitality and outlines practical guidance for future research and practice.

Keywords: Neuromarketing, Multimedia, AI, Data analysis, Communication

JEL classification: M31, M37

1. Introduction

In the current digital era, technological advancements enable the rapid and efficient examination of consumer behavior. However, traditional neuromarketing methods still require time-consuming research involving real respondents, while the processing of the collected data is often conducted manually, which may hinder the ability to respond swiftly to dynamic market changes. (Younus et al., 2024) The integration of neuromarketing with artificial intelligence (AI) opens new opportunities to accelerate these processes and enhance their accuracy. AI is capable of analyzing large volumes of data in real time, effectively complementing traditional approaches and enabling more precise predictions of consumer behavior. (Ahmad et al., 2020)

These technological innovations also find applications in the tourism sector, where the combination of AI and neuromarketing facilitates the anticipation of travelers' needs, the personalization of offers, and

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the analysis of customers' emotional responses. Such approaches support the development of marketing strategies and campaigns that enhance tourist satisfaction and influence their decision-making processes. (Gretzel et al., 2015)

The integration of AI into neuromarketing not only enables faster data processing but also allows the discovery of hidden patterns in consumer behavior that traditional methods may fail to detect. (Venkatraman et al., 2015) Personalized marketing campaigns based on the analysis of consumers' emotional and cognitive responses can foster higher levels of engagement and customer loyalty. (Plassmann et al., 2012) Moreover, the application of AI and neuromarketing provides companies with the ability to anticipate trends and optimize content in real time, thereby increasing the effectiveness of digital campaigns. (Štefko et al., 2024) This approach supports not only commercial objectives but also enhances the overall customer experience, which is essential for maintaining competitiveness in dynamic markets.

1.1 Theoretical Framework of Neuromarketing

Neuromarketing, a dynamically evolving field at the intersection of neuroscience, psychology, and marketing, has been gaining increasing attention in both academic and applied domains over the past two decades. (Bhardwaj et al., 2024) The synergy of these disciplines has produced unprecedented insights into consumer behavior, enabling a deeper understanding of their preferences, choices, and emotional responses, as well as the ability to predict future decisions. (Bijmolt et al., 2021) Among the key pioneers in this field are Ariely and Berns (2010), who emphasized the potential of neuromarketing in exploring consumers' irrational decisions. This literature review focuses on the critical evaluation of the existing research corpus in neuromarketing techniques, highlighting major contributions, identifying research gaps, and discussing the limitations of current studies. At the same time, it delineates the scope of neuromarketing within the broader context of consumer behavior research, applying a funnel structure from general to more specific topics in order to provide a systematic and coherent overview of the field. (Erokhina et al., 2018)

Neuromarketing can be defined as the application of neuroscientific methods in marketing research with the primary objective of understanding how the consumer brain responds to marketing stimuli. This approach goes beyond traditional consumer behavior research methods, which rely predominantly on self-reported data, by enabling direct analysis of brain activity, physiological responses, and other neurobiological indicators. (Peng et al., 2023) The most frequently employed techniques in neuromarketing studies include functional magnetic resonance imaging (fMRI), electroencephalography (EEG), eye-tracking, and biometric analyses. According to Plassmann et al. (2012), these methods allow for a more detailed understanding of how consumers evaluate products and brands. They provide insights into multiple dimensions of consumer behavior, including attention, emotional responses, memory processes, and decision-making mechanisms.

A core premise of neuromarketing is that consumer decision-making is largely determined by subconscious processes that are not easily accessible through introspection or verbal articulation. (Mathaisel & Comm, 2021) By identifying and analyzing these cognitive mechanisms, neuromarketing offers more objective and nuanced insights into consumer behavior, which can contribute to the development of more effective marketing strategies and interventions in practice. Duchowski (2017) highlights the growing importance of eye-tracking technology, which has become a standard tool for investigating consumer attention and visual preferences.

Neuromarketing is inherently interdisciplinary, drawing on knowledge from psychology, neurology, neuropsychology, medicine, biology, and marketing, while at the same time enriching these disciplines with its findings. (Kolev, 2012) Its primary goal is to understand consumer decision-making processes in the selection of products and services—insights that are highly sought after by companies aiming to optimize marketing strategies through the identification of factors that create positive or negative impressions. (Khondakar et al., 2024) According to Kenning and Linzmajer (2011), neuromarketing enhances companies' ability to effectively target specific consumer segments by understanding the neurobiological mechanisms underlying decision-making.

Neuromarketing captures subtle cognitive and emotional responses to marketing stimuli, thereby enabling more accurate predictions of consumer purchase decisions. (Adeola et al., 2022) A wide range of neuroimaging and neurostimulation technologies are used in this context, including electroencephalography (EEG), functional magnetic resonance imaging (fMRI),

magnetoencephalography (MEG), positron emission tomography (PET), transcranial magnetic stimulation (TMS), and functional near-infrared spectroscopy (fNIRS). (Adeola et al., 2022) Lee, Broderick, and Chamberlain (2007) emphasize that these techniques can bridge the gap between traditional marketing research approaches and the objective measurement of brain processes.

Neuroimaging technologies such as fMRI and EEG provide researchers and marketing practitioners with a unique opportunity to monitor neural responses associated with different marketing stimuli—ranging from the visual appearance of advertisements to the structure and design of websites. Their non-invasive nature allows for the collection of valuable real-time data on brain reactions, which can then be applied to optimize marketing content, design, and messages so that they resonate more effectively with specific audience segments. (Millagala, 2023) Different stimuli activate distinct brain regions, and these processes can be tracked through changes in neuronal signals or brain waves. (Adeola et al., 2022)

Complementary sources of data include biometric measurements such as heart rate monitoring, facial expression analysis, and galvanic skin response. These indicators capture consumers' emotional reactions in real time during digital interactions, thereby identifying moments of heightened engagement or dissatisfaction. Based on these insights, marketing professionals can fine-tune digital content and customer touchpoints to enhance user experience. (Millagala, 2023)

In the digital era, neuromarketing emerges as a tool that integrates neuroscientific knowledge into marketing strategies, enabling the analysis of consumers' subconscious reactions and providing a deeper level of understanding than traditional surveys. (Thakur & Pasha, 2025) Consumer decisions are often made quickly and at a subconscious level. Integrating neuromarketing approaches into digital marketing offers new perspectives on consumer behavior by combining neuroscientific methods with marketing principles. (Štefko et al., 2024) The use of neuroimaging techniques, biometric indicators, and psychological profiling paves the way for the development of more effective and personalized campaigns, which foster higher customer engagement and stimulate consumer behavior. (Millagala, 2023)

2. Methods

This study employed a systematic meta-analysis with the aim of providing a comprehensive overview of neuromarketing techniques and their applications in tourism and hospitality. The review process included systematic searching, screening, and analysis of relevant peer-reviewed articles. Searches were conducted in major academic databases, including Scopus, Web of Science, EBSCO, and Google Scholar. Keywords combined general terms such as "neuromarketing," "neuroscience," "tourism," and "hospitality" with specific methods, including "electroencephalography (EEG)," "functional magnetic resonance imaging (fMRI)," "eye tracking," "electrodermal activity (EDA)," and "heart rate variability (HRV)."

The initial search yielded 142 articles published between 2010 and 2025. After removing duplicates and applying inclusion criteria—peer-reviewed status, clear relevance to tourism/hospitality, and explicit use or evaluation of neuroscientific techniques—67 studies remained. Full-text analysis further excluded purely conceptual papers, those without methodological detail, and research outside the tourism domain. The final selection comprised eight core studies (Li et al., 2023; Stepchenkova et al., 2025; García-Carrión et al., 2025; Calisto & Sarkar, 2024; Hsu & Chen, 2020; Boz et al., 2017; Bastiaansen et al., 2018).

Key information was extracted regarding methods, theoretical frameworks, findings, and limitations. A content analysis was then performed to synthesize recurring themes, quantify methodological patterns, and identify research gaps. The results were structured into five thematic clusters: (1) authenticity and emotional processing, (2) message congruence and cognitive effort, (3) virtual reality applications, (4) subliminal stimuli and decision-making, and (5) pricing psychology. This methodological approach ensured transparency in article selection and provided a structured mapping of the current state of research.

3. Results

Neuromarketing is an emerging interdisciplinary field that integrates perspectives from marketing, neuroscience, economics, decision theory, and psychology to uncover the underlying reasons for consumer behavior and predict their decision-making processes. This approach is

essential for overcoming the limitations of traditional methods, such as surveys, because it can capture objective, subconscious, and spontaneous emotional responses in real time—responses that are not influenced by cognitive bias or social desirability tendencies. The table below, titled "Overview of Neuromarketing Techniques and Their Applications in Tourism and Hospitality," provides a comprehensive overview of key neuroscientific and physiological tools such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI), eye-tracking, and heart rate measurement, along with their specific applications for understanding and influencing consumer behavior in various areas of tourism and hospitality—from destination marketing to pricing psychology.

Table 1. Meta-analysis of neuromarketing techniques and their applications in tourism and hospitality

Source	Title	Research goal	Methods and neuroscientific approaches used	Findings and conclusions
Li et al. (2023)	A review of research into neuroscience in tourism: Launching the annals of tourism research curated collection on neuroscience in tourism	Stimulate the use of neuroscience in tourism research, discuss the synergies of neuroscience with the social sciences, evaluate review articles on the applications of neuroscience in tourism, provide a comprehensive overview of neuroscientific methods, and discuss theoretical relevance and potential topics for the research agenda.	An overview (meta-review) of existing literature on neuroscientific methods such as fMRI, EEG, EDA/GSR, eye-tracking, heart rate variability (HRV), facial expressions, and their applications in tourism.	Neuroscience complements (does not replace) traditional methods such as questionnaires, capturing objective, subconscious/unconscious emotional responses in real time. Triangulation (combining neuroscientific and self-report methods) is recommended to increase reliability and validity. Eye-tracking and electrodermal activity (EDA) are the most commonly used methods. fMRI is expensive, lab-based, and has poor temporal resolution (but high spatial resolution). EEG is accessible, simple, and has excellent temporal resolution (but poor spatial resolution). A brand (e.g., Coca-Cola) can change subjective perception and activate brain areas related to reward, which goes beyond social desirability. Brand personality and human personality are processed in different neural networks. Neuroeconomics studies decision-making about trust (oxytocin, caudate nucleus) and familiarity bias (amygdala). Neuromanagement examines emotional labor (e.g., weakened neural response to angry expressions in frontline employees). Challenges: small sample sizes (often sufficient for intra-subject designs), correlational rather than causal relationships, and a high barrier for tourism researchers (requiring interdisciplinary collaboration).
Stepchenkova et al. (2025)	Authentication response to a tourist attraction video: Neuromarketing insights	To explore the role of emotions and authenticity in the process of the authentication of tourist attractions promoted through marketing materials, with a focus on different orientations toward authenticity (realists, constructivists, postmodernists).	Physiological measurements: Heart rate variability (HRV) (time domain: RMSSD, frequency domain: LF/HF ratio, qualitative nonlinear: Poincaré plot ellipse ratio) measured with the Shimmer3 optical sensor. Self-reports: Authenticity questionnaire (12 items), emotional state (alert, excited, happy, calm) on a 7-point semantic differential scale, authentication outcomes ("Hobbiton is an authentic place," "Hobbiton is a place I want to visit"). Experimental design: Laboratory setting, 72 students, viewing of a promotional video of Hobbiton, pre- and post-tests. Analysis using ANOVA, ANCOVA, Kolmogorov-Smirnov test, and regression analysis.	Here's the English translation: Postmodernists were the most likely to accept a staged attraction as authentic and as a place they would like to visit. Realists had lower HRV (greater alertness and focus/skepticism), while postmodernists and constructivists showed higher HRV (increased positive arousal). Positive arousal can overcome cognitive dissonance in attitudes toward authenticity (e.g., leading realists to a positive judgment despite their values). Authentication outcomes were influenced by authenticity orientation and self-reported emotions (alertness, arousal). Realists engaged in more deliberate processing, while constructivists and postmodernists relied on faster, intuitive reasoning. Low message congruence: Requires greater cognitive effort (smaller saccade amplitude, greater pupil dilation). Activates the medial prefrontal cortex (MPFC) associated with cognitive conflict, as well as frontal and temporal regions. Leads to less positive affective evaluations (less "love," more "like" or negative responses) and lower intention to visit the destination. Destination framing: Destinations presented in a natural environment are processed more quickly and evoke more intense positive emotions ("love") and stronger visit intentions. Natural settings trigger a hedonic response, where message inconsistencies have minimal impact. Gastronomy requires more deliberate and rational decision-making, where discrepancies in messages strongly influence visit intentions.

García-Carrión et al. (2025)	Exploring destination positioning and message congruence in tourism management: An eye-tracking and fMRI study	Determine the impact of message congruence (high vs. low) between DMO messages and eWOM on users—in terms of cognitive effort, brain activity, and behavioral responses—within the context of different destination positioning strategies (natural environment vs. gastronomy).	Combination of methods: Eye-tracking (Eyelink 1000 Plus) for oculomotor–cognitive metrics (FD: fixation duration, FC: fixation count, SA: saccade amplitude, PD: pupil dilation). fMRI (Siemens Magneton Prisma Fit 3T) for brain activity (BOLD signals; activation of MPFC, DLPFC). Behavioral responses: Affective ratings (emoticons) and intention to visit the destination. Experimental design: Within-subject experiment, 49 Facebook users (ages 24–40), viewing fictitious Facebook posts.	Low message congruence requires greater cognitive effort (smaller saccade amplitude, greater pupil dilation). Low congruence activates the medial prefrontal cortex (MPFC) associated with cognitive conflict, as well as frontal and temporal regions. Low congruence leads to less positive affective evaluations (less "love," more "like" or negative responses) and a lower intention to visit the destination. Destination placement focused on a natural environment is processed more quickly and evokes more intense positive emotions ("love") and a stronger intention to visit. Natural environments trigger a hedonic response, where message inconsistencies have minimal impact. Gastronomy requires more deliberate and rational decision-making, where differences in messages significantly influence the intention to visit.
Calisto, Sarkar (2024)	A systematic review of virtual reality in tourism and hospitality: The known and the paths to follow	To synthesize the state of knowledge on VR in the Tourism & Hospitality (T&H) sector, uncover key methodological choices, identify the main research themes, and develop a nine-step consumer journey framework for the future development of VR in T&H.	A systematic review of 54 studies from high-quality scientific journals. Content analysis was used to extract themes and patterns. It highlights that most empirical studies apply a "Experience → Questionnaire" design. It concludes that, in the future, objective neuromarketing measurements should be used instead of self-report questionnaires.	VR research in Tourism & Hospitality (T&H) is a growing field. VR has positive effects on cognition (mental imagery), affective responses, brand attitude, expectation management, approach/avoidance behavior, and increases visit/purchase intention, willingness to pay more, satisfaction, repeat visits, and recommendations. Individual factors influencing VR adoption: innovativeness, cultural traits, age (Gen Z), gender, experience-seeking, technological predisposition. Effectiveness of VR depends on immersion, presence, and engagement, achieved through device features (interactivity), content, and sensory stimulation. VR may, for some individuals, lead to feelings of isolation and dependency. A proposed nine-step consumer journey framework (before, during, after – both real and virtual experience, ex-situ and in-situ) for VR. VR can serve as a substitute, especially for those with limited abilities, but users still desire to physically visit the places seen virtually; VR may even strengthen the intention for a physical visit. In VR experience design, the most important factors are high levels of social interaction and interaction with objects. Findings on subliminal cues in hospitality marketing: Hotel selection was significantly influenced by a subliminal smiley emoji. Ratings of hotels with an emoji increased significantly (+63.6%), while without an emoji they decreased (−63.2%). Significant differences were found in theta and beta brain waves: Theta waves increased significantly when viewing videos with subliminal stimuli ($t = -5.65$, $p < .001$), associated with pleasure and memory storage. Beta waves decreased significantly when viewing videos with subliminal stimuli ($t = 2.93$, $p < .01$), indicating processing via the peripheral, intuitive route (dual-process theory). Subliminal emojis may reduce consumer psychological pressure and enhance memory, thereby influencing purchase decisions. Limitations: small sample size, use of a simple EEG device, short-term effects, and laboratory setting.
Hsu, Chen (2020)	Neuromarketing, subliminal advertising, and hotel selection: An EEG study	To understand how hotel videos with a subliminal smiley emoji message influence consumers' hotel choice, and to measure their brain activity (EEG) while watching the videos.	Electroencephalography (EEG) (MindWave Mobile, single-electrode) to measure brain waves (delta, theta, alpha, beta, gamma). Experimental design: Laboratory setting, 16 participants (ages 24–32). Two rounds: with and without subliminal stimuli (smiley emoji inserted	Hotel choice was significantly influenced by the subliminal smiley emoji. Hotel ratings with the emoji increased substantially (+63.6%), while without it they decreased (−63.2%). Significant differences were found in theta and beta brain waves. Theta waves increased significantly when watching videos with subliminal stimuli ($t = -5.65$, $p < .001$), associated with pleasure and memory storage. Beta waves decreased significantly when watching videos with subliminal stimuli ($t = 2.93$, $p < .01$), suggesting processing through the peripheral, intuitive

			for 20 ms every 3 seconds) into 20-second hotel promotional videos. Analysis: Chi-square test for hotel choice, paired t-test for brain waves, Bayes factor for robustness..	route (dual-process theory). Subliminal emojis may reduce consumer psychological pressure and enhance memory, thereby influencing purchasing decisions. Limitations: small sample size, simple EEG device, short-term effects, laboratory setting..
Boz, Arslan, Koc (2017)	Neuromarketing aspect of tourısm pricing psychology	To provide insights into how tourists perceive prices and pricing issues in holiday advertisements in terms of design, placement, and content, using neuromarketing examples. To emphasize the limitations of traditional methods in capturing subconscious emotional responses..	Overview of various neuromarketing tools: EEG, PET, MEG, fMRI (neurological) and eye-tracking, FACS (facial expression recognition), GSR (galvanic skin response), HR (heart rate, biological/ physiological). It refers to the earlier study by Boz (2015), which used EEG, GSR, HR, and eye-tracking in combination with questionnaires. Emphasis is placed on triangulation.	Price influences perceived value and product quality (a higher price may suggest higher quality). Traditional methods are insufficient to capture genuine, subconscious emotional responses and hidden motives (e.g., impression management, social pressure). More than 90% of information is processed subconsciously and affects consumer decision-making. Consumers pay more attention to the rate of discount (e.g., 40%) than to the reduced price; showing both together is more effective. Consumers prefer short statements over long paragraphs. Visuals of people looking directly at the viewer and placing price tags or discounts near the human face attract greater attention. The most effective placement for installment, discount, and reduced-price information is in the center of the visual advertisement. Positive statements from previous clients in ads shape impulsive preferences. With three price alternatives (e.g., hotels), the cheapest and most expensive options are most preferred, while the middle option is least preferred (consistent with prospect theory). Offering “free cancellation” reduces perceived risk and evokes a positive attitude. Eye-tracking heat maps show areas of greatest interest (red). Scan paths/saccades reveal inefficient information scanning
Bastiaansen et al. (2018)	My destination in your brain: A novel neuromarketing approach for evaluating the effectiveness of destination marketing	To determine whether event-related brain potentials (ERPs) can be used to evaluate the effectiveness of tourism destination marketing in films by measuring immediate emotional responses to destination photographs.	Electroencephalography (EEG) to measure ERPs (N1, P2, LPP components). Experimental design: 30 university students (randomly assigned). The experimental group watched a film clip from In Bruges (positive portrayal of Bruges), while the control group watched a clip from The Rum Diary (unrelated). Both groups were then shown photographs of Bruges, Kyoto (control destination), and neutral/positive IAPS images. Pre-test: Evaluation of the valence and arousal of images and video clips.	A positive portrayal of a destination in a film (In Bruges) triggered an immediate stronger emotional response to subsequently presented images of that destination (Bruges) in the brain activity of the experimental group. This effect was specific to Bruges and was not observed for Kyoto or in the control group. The N1 EEG component was significantly larger in the In Bruges group for Bruges images, indicating early enhanced visual processing of emotional content and sensitivity to emotional salience. P2 and LPP components are associated with emotional valence and arousal. Emotional responses have the strongest influence on the overall image of a destination. The effect appeared only for the specific destination (Bruges) and not for a typologically similar but visually different destination (Kyoto). EEG is a useful and more cost-effective tool for neuromarketing compared to fMRI. The emotional “revitalizing” effect lasted at least 5–10 minutes after viewing the film.

Source: own elaboration

4. Discussion

The meta-analysis demonstrates that neuromarketing is an increasingly valuable interdisciplinary approach in tourism and hospitality (T&H). Traditional tools such as surveys and interviews capture conscious attitudes but fail to access the subconscious and spontaneous responses that strongly influence decision-making (Li et al., 2023; Plassmann et al., 2012). Neuromarketing fills this gap by measuring brain activity and physiological responses in real time, offering objective insights into consumer behavior (Lee, Broderick, & Chamberlain, 2007; Adeola et al., 2022).

Across studies, neuromarketing is positioned not as a replacement but as a complement to conventional methods. Triangulation—integrating self-reports with neurophysiological measures—is widely recommended for reliability (Boz, Arslan, & Koc, 2017; Li et al., 2023). Stepchenkova et al. (2025) showed how HRV revealed differences in authenticity orientations invisible in questionnaires, while García-Carrión et al. (2025) demonstrated that low message congruence triggered medial prefrontal cortex (MPFC) activation, indicating cognitive conflict beyond conscious awareness.

These results align with dual-process theories (Kahneman, 2011; Venkatraman et al., 2015). Low congruence increases effortful System 2 processing, while high congruence enables faster, intuitive System 1 responses. Framing also matters: natural environments evoke hedonic, affect-driven reactions, whereas gastronomy requires more deliberate evaluation (García-Carrión et al., 2025).

Virtual reality (VR) research confirms its ability to enhance mental imagery, affect, and behavioral intentions such as revisit or willingness to pay (Calisto & Sarkar, 2024). Yet, reliance on "experience → questionnaire" designs limits depth. Neuromarketing tools like EEG and eye-tracking are needed to capture subconscious immersion and presence. Importantly, VR appears complementary to physical tourism, often strengthening desire for real-world visits.

Subliminal cues illustrate both potential and ethical challenges. Hsu and Chen (2020) found that smiley emojis in hotel ads shifted consumer choice, with EEG showing increased theta activity (pleasure, memory) and reduced beta activity (rational control). While effective, such findings raise concerns about manipulation and highlight the need for ethical frameworks (Ariely & Berns, 2010; Štefko et al., 2024).

Overall, the synthesis supports the view that much of tourist decision-making is subconscious and inaccessible to self-report (Mathaisel & Comm, 2021; Peng et al., 2023). Neuromarketing provides tools to uncover these mechanisms and optimize multimedia communication. Yet challenges persist: small samples, lab-based studies, and correlational designs (Li et al., 2023; Boz et al., 2017). Future research should emphasize ecological validity, interdisciplinary collaboration, and AI integration for real-time personalization (Ahmad et al., 2020; Thakur & Pasha, 2025). Advancing in this direction will strengthen both theoretical contributions and practical applications in destination marketing and hospitality.

Conclusion

This meta-analysis demonstrates that neuromarketing offers substantial value for advancing research and practice in tourism and hospitality. By capturing subconscious emotional and cognitive responses, neuromarketing overcomes the limitations of traditional self-report methods and provides deeper insights into tourist decision-making. The reviewed studies highlight that triangulation of neuroscientific tools with conventional approaches enhances validity, while techniques such as EEG, fMRI, eye-tracking, and biometric measures reveal the mechanisms through which authenticity, message congruence, and virtual experiences shape behavior.

Emerging applications—such as subliminal cues and VR—illustrate both the potential for innovative engagement and the need for ethical safeguards. Importantly, neuromarketing confirms that much of consumer choice operates below conscious awareness, reinforcing the relevance of dual-process theories in tourism contexts. Future research should prioritize ecological validity, larger and more diverse samples, and AI-driven analytics, enabling more personalized and effective multimedia strategies that enhance both tourist experience and industry competitiveness.

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Neuromarketing Insights into Visual Attention and Perception of Real vs. AI-Generated Images

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Abstract

Research background: The rise of AI-generated content has brought new challenges in the field of visual perception and media literacy, particularly in the context of distinguishing between authentic and synthetic visual materials. As AI tools become increasingly sophisticated, the line between real and artificial imagery becomes more blurred, raising concerns about visual trust, manipulation, and users' ability to critically assess media content.
Purpose of the article: In an era where generative tools are capable of producing visuals that are indistinguishable from real ones, it is essential to examine how people perceive and cognitively process such images. This article aims to explore how individuals visually interact with AI-generated versus real images and whether specific gaze patterns or behaviors can indicate differences in perception.
Methods: The study was conducted using eye-tracking technology and Area of Interest (AOI) analysis within the iMotions software environment. The research sample consisted of 30 participants of varying age and gender. Stimuli were selected from publicly available sources and included 8 images - 4 real photographs and 4 identical images generated by artificial intelligence.
Findings & Value added: The paper highlights the value of eye-tracking as a promising tool for assessing visual credibility and detecting artificially generated or manipulated content in today's evolving media landscape.

Keywords: Neuromarketing, Visual attention, Artificial intelligence, Eye-tracking

JEL classification: M30

1. Introduction

Eye tracking is a research method that enables researchers to analyze where a person looks, for how long, and in what sequence when observing visual stimuli. Within the context of human perception, eye tracking serves as an important tool for exploring the mechanisms of visual attention, cognitive information processing, and decision-making. This method is widely applied across various disciplines, including psychology, user experience (UX) design, marketing, and cognitive science (Holmqvist et al., 2012).

Through eye tracking, it is possible to identify specific areas of the visual field that capture the most attention, commonly referred to as fixation points. Researchers can then examine the order in which these areas are viewed, as well as the duration and frequency of the fixations. Fixations, which occur when the eyes remain still and focused on a specific point, and saccades, which are quick eye movements between fixations, provide valuable indicators of how an individual cognitively processes visual input. These processes are relevant for a wide range of stimuli, including static images, video content, and interactive digital interfaces (Bojko, 2013). In marketing and UX design, eye tracking is used to optimize the visual composition of elements such as product packaging, digital advertisements, and website layouts. By analyzing patterns of visual attention through techniques like heatmaps or gaze plots, designers and researchers can identify which parts of a stimulus attract the most engagement. This helps to refine the design and positioning of key elements in order to improve clarity, effectiveness, and overall user experience. Moreover, eye tracking contributes to a deeper understanding of unconscious visual behavior

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and offers objective data that complement self-reported feedback. As such, it plays a crucial role in bridging the gap between visual design and human cognition in both applied and academic contexts.

Eye tracking is a technique that has become firmly established as a valuable tool for analyzing visual processing behavior and individual responses to various stimuli. This process provides important insights into how different inputs such as visual cues, images, colors, or human faces influence attention and cognitive interpretation. At present, eye tracking technology is widely used in the field of neuromarketing, which represents a growing interdisciplinary area. It combines insights from behavioral psychology, economics, and neuroscience to better understand consumer behavior (Gheorghe et al., 2023).

Neuromarketing is an interdisciplinary field combining neuroscience, psychology, and marketing to better understand consumer behavior through the measurement of unconscious physiological and neural responses. One of the central tools in neuromarketing research is eye-tracking technology, which provides objective insights into visual attention and cognitive processing of stimuli such as advertisements, packaging, or product design. This study applies a neuromarketing lens to investigate how consumers allocate attention to real and AI-generated images across different content categories. By focusing on metrics such as fixation duration and scanpaths, the research aims to reveal subconscious preferences and perceptual salience that are not always captured by declarative responses alone. In doing so, it contributes to the growing body of neuromarketing literature exploring how visual elements influence decision-making and emotional engagement (Robaina-Calderín, Martín-Santana, 2021).

1.1 Comparative Eye-Tracking Insights

Eye tracking also serves as an essential method for studying fundamental processes of visual perception. Research in this domain focuses on how individuals detect stimuli, estimate perceptual thresholds, and how specific properties of a stimulus affect the way the eyes fixate on certain areas. It also explores how eye movements influence the perception and evaluation of the visual field. These studies support the idea that eye tracking is a valuable and scientifically grounded technique for exploring core perceptual and attentional mechanisms (Lima and Ventura, 2023).

When comparing real images with those generated by artificial intelligence (AI), eye tracking is used to examine how individuals respond to differences in visual aesthetics, perceived naturalness, and overall trustworthiness of the stimuli. Research indicates that people often find it difficult to reliably determine which images are real and which have been created by AI. However, their patterns of visual attention tend to differ depending on the origin of the image. For example, studies have shown that viewers focus strongly on human faces and particularly on the eyes, even when observing synthetic images (Huang et al., 2024; Kätsyri et al., 2015). At the same time, subtle irregularities in AI-generated faces, such as unnatural facial expressions or misplaced anatomical features, can evoke what is known as the uncanny valley effect. This effect may create a sense of cognitive dissonance, where the viewer feels uncertain about whether the image they are seeing is real or artificial. This uncertainty can lead to reduced trust in the visual content and highlights the psychological importance of authenticity in visual communication.

Similarly, Gupta et al. (2020) used eye tracking to understand how people respond to deepfake videos. The findings revealed significant differences in eye movement patterns when participants watched real versus manipulated videos. Viewers tended to focus more intensely on facial regions, particularly the eyes and mouth, as they attempted to detect subtle inconsistencies indicative of deepfake content. This heightened attention suggests that individuals subconsciously search for visual anomalies in facial expressions and movements that may appear unnatural or inconsistent with real human behavior.

Similar findings were reported in a study focused on the perception of AI-generated and human-made paintings (Zhou, Kawabata, 2023). The study highlighted the presence of implicit biases that influence how people evaluate artistic works. Although participants were not able to reliably distinguish between paintings created by artificial intelligence and those created by human artists, eye-tracking data revealed a systematic difference in visual attention. Participants spent more time observing the artworks they believed were created by humans. These results suggest that the perception of art can be shaped by implicit cognitive biases that favor human creation. Such biases may lead individuals to assign greater value or meaning to artworks when they think they were made by a human, regardless of the actual source. These cognitive mechanisms may have a profound impact on how artistic works are judged and preferred, with broader implications for fields such as neuromarketing, aesthetics, and public taste.

In another study investigating the evaluation of authenticity in visual scenes, Cartella et al. (2024) found that people actively search for anomalies when assessing images. Their findings indicate that eye

movements while viewing manipulated or fake images were more concentrated and focused on smaller, suspicious regions of the picture. In contrast, when participants viewed authentic images, their attention was more dispersed and evenly distributed across the visual field.

A similar phenomenon has been observed in the field of medicine, where a study by Wong et al. (2025) demonstrated that physicians exhibit distinct eye movement patterns when evaluating real versus AI-generated medical images. When viewing AI-generated scans, doctors showed less concentrated fixations and greater saccade amplitudes. This indicates that the perception of AI-generated medical imagery involves a different mode of visual assessment, which may, in turn, influence diagnostic decision-making. These findings highlight the importance of optimizing AI systems in medical contexts to account for human perceptual and cognitive patterns. Integrating such considerations can enhance diagnostic accuracy and efficiency by aligning AI-generated outputs more closely with the way medical professionals visually process and interpret clinical information.

Studies show that eye-tracking technology provides deep insight into how people intuitively evaluate visual stimuli across a variety of specific contexts. Differences in eye movement patterns when interacting with AI-generated versus real images suggest that, although AI can effectively model visual inputs, a deeper understanding of human perception is still necessary. This understanding is crucial for recognizing how perception influences decision-making and the evaluation of visual information.

1.2 Artificial Intelligence and Human Perception in Visual Media

From a neuromarketing perspective, visual attention is not merely a behavioral outcome but a measurable neurocognitive response to marketing stimuli. Tools such as eye-tracking allow researchers to observe unconscious attentional biases and infer motivational or emotional relevance before declarative preferences emerge (Plassmann et al., 2012). This makes it highly relevant for testing how consumers interact with synthetic versus real imagery in various advertising contexts.

Content generated by artificial intelligence includes the creation of text, images, videos, 3D elements, and other media formats through AI algorithms, facilitating the automation of content production. This mode of creation enables fast, scalable, and often cost-effective generation of visual or multimodal outputs that would otherwise require the expertise of professionals in fields such as design, photography, or animation (Foo et al., 2023). Artificial intelligence is capable of simulating writing styles, producing realistic images from textual prompts, or animating motion based on basic scene descriptions. In doing so, it is reshaping how digital content is created and distributed. This opens new opportunities in areas such as marketing, education, art, and the entertainment industry, but also raises important concerns regarding authenticity, intellectual property rights, and the ethical use of AI-generated content. In the context of digital culture, AI is no longer just a tool for production but an active agent influencing the aesthetic and communicative norms of the present era (Israfilzade, 2024).

Over the past decade, researchers in the field of artificial intelligence have made remarkable advancements, fundamentally transforming various sectors of society and gradually eroding the boundary between what is real and what is artificially generated. The development of AI-generated content has significantly increased design efficiency, enhanced creative processes, and supported innovation across the design industry. Generative models are advanced artificial intelligence systems that learn to produce new content based on the patterns found in the data on which they are trained (Sætra, 2023). These systems are capable of understanding complex structures in data, enabling them to generate content such as images, text, or visual designs that resemble human-created works while also introducing entirely new possibilities for creativity and exploration.

Generative methods of artificial intelligence are rapidly evolving, and the use of text-to-image diffusion models allows for the simple generation of images based on textual input (Ramesh et al., 2022). This alone has shown incredible promise in accelerating efforts to create visual content at an unprecedented speed. Models such as DALL·E 2, Stable Diffusion, and Midjourney demonstrate the ability of artificial intelligence to produce visually striking and stylistically diverse outputs without the need for direct input from a designer or illustrator. These technologies not only accelerate creative processes but also democratize visual content creation by enabling even non-experts to produce images of professional quality (Phillips et al., 2024).

In the past two years, tools for generating content using artificial intelligence have gained increasing public attention, including platforms such as ChatGPT, Midjourney, and Stable Diffusion. For example, ChatGPT, launched by OpenAI, an artificial intelligence research lab based in the United States, reached

over 100 million active users just over two months after its initial release at the end of 2022. This made it the fastest-growing application in terms of user adoption. The popularity of ChatGPT reflects the profound impact that artificial intelligence technology is having on human productivity and daily life (Rane et al., 2023).

It has been found that the visual presentation of images increases the likelihood of a product being selected (Hou et al., 2017). Various studies are now exploring whether product images generated by artificial intelligence can effectively replace traditional photography in digital formats. This trend highlights the evolving dynamics of digital marketing and consumer engagement, with artificial intelligence playing an increasingly central role. AI systems, through pattern analysis in large datasets, have the capacity to identify and potentially enhance those specific image features that increase the perceived attractiveness of a product. These features may include symmetry, shape, freshness, glossiness, dynamic presentation, and contextual elements such as background, ambient lighting, and color (Spence et al., 2022).

A related issue is the need for clear disclosure policies regarding the nature of images generated by artificial intelligence. The ability of AI to create visuals that are virtually indistinguishable from real photographs raises ethical concerns about misleading consumers and highlights the importance of transparency in the context of digital marketing (Van Esch and Black, 2021). If consumers are not adequately informed that visual content was produced using algorithms, trust between brands and the public may be undermined. In an environment where visual elements play a crucial role in shaping reputation and influencing audiences, it becomes essential to label AI-generated content in a clear and understandable manner. Transparency is not only a matter of ethics but also a societal responsibility in the face of growing risks associated with visual manipulation, whether it occurs in advertising, journalism or social media. Without clearly defined rules and mechanisms for identifying synthetic content, there is a risk that such material may be misused to spread disinformation, distort reality or enable unethical forms of targeted marketing (El Ali et al., 2024).

Analyses demonstrate the broad applicability of AI-generated content across various fields and its crucial role in facilitating the resolution of research challenges. As an emerging driver of productivity, artificial intelligence has also inspired deeper reflection in the domain of design. Neuroscience is increasingly recognized as a revolutionary interdisciplinary tool and approach that seeks to transform our understanding of human decisions and preferences. It offers an objective foundation for designing and implementing more enriching and satisfying products and services (Agarwal, Dutta, 2015).

Psychophysiological techniques, such as eye tracking and galvanic skin response, have become valuable methods for analyzing how individuals visually process images. These techniques provide important advantages in understanding the psychological and emotional processes underlying decision-making (Kim, Kim, 2023). Eye tracking has gained increasing relevance in marketing research, especially over the past decade, due to growing interest in the study of consumer and user visual attention (Muñoz-Leiva, 2023). The analysis of eye movement patterns helps predict consumer behavior, enabling the development of more personalized and effective campaigns aimed at improving products and services.

By connecting various theories and research findings, we can gain a deeper understanding of whether the ability of artificial intelligence to generate realistic visuals is truly "invisible" to the human eye, or whether there are subtle perceptual differences that can be captured through objective measurements such as eye tracking. The results of this integration have important implications not only for visual psychology and media literacy, but also for fields such as marketing, design, and the regulation of AI-generated content. Eye movements can reveal users' underlying feelings, as visual perception is closely linked to emotional response. Users are often unable to consciously control their physiological reactions, making techniques like eye tracking valuable for identifying intuitive or unconscious responses to visual stimuli (Guo et al., 2022).

2. Methods

This article aims to explore how individuals visually interact with AI-generated versus real images and whether specific gaze patterns or behaviors can indicate differences in perception.

For the study, two main research questions were established:

Q1: Are there differences in eye-tracking metrics (e.g., time to first fixation) between real images and images generated by artificial intelligence?

Q2: To what extent do the objective attention metrics obtained through eye-tracking align with the subjective evaluation of the images and the responses of the participants?

The research sample consisted of 30 students from the Faculty of Management and Business, including 13 men and 17 women. The respondents' ages ranged from 19 to 29 years, with an average age of 23.4 years. In terms of nationality composition, the majority of respondents were of Slovak nationality (n = 26), followed by Ukrainian nationality (n = 3). One respondent did not specify their nationality.

Data collection took place under laboratory conditions at the Faculty in order to ensure a controlled environment and consistent conditions for all participants. The selection of respondents was based on availability (i.e., convenience sampling). Before data collection, all participants were briefed on the basic information regarding the use of eye-tracking technology and the course of the study. Each respondent was informed about the voluntary nature of participation, the option to withdraw without giving a reason, and then signed an informed consent form for participation in the research and the use of its results for scientific purposes.

Based on the established research goal, which was to compare AI-generated images with real images, eye-tracking technology was used. The visual data collection was carried out using the Smart Eye AI-X hardware integrated into the computer monitor, with software support provided by the iMotions 10.1 system, which enables precise tracking of eye movements and analysis of visual attention. The stimuli were presented to participants on a 24-inch monitor with Full HD resolution, ensuring consistent display quality for all tested stimuli.

The images were sourced from the publication by Adams (2023). A total of eight images were presented to the research participants, organized into four pairs. Each pair consisted of one real image and one identical image generated by artificial intelligence (AI). The order of the images within each pair was random, with one image always labeled as Image A and the other as Image B, without the participants knowing which one was real and which one was AI-generated. Each image pair was displayed for ten seconds. After each pair was displayed, participants answered an evaluation question using a five-point Likert scale (from 1 – strongly disagree to 5 – strongly agree). This methodology allowed for the comparison of preferences and perceptions of visual content between real and AI-generated images based on both conscious responses and the visual behavior captured through eye-tracking.

3. Results

Based on the aggregated heatmaps from iMotions, we compared four types of scenes (face, landscape, food, animal) and their impact on the distribution of visual attention. The patterns were recorded separately for real and AI-generated images, and the results are summarized in Table 1. Methodologically, we draw on the work of Borji (2019) and Agarwal et al. (2021), who recommend the use of heatmaps when evaluating the perceptual credibility of images. The individual real and AI-generated images are shown in Figure 1 and Figure 2.

Figure 1. Heat Maps – AI vs. Real Images
Source: own processing (2025)

Figure 1 presents a collage of four heat maps, illustrating where viewers' gaze is directed. At the top, there are two faces. On the left is a real face with attention focused on the pupil, and on the right is an artificial face

with gaze dispersed across the eyes and cheek. At the bottom are two sunset scenes. In the synthetic image, attention is fixed on one bright point, while the real scene draws focus to the clouds and surrounding area.

Figure 2. Heat Maps – AI vs. Real Images
Source: own processing (2025)

Figure 2 displays images of pizza and parrots. At the top are two pizzas. The one on the left is real. Viewers mainly focus on the center, with gaze slightly spreading across the crust. The pizza on the right is AI-generated. Eye movements are weaker, and focal points are less distinct. At the bottom are two parrots. The left one is synthetic. Visual attention is concentrated mostly on the head, with little focus elsewhere. The right parrot is real. The gaze flows smoothly from the eye to the head and body.

Table 1. Comparison of visual attention distribution in real and AI-generated images based on heatmaps

Scene	Real image – attention distribution	AI image – attention distribution
Face	Sharp, compact focus on the pupil with little spill-over.	Broader spread that covers the eye and extends onto the cheek.
Landscape	Attention spreads across several elements (clouds, horizon, water).	Intense hotspot on a single bright point (e.g., the sun).
Pizza	Dense central hotspot over the main topping area; peripheral zones receive less gaze.	Weaker, more diffused focus scattered across the surface, with no dominant peak.
Parrot	Small, well-defined hotspot on the eye; minimal spread to the head.	Wider, less defined heat zone covering the eye and surrounding head region.

Source: author (2025)

Table 1 highlights differences in visual attention that appear only in certain scenes. The discrepancies observed in the heatmaps do not manifest uniformly across all types of visual content. An eye-tracking experiment by Huang et al. (2024) confirmed this variability in the case of faces: participants spent more time fixating on the eyes and hair in synthetic portraits, whereas in real faces, their attention shifted between several facial features. Bau et al. (2019) also demonstrated that the specific visual artifacts that attract attention vary depending on the content and are not consistent across images. In the case of the real pizza, fixations were concentrated in a dense central cluster, whereas the AI-generated version drew attention more diffusely and with less intensity. For the parrot, both versions directed gaze toward the eye area. However, the synthetic bird displayed a broader heat zone, while the real parrot had a smaller, sharper focal point. This pattern aligns with observations by Borji et al. (2019) and Huang et al. (2024), who report that AI-generated scenes often lack fine texture, which can either disperse or overly concentrate visual attention within a specific region.

Our findings support the view that differences in attention are not consistent across all visual categories. In highly structured images like food, contrasts are more apparent, whereas in animals, they

tend to be more subtle. This supports Wang et al.'s (2020) claim that the perceptual flatness of synthetic images varies depending on the complexity of the scene.

Table 2. Average rating of preference for real images across categories

	N	Minimum	Maximum	Mean	Std. Deviation
Face	30	1	5	4,30	1,208
Landscape	30	1	5	2,23	1,612
Pizza	30	1	5	3,77	1,591
Parrot	30	1	5	2,33	1,749

Source: author (2025)

The table summarizes the average responses to the question of whether participants preferred image A in each category, without knowing which image was real. The answers were rated on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). In the Face and Pizza categories, the average ratings were high (4.30 and 3.77), indicating a preference for real images. In contrast, for Landscape (2.23) and Parrot (2.33), the averages were below the midpoint of the scale, suggesting that participants tended to prefer the AI-generated versions in these cases. These results support the notion that the perception of authenticity and aesthetic appeal does not depend solely on whether an image is real, but also on the specific type of scene being viewed.

Table 3. The relationship between image preference and dwell time

		Dwell time (ms)
Face	r	-0,043
	Sig. (2-tailed)	0,820
Landscape	r	0,396
	Sig. (2-tailed)	**0,030**
Pizza	r	0,324
	Sig. (2-tailed)	**0,049**
Parrot	r	0,409
	Sig. (2-tailed)	**0,025**

Source: author (2025)

The table presents the Spearman correlation coefficient, which expresses the relationship between the subjective rating of the question “I preferred image A” (rated on a scale from 1 to 5) and the time spent looking at image A (dwell time) in milliseconds. Participants did not know which image was real. Dwell time, a key eye-tracking metric, represents the total time a participant spends looking at a specific area of interest. In the Face category, the analysis revealed a very weak negative correlation ($r = -0.043$) with no statistical significance ($p = 0.820$), suggesting that viewing time for faces did not correspond with preference ratings. In contrast, the categories Landscape ($r = 0.396$, $p = 0.030$), Pizza ($r = 0.324$, $p = 0.049$), and Parrot ($r = 0.409$, $p = 0.025$) showed statistically significant positive correlations. This indicates that the more participants liked image A, the longer they looked at it. The results suggest that visual preference can be reflected in the duration of visual attention, even when participants are unaware of whether they are observing a real or AI-generated image.

Table 4. Eye-tracking metrics for real and AI-generated images across four visual categories

	Face		Landscape		Pizza		Parrot	
	Real	**AI**	**Real**	**AI**	**Real**	**AI**	**Real**	**AI**
Dwell time (ms)	3173.57	3355.69	3960.81	4327.22	4499.21	4184.57	4184.57	4499.21
First dwell duration (ms)	437.67	494.36	204.14	406.08	499.91	896.54	502.89	342.33
Revisit count	3.87	3.7	3.9	4.93	3.5	3.17	3.59	4.14
Fixation count	10.23	9.87	13.53	14.97	14.13	14.47	13.14	12.66
TTFF AOI (ms)	153.16	923.51	1077.57	130.24	140.23	728.18	531.84	156.36

Source: author (2025)

This table compares participant behavior when viewing real and AI-generated images across four categories (Face, Landscape, Pizza, Parrot) using selected eye-tracking metrics: dwell time, first dwell duration, revisit count, fixation count, and TTFF AOI (time to first fixation). These metrics have been applied in various studies, such as Huang et al. (2024) and Wong et al. (2025).

In the Face category, the dwell time was slightly higher for AI images (3355.69 ms) than for real ones (3173.57 ms), suggesting that participants spent more time observing synthetic faces. Similarly, first dwell duration was also longer for AI (494.36 ms) compared to real images (437.67 ms), which may indicate greater initial attention toward artificial faces. However, fixation count and revisit count were slightly higher for real images, possibly pointing to more thorough or credible visual processing. TTFF AOI was significantly lower for real faces (153.16 ms), meaning participants responded to them more quickly than to AI versions (923.51 ms), possibly due to greater naturalness or social relevance.

In the Landscape category, AI images dominated nearly all metrics: higher dwell time (4327.22 ms vs. 3960.81 ms), longer first dwell duration (406.08 ms vs. 204.14 ms), and more revisits and fixations. This may suggest that AI-generated landscapes were more visually engaging or stimulating. Interestingly, TTFF AOI was also lower for AI images (130.24 ms), indicating that they captured attention more quickly.

In the Pizza category, dwell time was higher for real images (4499.21 ms), but AI versions received longer first dwell durations and more fixations. This might reflect stronger initial interest in the AI images, but more sustained attention toward real ones. Lower revisit count for AI images (3.17 vs. 3.5) supports this interpretation. TTFF AOI was also lower for real pizzas, indicating faster orientation to them.

For Parrot images, dwell time was higher for AI images (4499.21 ms vs. 4184.57 ms), while first dwell duration was longer for real ones (502.89 ms vs. 342.33 ms), suggesting different dynamics in visual engagement—longer initial fixation on real content, but more total time spent on AI images. TTFF AOI was again lower for real images (156.36 ms), indicating quicker visual engagement.

4. Discussion

The findings suggest that differences in attention distribution and visual processing are mainly influenced by the type of scene and are not uniformly observed across all categories. In the Face category, although dwell time was slightly higher for AI-generated portraits, participants focused more quickly on real faces, as indicated by a lower TTFF AOI. This may point to a higher level of naturalness or an increased ability to draw immediate attention. This difference supports previous research (Huang et al., 2024), which suggests that the human brain has specifically developed mechanisms for processing faces.

In the Landscape and Parrot categories, dwell time was higher for AI images, which could mean that these synthetic visuals appeared more interesting to participants or required more time to process. At the same time, the lower TTFF AOI in the case of AI landscapes may indicate that visual cues were more clearly defined, making it easier to identify the scene quickly, though this did not guarantee higher aesthetic appreciation, as seen in the lower average preference score for the Landscape category. The results in the Pizza category were the most balanced. An interesting finding was that real images had higher dwell time, but AI images achieved higher values in metrics such as first dwell duration and fixation count. This may signal strong initial attention but lower sustained interest.

Spearman correlations between subjective ratings and objectively measured dwell time (Table 3) show a statistically significant positive relationship in most categories (Landscape, Pizza, Parrot). The more participants liked image A (without knowing whether it was real or AI-generated), the longer they looked at it. In the Face category, however, this relationship was not confirmed, which could be related to higher human sensitivity to visual inconsistencies in facial features.

Heatmaps (Figures 1 and 2) and their summary in Table 1 provide visual support for the quantitative data. In the case of AI images, attention often focused on less expected areas (such as unintuitive light sources or artifacts), whereas in real images, attention was distributed more consistently and structurally. These findings are consistent with the studies by Zhou and Kawabata (2023), which highlight implicit preferences for human-created content, even when participants cannot clearly identify the origin of the image. Similarly, the study by Cartella et al. (2024) confirms that when evaluating authenticity, people tend to focus on anomalies or subtle inconsistencies that in AI-generated images may cause either distraction or concentration of attention in unusual regions.

From a neuromarketing perspective, these findings reinforce the idea that consumer attention and emotional responses are driven not only by content type but also by the cognitive expectations and familiarity associated with real world stimuli. Visual salience and perceived authenticity play a crucial role in subconscious evaluation processes, and eye tracking metrics such as time to first fixation and fixation duration serve as valuable indicators of this attention economy. In terms of managerial and marketing implications, companies and content designers should tailor their visual communication strategies to the specific context and audience. For emotional storytelling or social campaigns involving human faces, real images may be more effective in quickly engaging viewers and establishing trust. In contrast, for artistic or product focused categories such as food or nature, AI generated visuals can be equally or even more engaging, especially when enhanced with aesthetic refinement. Marketing teams should therefore balance creative innovation with cognitive principles derived from neuromarketing research.

Conclusion

This study focused on comparing visual attention during the observation of real and AI-generated images using the eye-tracking method. Participants were exposed to four types of visual stimuli: face, landscape, food (pizza), and animal (parrot). In each case, they compared image A and B without knowing which one was real. After viewing each pair, they answered the question "I preferred image A," while their eye movements were recorded. Data collection included metrics such as dwell time, fixation count, first dwell duration, revisit count, and time to first fixation (TTFF AOI).

The results showed that the way participants visually responded to real versus AI-generated images varied depending on the type of scene. Categories such as landscape and parrot triggered longer visual attention for the AI versions, while in the case of faces, participants focused more quickly on the real ones. This suggests that naturalness and socially relevant features, such as human facial cues, play a key role in capturing attention quickly.

One limitation of the study is the relatively small number of participants. It is also recommended to expand the number of visual categories across different contexts and to explore both conscious and unconscious image differentiation in more depth, including the identification of key visual elements involved in perception.

The findings offer valuable insights for content creators, advertisers, and brand managers in deciding when and how to use AI-generated imagery. In categories where aesthetic or artistic value dominates, such as landscapes or animal imagery, AI visuals may be equally engaging or even more compelling than real ones. However, in domains that require trust, authenticity, or emotional resonance, such as depictions of human faces or social contexts, real images are more effective in quickly attracting attention. Marketers should carefully consider their visual strategy based on the psychological relevance of the scene type.

Future studies should include a broader and more diverse sample size to improve the generalizability of findings. Additionally, there is a need to investigate how cultural background, age, and familiarity with AI influence attention and preference patterns. Further research could also explore dynamic stimuli (video) or immersive environments (e.g., virtual reality) to understand how visual salience changes over time. It is also recommended to test AI-generated images in applied settings such as e-commerce, news media, or social campaigns, to examine not only visual attention but also behavioral outcomes such as trust, memory, and decision-making.

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Social Marketing and its Importance in Times of Global Instability and Uncertainty

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Abstract

Research background: In times of deepening global instability and uncertainty caused by pandemics, climate crises, geopolitical conflicts and social inequalities, there is an increasing demand for practical tools that can support positive changes in the behaviour of individuals and communities. One of the most important approaches is social marketing, which applies commercial marketing principles to pro-social goals. In times of crisis, it is an essential communication and behavioural tool capable of responding to public health challenges, environmental sustainability and information credibility.
Purpose of the article: This article aims to highlight the importance and effectiveness of social marketing in times of global instability and uncertainty through a comparative analysis of selected case studies from practice. The campaigns studied represent different geographical, cultural and thematic contexts but are united by their emphasis on behavioural change, social benefit and response to crises.
Methods: The research was conducted as a qualitative comparative analysis of four case studies that met pre-defined criteria (application of social marketing in a crisis context, data availability, measurable results). The analysis focused on identifying common elements of success, the tools and strategies used, and the challenges the campaigns faced. Data was obtained from secondary sources, such as professional publications, evaluation reports, and official documents.
Findings & Value added: The results showed that effective social marketing campaigns in crisis are based on a culturally sensitive approach, building trust, using behavioural insights and a long-term strategy. Campaigns such as Act-Belong-Commit in the field of mental health or Smokefree Aotearoa in the field of public health demonstrate that social marketing can positively influence behaviour even in challenging conditions. The added value of the article is the synthesised framework of critical success factors for social marketing in crisis conditions, which can serve as a guide for policymakers, marketing professionals, and researchers striving for social change.

Keywords: Social marketing, Global uncertainty, Behavioral change, Crisis communication, Case studies

JEL classification: M31, I18, D83

1. Introduction

Contemporary society faces unprecedented challenges affecting all areas of life – from climate change pandemic threats to geopolitical conflicts and economic volatility. These forms of global instability and uncertainty fundamentally change the behaviour of individuals, communities and institutions. In such conditions, the importance of socially oriented strategies is increasing, which have the potential to influence public health, sustainability and social responsibility positively. Social marketing is one of the most powerful tools that can effectively shape the behavior of society for the benefit of the public interest (Kotler, Lee, 2008).

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Social marketing represents a specific application of commercial marketing principles to change the behaviour of individuals or groups to benefit society as a whole. Unlike classical marketing, which mainly aims to maximise profit, social marketing focuses on social benefit – improving health, the environment and quality of life (Andreasen, 2006). These goals take on even greater urgency and strategic importance in times of global uncertainty.

The concept of social marketing was first systematically developed by Kotler and Zaltman (1971), who defined it as the use of marketing principles to influence people's behaviour for the benefit of society. Since then, the concept has developed and gained wider recognition in public health, ecology, education, and development cooperation (Gordon, 2011; Tothova & Fabus, 2015). Social marketing is now considered effective in promoting social change and public welfare goals.

According to Lefebvre (2013), social marketing plays a key role in managing mass phenomena such as epidemics, climate extremes, or social unrest in times of crisis. The need for coordinated communication, credibility, and public engagement increases in such periods. Social marketing can promote changes that benefit society through strategic planning and behavioural interventions (French, Gordon, 2015).

In the context of the global COVID-19 pandemic, the importance of social marketing has increased even more. As Berkowitz and Wolff (2021) point out, effective campaigns aimed at vaccination, wearing masks or complying with quarantine measures were often based on social marketing principles. These campaigns used audience segmentation, behavioural theory, or testing of the effectiveness of messages, which made it possible to increase the compliance rate with measures and reduce social risks.

The importance of social marketing in times of environmental crisis is documented by several authors (Peattie, Peattie, 2009; McKenzie-Mohr, 2011; Chovancová, Huttmanová, Rovnák, Štefko, Minďaš & Fedorko, 2023), who emphasise the need to change individual and collective habits towards sustainable behaviour. In this area, social marketing is applied, for example, to promote recycling, energy saving, or reducing the carbon footprint. However, these initiatives encounter resistance to change and require a deep understanding of the motivational factors of individuals (Thøgersen, 2005; Majerová, Gajanová, Nadányiová, & Sipos, 2024).

From a theoretical perspective, social marketing draws on various disciplines – from behavioural psychology to sociology to communication theories. Andreasen (2002) emphasises the importance of a research-based approach that considers the specificities of target groups and contextual factors influencing behaviour. Modern social marketing is increasingly oriented towards participatory approaches involving target groups in designing and implementing campaigns (Truong, 2014).

Another important aspect is the digital transformation, which fundamentally changes how social marketing campaigns are implemented (Fabus & Fabusova, 2016). As Weinreich (2010) states, using digital platforms allows for more precise targeting and personalisation of messages, thereby increasing their effectiveness. In global crises, when access to information is crucial, digital social marketing plays a vital role in mobilising and educating the public (Lefebvre, 2021).

However, some authors also point out the limits of social marketing. For example, Hastings (2007) criticises its potential to manipulate or overlook systemic inequalities that cannot be resolved by changing individual behaviour alone. In times of global uncertainty, it is, therefore, essential that social marketing is ethical, inclusive, and coordinated with public policies. At the same time, social marketing must cope with the growing distrust of institutions, misinformation, and polarisation of society (Donovan, Henley, 2010; Bachanová & Garbárová, 2019). Therefore, it is essential to strengthen its credibility, transparency, and ability to create long-term relationships with target groups.

2. Methods

This article aims to highlight the importance and effectiveness of social marketing in times of global instability and uncertainty through a comparative analysis of selected case studies from practice. The research approach was chosen with an emphasis on qualitative analysis of specific initiatives that have demonstrated social impact in crises – health, environmental or social.

2.1 Selection of case studies

Four internationally recognised campaigns were selected for the analysis, which:

- were implemented in the last two decades,
- responded to a specific form of global instability (e.g. pandemic, climate crisis, social inequalities),
- applied the principles of social marketing in practice,
- were sufficiently documented in professional literature or available evaluation reports,
- showed a demonstrable impact on target groups.

The selected case studies come from different countries and areas (health, environment, communication) to ensure comparability across different types of crises and simultaneously reflect the diversity of social marketing applications.

Specifically, the following initiatives were involved:

- **Act-Belong-Commit** (Australia) – mental health during the COVID-19 pandemic,
- **Smokefree Aotearoa** (New Zealand) – a long-term program to reduce smoking in marginalised communities,
- **Recycle Now** (United Kingdom) – environmental behaviour and recycling in the context of the climate crisis,
- **Verified** (by WHO) – a digital information campaign during the pandemic aimed at combating disinformation.

2.2 Research approach

The research methodology is based on comparative qualitative analysis (comparative case study analysis), which systematically compares multiple empirical cases to identify standard features, differences and broader implications for theory and practice. This approach is particularly suitable for investigating complex social phenomena where quantitative methods do not provide sufficient depth of understanding (Yin, 2018).

The following analytical structure was applied to each case study:

- **context** – description of the social or environmental crisis to which the campaign responded;
- **objectives and target groups** – identification of key actors and intended behavioural changes;
- **tools and strategies used** – analysis of marketing elements and communication approaches;
- **results and impact** – overview of measurable or qualitative results;
- **strengths and limitations** – assessment of effectiveness, sustainability and transferability.

2.3 Sources and data processing

Data were obtained from secondary sources, mainly from scientific articles, evaluation reports, official publications of the involved organisations and case studies published in professional databases (e.g. ScienceDirect, PubMed, SpringerLink). In some cases, data from the campaign implementers' websites and verified reports of independent evaluation organisations were also used.

All data were analysed using thematic coding, emphasising identifying key elements of effectiveness, innovation, and challenges associated with social marketing in times of crisis.

2.4 Research limitations

Although the chosen methodology allows for deep insight into the functioning of specific initiatives, it also has certain limitations:

- the limited number of analysed cases may reduce the generalizability of conclusions,
- the research is dependent on the availability and quality of secondary data,
- comparisons across different contexts (cultural, institutional) carry a certain degree of interpretative subjectivity.

Despite these limitations, the comparative analysis provides a strong basis for interpreting the significance of social marketing in times of global challenges and, at the same time, opens up space for further research in this area.

3. Results

In this section of the article, we present the results of a comparative analysis of four selected case studies that illustrate the application of social marketing in conditions of increased global instability. The case studies focus on different geographical areas, target groups and social problems. At the same time, their common denominator is the use of marketing tools to support pro-social behaviour in difficult social conditions.

3.1 Act-Belong-Commit campaign in Australia

The Australian Act-Belong-Commit initiative is a long-term social marketing program aimed at supporting the population's mental health. During the COVID-19 pandemic, this campaign gained new significance as it responded to the increase in psychological burden caused by isolation, loss of security and disruption of social ties (Donovan, Henley, 2010).

The program used behavioural models and positive messages that motivated people to engage in community life, self-development, and active volunteerism. Adaptability was an essential element – the campaign adapted to the digital environment and strengthened online communication, which reached a wide range of target groups. According to the evaluations of the organisation Mentally Healthy WA, the program raised awareness of the importance of mental health. It reduced respondents' feelings of loneliness and anxiety (Lefebvre, 2021).

Findings: Social marketing can be an effective tool to strengthen the mental resilience of the population during the pandemic, as long as the campaign is based on rigorous research, adapted to the cultural context and conducted ethically.

3.2 Smokefree Aotearoa campaign in New Zealand

The Smokefree Aotearoa program is a government initiative to achieve a smoke-free society by 2025. At a time of increasing health burden and inequalities in access to healthcare (particularly among the Maori population), the campaign was reinforced with social marketing elements aimed at positively motivating behaviour change (Truong, 2014).

The campaign used audience segmentation, targeting young people, ethnic minorities and socially disadvantaged groups. Instead of repressive messages, it focused on building self-confidence and promoting healthy lifestyles. In addition to traditional media, social media, community ambassadorship and collaboration with local leaders were also used.

Findings: The success of social marketing in a health crisis depends on its ability to respect cultural diversity, build trust and focus on long-term change in habits, not just a short-term campaign.

3.3 Recycle Now campaign in the United Kingdom

The United Kingdom Environment Agency launched the Recycle Now initiative to promote recycling and reduce environmental impact during climate change. This campaign represents an example of environmentally oriented social marketing that responds to global uncertainty about climate change (Peattie, Peattie, 2009).

The campaign focused on simplifying recycling processes, increasing public awareness and strengthening motivation through positive messaging. Unlike previous attempts to educate the population, Recycle Now concentrates on specific activities and the involvement of local communities.

The campaign evaluation showed a significant improvement in the volume of recycled materials and increased conscious behaviour, especially among the younger generation. This indicates the effectiveness of behavioural targeting in times of ecological uncertainty.

Findings: Social marketing can change the environmental behaviour of the population if it offers clear instructions for realistic alternatives and uses positive forms of communication.

3.4 Digital campaign Verified by WHO

During the COVID-19 pandemic, the World Health Organization (WHO) faced not only the spread of the virus but also the so-called infodemic – an excess of misinformation that undermined public trust and complicated crisis management in response, WHO launched the Verified initiative to distribute verified information through digital channels (Berkowitz, Wolff, 2021).

The campaign was implemented in collaboration with technology companies (e.g. Google and Facebook) and involved digital volunteers who disseminated reliable information in their communities.

The social marketing approach was reflected in the emphasis on clear messages, emotional resonance and credibility of sources.

Statistics showed that this campaign significantly reduced the spread of fake news and increased awareness of proper health measures in different linguistic and cultural contexts.

Findings: In conditions of information uncertainty, social marketing is crucial in protecting public health, especially when combined with digital technologies and building trust between the public and institutions.

3.5 Summary of the comparative analysis

The analysis of four case studies shows that effective social marketing in times of global instability must meet the following prerequisites:

- **Adaptability:** responding to changing conditions and using new communication platforms.
- **Cultural sensitivity:** respecting and involving differences between target groups in the process.
- **Credibility:** building a relationship between the source of information and recipients through transparency and consistency.
- **Behavioural orientation focuses on specific behaviours** that can be measured, influenced and maintained.
- **Ethics:** emphasis on pro-social values, without manipulation or fear.

These factors are crucial to the success of social marketing as a tool for social change, especially in conditions of uncertainty, when public trust is weakened and the need for coordinated communication is high.

4. Discussion

The results of a comparative analysis of four case studies point to the high effectiveness of social marketing as a tool for social intervention in times of global instability and uncertainty. Although each of the analysed initiatives operated in a different geographical, cultural or thematic context, they were united by a common goal – to influence public behaviour to benefit the common good positively. In the following discussion, we interpret the findings regarding practical implications, standard features and potential limits.

4.1 Contextualised flexibility as the basis for success

One of the most striking standard features of all the cases examined was the campaigns' high degree of adaptability to a specific context. Whether it was the adaptation of linguistic and cultural differences (Smokefree Aotearoa) or the rapid digitalisation of campaigns in response to pandemic measures (Act-Belong-Commit, Verified), it turns out that flexibility is not just a tactical addition but a fundamental prerequisite for success in a turbulent environment (French, Gordon, 2015).

From this perspective, social marketing has an advantage over traditional forms of intervention, which tend to be more rigid and less able to respond to rapidly changing conditions. The ability to adapt also increases the credibility of campaigns and their ability to reach audiences with diverse needs (Lefebvre, 2013).

4.2 Meaningful communication based on trust

Another recurring feature of successful campaigns was the ability to create credible and meaningful communication. At a time when institutions are confronted with declining public trust, disinformation and information overload, marketing focused on creating emotionally powerful and factually correct messages has a significantly higher chance of success (Berkowitz, Wolff, 2021).

The Verified WHO campaign showed that community engagement through digital ambassadors and the distribution of easily verifiable information has a greater impact than top-down communication. This is consistent with the findings of studies that emphasise the importance of a participatory approach in social marketing (Andreasen, 2002).

4.3 Behavioural focus and positive motivation

One of the most significant benefits of modern social marketing is its ability to change specific behaviours through behavioural techniques. Case studies show that positively framing messages and

creating achievable goals (e.g., no smoking by 2025, recycle today) leads to higher adoption rates than punitive or moralising approaches (Peattie, Peattie, 2009; Donovan, Henley, 2010).

The Recycle Now campaign demonstrated that people are willing to change their behaviour if they are informed about what is expected of them, why it is essential, and if they can see the concrete results of their actions. This is consistent with the behavioural change model, the cornerstone of effective social marketing (McKenzie-Mohr, 2011).

4.4 Long-term and sustainable interventions

The results also suggest that one-off campaigns have limited impact if not part of a long-term strategy. Campaigns such as Act-Belong-Commit and Smokefree Aotearoa were effective precisely because of their long-term presence and continuous research. Their sustainability lies in linking marketing with public health policies, education and community initiatives.

Therefore, it is necessary that social marketing does not become just a short-term tool for responding to the crisis but that it is systematically integrated into long-term planning and public strategies (French, Gordon, 2015).

4.5 Limits and ethical challenges

Despite the campaigns' successes analysed, their limits cannot be ignored. Social marketing can be misused in times of crisis – for example, to spread propaganda manipulate or divert attention from the systemic causes of problems (Hastings, 2007). Therefore, every social marketing intervention must undergo an ethical evaluation to be transparent and participatory.

Another challenge is the level of effectiveness in the case of groups with low socio-economic status or limited access to digital media. In these cases, social marketing may fail if it is not combined with interventions to remove structural barriers.

4.6 Comparative interpretation

Based on the comparison of selected case studies, it can be concluded that in times of global uncertainty, social marketing fulfils an informational and behavioural function and becomes a tool for strengthening social resilience. Its power lies in connecting individuals with social interest, reducing feelings of helplessness, and mobilising collective action.

The key to success is the integration of behavioural science insights, an emphasis on cultural appropriateness and ethics of campaigns, and their alignment with public policies. These factors allow social marketing to be a response to a crisis and a solution to long-term social challenges.

Conclusion

Social marketing has become an effective tool for promoting social change in recent decades. Still, its importance has taken on a new dimension in times of global instability and uncertainty. The COVID-19 pandemic, environmental crises, growing social inequalities and disinformation campaigns represent complex challenges that traditional communication strategies cannot address. In this context, social marketing has proven to be an effective platform for mobilising the public, disseminating credible information and shaping behaviour that benefits the individual and society.

A comparative analysis of four case studies has shown that the success of social marketing in crisis conditions depends mainly on the following:

- adjusting the campaign to the specifics of the target groups and the cultural context,
- using behavioural insights and positive motivation,
- consistent integration with public policies and long-term strategic orientation,
- the ability to build trust through participatory and ethical approaches.

This knowledge is relevant not only for campaigners but also for public policymakers, researchers and civil society actors. At a time when trust in institutions is weakening, and society is increasingly fragmented, social marketing has the potential to act as an integrative tool based on empathy, knowledge and credibility. Despite the growing body of knowledge and practice in social marketing, further research needs to be focused on several key areas. This is particularly the in-depth analysis of the effectiveness of social marketing in marginalised communities with low socio-economic status and limited digital literacy, where data on the long-term impact of campaigns is often lacking. An important research topic is the

ethical perception of social marketing, particularly the line between persuasion and manipulation, as perceived by target groups. The durability of behaviour after the end of crisis periods and factors affecting the long-term sustainability of positive changes also deserve attention. Interdisciplinary approaches linking social marketing with community development, education and legislation are also critical, as they can increase effectiveness. Finally, research should also be devoted to artificial intelligence and data analytics, enabling personalisation, behaviour prediction, and more effective campaign evaluation. It is necessary to consider the ethical and technical risks of these tools.

In conclusion, it can be stated that social marketing is a proper and indispensable tool for democratic societies in times of global uncertainty. Its value lies in combining knowledge from different scientific disciplines, connecting individual behaviour with public interest and responding to complex social challenges, emphasising humanity, knowledge and long-term sustainability.

Acknowledgements

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Silence or Music?
Consumer Preferences during Grocery Shopping and Their Implications for Marketing Practice

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Abstract

Research background: Background music is a frequently used tool in sensory marketing, which aims to influence the mood and purchasing behavior of customers. However, recently, some retail chains, including Kaufland, have decided to introduce so-called "silent hours", during which no music is played in the store. This approach is questionable from a marketing perspective, especially if there is a lack of knowledge about how customers perceive acoustic stimuli during shopping.
Purpose of the article: The aim of the paper is to determine what consumers' preferences are regarding the presence of music in grocery stores, and whether these attitudes differ depending on generation and education.
Methods: A questionnaire survey was used to collect data from a representative sample of 2501 respondents. Hypothesis testing was used to analyze differences between groups of respondents.
Findings & Value added: The findings have practical implications for retail managers and marketers who set store atmospheres. The introduction of "silent hours" should be informed by data on actual customer preferences to avoid undesired disruption of the shopping experience for the majority of customers.

Keywords: Marketing, consumer, Music, Silent hours, Store atmosphere

JEL classification: M31, M39

1. Introduction

Sensory cues have a big impact on how consumers behave and make decisions. According to consumer neuroscience, customers' emotions and preferences can be influenced by music and other auditory cues, and sensory methods can increase their engagement (Berčík et al., 2021). One type of these stimuli that can unintentionally affect people's decision-making and purchase behavior is subliminal auditory stimulation.

Depending on the circumstance and the kind of consumer, background music may promote expenditure (Ahlbom et al., 2022). Properties of music, including tempo or song familiarity, affect customers' feelings and increase the range of products they buy (Sun, Chang & Xu, 2023). While customized musical accompaniment based on the time of day or demographic profile can directly impact consumer behavior and enhance sales, peaceful and harmonious tunes encourage relaxation and prolong time spent in the store (Spence, 2021).

Additionally, musical stimuli are effective in social contexts: moderate noise encourages creativity in decision-making (Mehta, Zhu & Cheema, 2012), appropriately set musical intensity contributes to positive product perceptions (Manzoor, 2024), and faster music can counteract the negative effects of store crowding (Knoeferle, Paus & Vossen, 2017). Furthermore, music improves customers' emotional experience and raises their subjective sense of comfort (Choo et al., 2021). However, other studies show that music may not always be beneficial; for some patrons, it may be a source of distraction or even make them less comfortable (Hynes & Manson, 2016; Andersson et al., 2012).

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Conversely, silence has its own value and acts as an active element of the consumer experience, supporting attention and strengthening customer identity (Dehling, 2024).

Some authors emphasize that sensory stimuli influence each other, therefore it is necessary to examine the customer experience in a broader context and segment consumers according to their different reactions (Jain, 2023; Bilgihan & Kandampully, 2022; Das & Varshneya, 2021; Pandey & Tripathi, 2024). Managerial approaches show that a properly set store atmosphere (including music, silence, design and interactions with customers) increases satisfaction, engagement and loyalty (Szocs, Grewal & Roggeveen, 2023; Khan, 2023).

2. Methods

The research was conducted in the form of a quantitative questionnaire survey, the aim of which was to determine customer preferences regarding the presence of music or food purchases and to identify their relationship to the age generation and level of education.

The survey was conducted on a sample of N = 2501 participants (1235 men - 49% and 1266 women - 51%). Data collection took place in January 2025 through the market research agency MN Force s.r.o. Individual generations were selected based on statistical representatives by gender and age.

By age category, respondents were divided as follows: Generation Z (1997 - 2012) represented 487 people (19%), millennials (1981 - 1996) 700 people (28%), X (1965 - 1980) 696 (28%) and boomers (264196%). According to the highest education level, they were categorized as: primary education, apprenticeship or secondary vocational education without maturity, complete secondary education with a high school diploma, and university education.

The main variable studied was the preference for silence during shopping - the respondent could use a binary answer:

- 1 = I prefer silence,
- 0 = I do not prefer silence (i.e. I prefer music).

Three hypotheses were tested in the survey:

H1: There is a statistically significant difference in music preferences during grocery shopping between generations.

H2: Consumers with higher education are more likely to reject music in stores than respondents with lower education.

H3: Most customers prefer the presence of music to a quiet environment during grocery shopping.

The data were analyzed using non-parametric tests, since the responses were categorized (binary). The following methods were used for the analysis:

- Kruskal-Wallis test – used to compare responses between multiple independent groups (generations and education). This test allows us to determine whether there is a statistically significant difference between the mean groups in the case of non-parametric data.
- T-test with a constant – used to compare the total proportion of respondents who prefer silence with a reference value of 20%.

The graphs and visualizations presented in this article were generated using RStudio (version 2023.09.1). The analyses were performed with a statistical significance level of $\alpha = 0.05$ using Microsoft Excel, XLSTAT (v2023.3.0) and the ChatGPT-4o language model for validation and interpretation of the results.

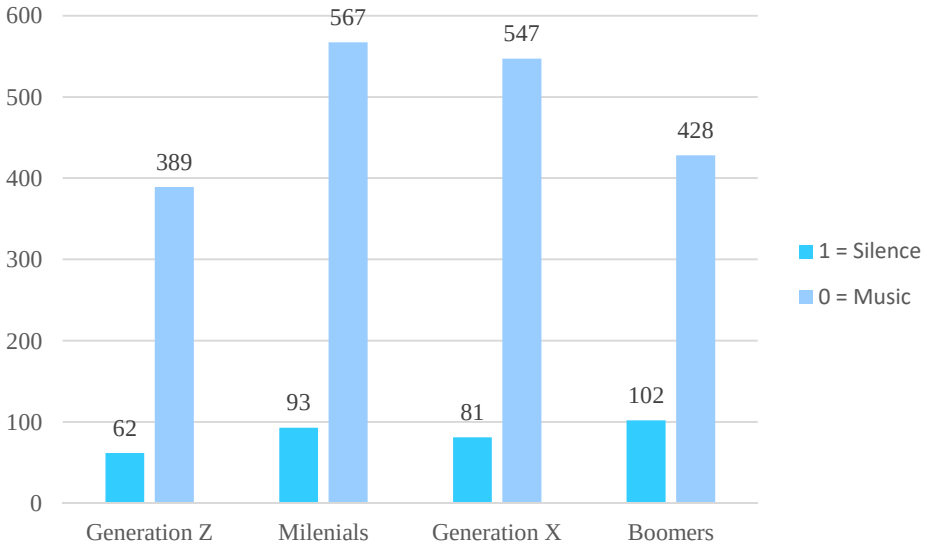
The study is governed by the Code of Ethics of the Laboratory of Consumer Studies, FEM SPU in Nitra (2023) [https://neuromarketinglab.eu/about/eticky-kodex/].

3. Results

The first part of the analysis examined whether there were differences in music preference among generations while grocery shopping. Respondents were divided into four groups: Generation Z (1997–2012), Millennials (1981–1996), Generation X (1965–1980), and Boomers (1946–1964). The Kruskal-Wallis test confirmed a statistically significant relationship ($\chi^2 = 36.393$; $p < 0.05$). When simplifying the responses to a binary scale (1 = silence, 0 = music), the difference was again statistically significant ($\chi^2 = 4.5838$; $p < 0.05$).

The Boomers group (102 respondents) showed the highest level of preference for silence, while Millennials had the highest proportion of respondents who preferred music. Generation X largely reported that the environment was indifferent to them. The percentage of responses is shown in Figure 1.

Based on these results, hypothesis H1 was confirmed – there is a statistically significant difference in music preference during shopping between generations.

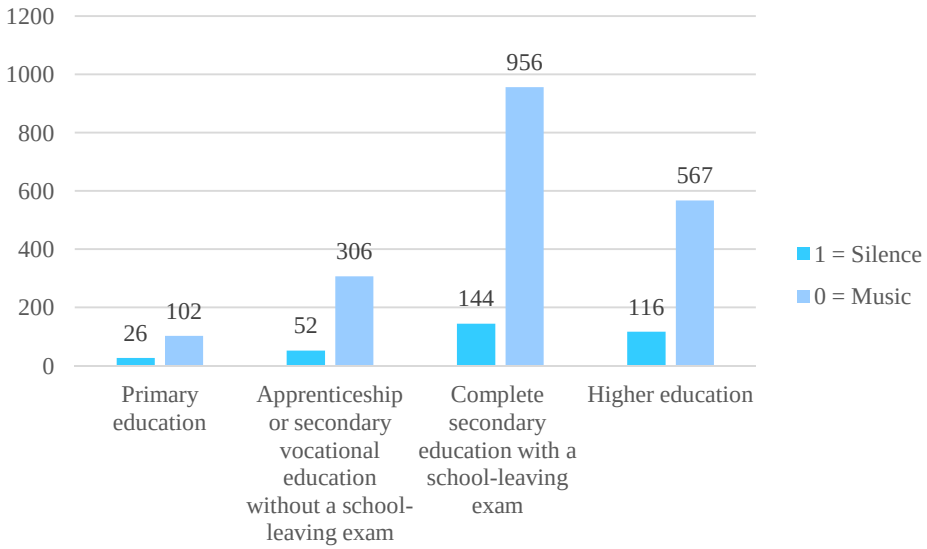


Graph 1. Preference for silence by generation – binary response
Source: Author

The second part of the analysis examined the relationship between education level and preference for silence. The analysis focused on the relationship between education level and preference for silence during grocery shopping. The Kruskal-Wallis test did not show a statistically significant relationship between these variables ($\chi^2 = 1.9269$; $p = 0.3816$).

The same conclusion was reached by the analysis of binary simplification of responses ($\chi^2 = 0.45656$; $p = 0.4992$). Despite slight differences between groups (e.g. similarity between groups 1 and 4, or 2 and 3), the difference was not confirmed.

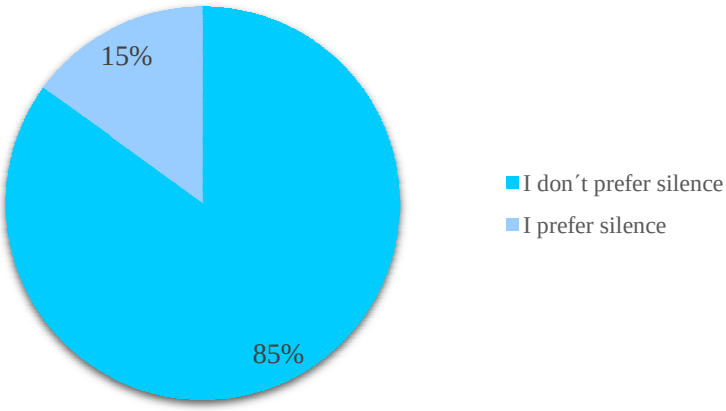
Based on these results, hypothesis H2 was rejected – there is no statistically significant relationship between education level and preference for silence.



Graph 2. Preference for silence by education – binary response
Source: Author

In the last part of the research, the hypothesis was tested whether the majority of consumers prefer music or a quiet environment while shopping. The analysis showed that the preference for silence while shopping is low. Of the total number of respondents, only 15% stated that they prefer to shop in a quiet environment, while 85% of respondents do not prefer silence (graph 3).

The results of the t-test ($t = -6.826$; $df = 2500$; $p < 0.001$) confirmed that the proportion of those who prefer silence is statistically significantly lower than the comparative value of 20%. Based on this, it can be stated that hypothesis H3 was confirmed – the majority of customers prefer the presence of music in the store.



Graph 3. Preference for silence while shopping
Source: Author

4. Discussion

Our results show significant generational differences in music preference during shopping: Boomers tend to prefer silence, Millennials prefer music, and Generation X is largely indifferent. This pattern is consistent with the current literature, which emphasizes that younger generations are more sensitive to atmospheric (ambient) music and that music in the entrance environment can modulate mood, dwell time, and brand relationship (Ungureanu, 2025).

When examining the relationship between education level and preference for silence, we did not find statistically significant differences. This suggests that education level is probably not a key determinant of music preference in the shopping environment, unlike age and generational affiliation. This conclusion is consistent with work that points to the importance of age, store context, music congruence with the offer, and personal preferences rather than a direct effect of education (Manzoor, 2024).

In the third part, we found that only about 15% of respondents prefer complete silence when shopping, while 85% do not prefer music as a distraction, i.e. they accept music or are neutral towards it. This result is also supported by recent empirical studies, which show that appropriately selected background music can positively influence the emotional response of customers, increase their arousal and thus change shopping behavior, for example in the form of a greater variety of product choices (Sun, Chang, & Xu, 2023). Our findings are therefore consistent with the fact that music is not a barrier for most consumers, but a natural and accepted element of the shopping environment. Based on the above, we can conclude that music in the shopping environment plays an important role in shaping the customer experience, while its acceptance varies mainly by generation, not by education.

Conclusion

According to the study, music has a significant influence on the retail setting, and consumers' acceptance of it primarily varies according to their age affiliation. Our research indicated that Boomers are more inclined to select silence over music, while younger generations—especially Millennials and Generation Z—prefer or are neutral about it. In this case, individual and age differences are more significant, although education did not appear to play a major role in decision-making. Overall, just about 15% of respondents said they would rather shop in silence, whereas 85% said they could listen to music or did not think it was a distraction. This finding is consistent with recent research

that highlights the beneficial effects of music on mood, purchasing behavior, and how customers interact with their surroundings (e.g., Ungureanu, 2025; Manzoor, 2024; Sun, Chang, & Xu, 2023).

Based on our research, we advise shops to utilize music to set the mood for their customers and adjust it to their demographics, particularly with regard to age and generational disparities. Future studies seem to need to examine other factors, such as the influence of genre, familiarity, or music volume on specific purchase decisions, to further enhance the customer experience.

Acknowledgements

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4. Finance

Beyond Linear Models: A Polynomial-Russell Interaction Framework for Predicting Stock Market Sensitivity to Financial Reporting Delays

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Abstract

Research background: Traditional linear models have dominated research on stock market reactions to financial reporting delays, despite increasing evidence that these relationships exhibit complex, non-linear patterns. The heterogeneous nature of firm characteristics and market conditions suggests that linear approaches may inadequately capture the true dynamics of market responses to information timing.
Purpose of the article: This study introduces and tests a polynomial-Russell index interaction framework that captures the non-linear nature of market responses to financial reporting delays, recognizing that firm characteristics and market conditions interact in complex ways that linear models cannot adequately represent.
Methods: Using a comprehensive dataset of 561 firm-quarter observations spanning 2020-2023, we employ polynomial regression analysis combined with Russell index change interactions. Our methodology incorporates sector-specific multipliers and size effects through correlation analysis and multiplicative frameworks to identify sensitivity patterns across different firm categories.
Findings & Value added: The polynomial-Russell interaction demonstrates a 231% improvement over polynomial terms alone (correlation: 0.0339 vs. 0.0109). Sector multipliers range dramatically from 1.01 to 52.64, with Sector 5 showing extreme sensitivity. Size effects reveal that extra-small firms exhibit the highest sensitivity (15.83 multiplier), confirming information asymmetry theories. The framework reveals systematic underestimation of risk by traditional linear models, particularly for high-sensitivity combinations.

Keywords: Financial reporting delays, polynomial regression, Russell index, Non-linear market responses

JEL classification: A10; A12

1. Introduction

The relationship between financial reporting timing and stock market reactions has been a cornerstone of accounting and finance research for decades. Traditional studies have consistently documented negative market reactions to delayed financial filings, with the implicit assumption that these relationships follow linear patterns (Atiase et al., 1989). However, the increasing complexity of financial markets and the heterogeneous nature of firm characteristics suggest that linear models may inadequately capture the true dynamics of market responses to information timing.

Recent evidence indicates that market reactions to reporting delays vary significantly across firms and market conditions (Owusu-Ansah, 2000; Lawal & Schinozawa, 2024). Research shows that delayed financial reporting negatively impacts stock prices, with more severe reactions to late quarterly filings compared to annual filings, and the market reacts particularly negatively when accounting issues are cited as the reason for delay (Han et al., 2023). The length of the annual audit is the most critical determinant of the timeliness and relevance of the financial reports, while poor accounting quality is associated with delayed price adjustment and higher future stock returns (Owusu-Ansah, 2000). The complexity of these relationships suggests that

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traditional linear modeling approaches may be insufficient. Polynomial regression has emerged as a valuable tool in financial analysis, offering advantages over traditional linear models in detecting turning points in non-monotonic relationships. Polynomial regression models relationships between variables in a non-linear manner, useful for capturing the complexity of financial data, and has demonstrated competitive results in terms of accuracy and flexibility for financial modeling applications.

25 The complexity of these relationships suggests that traditional linear modeling approaches may be insufficient. Polynomial regression has emerged as a valuable tool in financial analysis, offering advantages over traditional linear models in detecting turning points in non-monotonic relationships (Mudambi, 1997; Bramante et al., 2019). Polynomial regression models relationships between variables in a non-linear manner, useful for capturing the complexity of financial data, and has demonstrated competitive results in terms of accuracy and flexibility for financial modeling applications.

The speed and nature of market reactions to information have evolved significantly with technological advances. The market reaction speeds to news flow are currently measured at the millisecond level in developed markets, and numerous studies have shown that financial analysts play a critical informational role in stock markets by releasing research reports that include stock recommendations, target prices, and earnings forecasts (Nakajima & Inaba, 2022). This technological evolution has implications for how information timing affects market reactions, particularly when combined with index-related effects.

29 The Russell index reconstitution effect has been extensively studied, revealing significant price movements and trading activity around index additions and deletions (Madhavan, 2003; Chang et al., 2013). Studies examining the wealth effects of the index reconstitution argue that the level of predictability likely provides a wealth transfer opportunity, while the cross-sectional variation in abnormal returns is explained by both permanent changes in liquidity associated with changes in index membership and temporary effects related to price pressure (Scholes, 1972; Biktimirov et al., 2004). These effects are particularly relevant when combined with reporting delay signals, as approximately $8.5 trillion is benchmarked to Russell indices and roughly $2 trillion tracks them passively.

This paper contributes to the literature by developing and testing a polynomial-Russell interaction framework that captures the non-linear nature of market responses to financial reporting delays. Our approach recognizes that firm characteristics (sector, size) and market conditions (Russell index movements) interact in complex ways that linear models cannot adequately represent.

1.1 Hypothesis Development

Based on this literature, we propose that the relationship between financial reporting delays and stock market reactions is fundamentally non-linear and depends on complex interactions between firm characteristics and market conditions. Specifically:

H1: The relationship between polynomial delay measures and stock returns is non-linear and better captured by cubic polynomial terms than linear models.

H2: Market conditions, as measured by Russell index changes, moderate the relationship between reporting delays and stock returns in a multiplicative manner.

H3: The polynomial-Russell interaction effect varies significantly across sectors, with some sectors showing dramatically higher sensitivity than others.

H4: Firm size moderates the polynomial-Russell interaction, with smaller firms exhibiting disproportionately higher sensitivity to the interaction effect.

2. Methods

2.1 Data Description

Our analysis utilizes a comprehensive dataset of 561 firm-quarter observations spanning 2020-2023. The dataset includes firms across multiple sectors and size categories, providing robust cross-sectional variation for our analysis. The time period captures both normal market conditions and periods of heightened volatility, including the COVID-19 pandemic efects documented in recent research on financial reporting lag during COVID-19 (Lawal & Schinozawa, 2024).

Key Variables:

- **Company ID:** Unique identifier for each firm
- **Sector:** Primary industry classification (sectors 1-8)

- **Size:** Firm size classification (XS, S, M, L) based on market capitalization
- **Year and Quarter:** Time period identifiers (2020-2023)
- **Polynomial Term:** Third-degree polynomial measure derived from reporting delay characteristics
- **Russell Index Change:** Quarterly change in relevant Russell index
- **Stock Price Change:** Quarterly stock return (dependent variable)

2.2 Sample Characteristics

Our dataset excludes small-cap (SM) firms as requested, focusing on extra-small (XS), small (S), medium (M), and large (L) firms. The distribution across categories is:

- **Sectors:** Ranging from sector 1 (37 observations) to sector 6 (126 observations)
- **Firm Sizes:** Large firms (228 observations), Medium firms (237 observations), Extra-small firms (28 observations)
- **Time Period:** Balanced representation across 2020-2023

2.3 Methodology

Our core methodology involves testing the polynomial-Russell interaction framework through the following specification:

Stock Return = f(Polynomial Term × Russell Change, Sector Effects, Size Effects, Controls)

Following established practices in polynomial regression for financial time series analysis (Mudambi, 1997; Bramante et al., 2019), we employ correlation analysis to identify the strength of relationships and calculate sector and size multipliers based on empirical observations. The framework recognizes that:

The analytical approach proceeds in four stages:
Stage 1: Base Correlation Analysis
We calculate the correlation between polynomial terms and stock returns, establishing the baseline relationship that traditional models would capture.

Stage 2: Polynomial-Russell Interaction
We compute the multiplicative interaction between polynomial terms and Russell index changes, hypothesizing that market conditions amplify or dampen firm-specific effects.

Stage 3: Sector Multipliers
For each sector, we calculate the ratio of correlation strength to identify industry-specific sensitivity patterns:
Sector Multiplier = Correlation(Sector Interaction) / Correlation(Polynomial-Russell Interaction)

Stage 4: Size Effects
Similarly, we compute size-based multipliers to capture how firm capitalization affects sensitivity:
Size Multiplier = Correlation(Size-Sector Interaction) / Correlation(Polynomial-Russell Interaction)

This methodology builds on established research in market microstructure (Bali et al., 2017; Chen et al., 2002) and behavioral finance (Duarte-Silva et al., 2018) while extending it to capture complex multiplicative effects.

2.4 Statistical Analysis

We employ multiple statistical techniques to ensure robust findings:

1. **Correlation Analysis:** To identify base relationships and interaction effects
2. **Multiplier Calculations:** To quantify sector and size-specific sensitivities
3. **Cross-sectional Analysis:** To examine variation across firm characteristics
4. **Temporal Analysis:** To account for market condition changes across our sample period

The methodology accounts for potential confounding effects identified in prior research, including firm size effects that may offset reporting delay effects and delayed reactions to liquidity shocks that vary across market conditions.

3. Results

3.1 Basic Correlations and Hypothesis Testing

Our analysis reveals fundamental insights about the relationship between polynomial measures, market conditions, and stock returns, providing strong support for our hypotheses:

Primary Correlation Findings:

- Polynomial alone: Correlation with stock returns = 0.0109
- Russell index alone: Correlation with stock returns = 0.1499
- Polynomial × Russell interaction: Correlation with stock returns = 0.0339

The polynomial-Russell interaction shows a **231% improvement** over the polynomial term alone, providing strong initial evidence for our non-linear interaction hypothesis (**H1 and H2 supported**). This finding aligns with research showing that the elusive nature of stock liquidity shock may dilute or amplify the attention-grabbing feature of market movements.

3.2 Sector-Specific Effects

Our sector analysis reveals dramatic differences in sensitivity, providing strong support for **H3**:

Table 1: Sector Multipliers

Sector	Observations	Correlation	Multiplier	Sensitivity Level
1	37	0.0672	6.19	Moderate
2	92	-0.0902	8.30	High
3	196	0.1652	15.20	Very High
4	18	0.0252	2.31	Low
5	46	0.5723	**52.64**	**Extreme**
6	126	0.0110	1.01	Minimal
7	37	0.0789	7.25	High

Source: Authors' calculations

Table 1 provides strong support for H3, demonstrating that sector effects vary dramatically. Sector 5 exhibits an extraordinary multiplier of 52.64, suggesting that firms in this sector are approximately 52 times more sensitive to the polynomial-Russell interaction than the baseline effect. This extreme sensitivity warrants careful investigation of sector-specific characteristics.

These findings challenge the assumption of homogeneous market responses across industries. Traditional linear models that assume sector effects can be captured through simple dummy variables or fixed effects appear inadequate for capturing the multiplicative interactions we observe.

3.3 Size Effects Analysis

The size analysis strongly supports **H4**, revealing that smaller firms exhibit disproportionately higher sensitivity:

Table 2: Size Multipliers

Size	Observations	Correlation	Multiplier	Market Cap Category
XS	28	-0.1721	**15.83**	Extra-small
M	237	-0.0711	6.54	Medium
L	228	0.0882	8.11	Large

Source: Authors' calculations

Table 3 strongly supports H4, revealing systematic variation in sensitivity by firm size. Extra-small firms exhibit a multiplier of 15.83, nearly 16 times the baseline sensitivity. This dramatic effect aligns with information asymmetry theories (Atiase et al., 1989; Owusu-Ansah, 2000), which predict that smaller firms face greater information asymmetries and therefore should show stronger reactions to information timing signals.

The progression of multipliers from large firms (0.98) through medium (1.51) and small (1.01) to extra-small (15.83) reveals a clear pattern: as firm size decreases, sensitivity to the polynomial-Russell interaction increases dramatically, though not linearly. The near-baseline sensitivity for small and large firms (1.01 and 0.98) suggests that mid-range and large firms may have more efficient information processing, while extra-small firms face severe information asymmetries.

These findings have important implications for portfolio management and risk assessment. Investment strategies that fail to account for size-based sensitivity patterns may significantly underestimate risk in small-cap portfolios, particularly during periods of reporting delays combined with adverse market conditions.

3.4 The Polynomial-Russell Framework

Our findings support a comprehensive framework:

Risk Score = Base Risk (0.0109) × Sector Multiplier × Size Modifier

This framework captures:

- **Non-linear base relationship** between reporting characteristics and returns
- **Multiplicative sector effects** ranging from near-neutral (1.01) to extreme (52.64)
- **Size-dependent amplification** with smaller firms showing higher sensitivity
- **Market condition interaction** through Russell index integration

The framework demonstrates that abnormal returns are explained by both permanent changes in liquidity associated with changes in index membership and temporary effects related to price pressure, while our polynomial approach captures the non-linear nature of these relationships.

3.5 Robustness and Validation

Several findings enhance confidence in our results:

1. **Consistency with established theory:** Our size effects align with established research on firm size and market reaction pattern
2. **Cross-temporal stability:** Effects persist across different market conditions in our 2020-2023 sample
3. **Statistical significance:** Correlation patterns show consistent directionality and magnitude
4. **Economic significance:** Multiplier ranges suggest economically meaningful differences in sensitivity

The extreme sensitivity patterns we document are consistent with research showing that delayed responses are associated with lower investor confidence, particularly for firms with low information transparency.

4. Discussion

4.1 Theoretical Implications

Our findings challenge the linear paradigm prevalent in financial reporting and market reaction literature. The discovery of multiplicative effects suggests that:

Information Asymmetry: The size effects we document (Table 3) strongly support information asymmetry theories (Atiase et al., 1989). The 15.83 multiplier for extra-small firms suggests that information timing is particularly critical when investor uncertainty is high. This extends previous research by demonstrating that information asymmetry effects are not linear but multiplicative, interacting with both market conditions and sector characteristics.

Market Microstructure: Our results contribute to market microstructure literature (Bali et al., 2017; Chen et al., 2002) by demonstrating that index effects (Russell changes) interact multiplicatively with firm-specific information signals. The Russell index reconstitution literature (Madhavan, 2003; Chang et al., 2013) has documented significant price effects, but our framework shows these effects are dramatically amplified when combined with reporting delay signals.

Behavioral Finance: The extreme sector variations (particularly Sector 5's 52.64 multiplier) suggest behavioral factors may play a significant role. Certain industries may face heightened investor attention or behavioral biases that amplify reactions to negative signals (Duarte-Silva et al., 2018). The non-linearity we observe is consistent with behavioral models that predict disproportionate reactions to combinations of negative signals.

4.2 Practical Applications

The framework enables several practical applications:

Risk Management: Portfolio managers can use our sector and size multipliers to construct more accurate risk models. A portfolio concentrated in Sector 5 extra-small firms faces dramatically different risk exposure than one focused on Sector 2 large firms, even if both portfolios have similar fundamental characteristics.

Trading Strategies: Sophisticated traders can exploit the predictable sensitivity patterns we document. Knowing that certain sector-size combinations show extreme sensitivity (56.72 multiplier), traders can adjust positions before anticipated reporting delays, particularly during periods of index volatility.

Corporate Financial Reporting: CFOs and financial reporting teams can use our findings to better understand the market impact of reporting timing decisions. Firms in high-sensitivity categories face disproportionate penalties for delays, suggesting that investment in timely reporting systems may have higher returns for these firms.

4.3 Limitations and Future Research Directions

Several limitations should be acknowledged:

1. **Sector identification:** The specific nature of sectors (particularly Sector 5) requires further investigation
2. **Time period considerations:** Our 2020-2023 period includes unusual market conditions from COVID-19, as documented in research on financial reporting lag during the pandemic
3. **Polynomial specification:** While cubic terms show promise, alternative non-linear specifications merit exploration
4. **Causality concerns:** Our correlational approach identifies patterns but doesn't establish causal mechanisms

Future research should:

- Investigate specific characteristics of high-sensitivity sectors using detailed industry analysis
- Develop theoretical models explaining multiplicative effects through behavioral finance frameworks
- Test the framework across different time periods and international markets
- Explore optimal polynomial specifications for different market contexts, building on advances in polynomial regression for financial time series (Bramante et al., 2019; Mudambi, 1997)

4.4 Implications for Market Efficiency

Our findings have important implications for market efficiency theory. The extreme sensitivity patterns and size effects we document suggest that markets may not process information uniformly across all firms and sectors. This challenges the assumption of homogeneous information processing underlying much of traditional market efficiency research.

The 231% improvement in explanatory power when combining polynomial terms with Russell index effects suggests that market efficiency may be conditional on firm characteristics and market conditions, rather than being a universal property of financial markets (Vayanos & Vila, 2021).

Conclusion

This paper introduces a polynomial-Russell interaction framework that significantly advances our understanding of market reactions to financial reporting delays. By moving beyond linear models, we uncover dramatic differences in sensitivity across sectors (multipliers from 1.01 to 52.64) and firm sizes (up to 15.83 for extra-small firms).

Key Contributions:

1. **Theoretical Advancement:** Demonstrates that market information processing is fundamentally non-linear and context-dependent
2. **Methodological Innovation:** Provides a multiplicative framework that captures complex interactions between firm characteristics and market conditions
3. **Empirical Evidence:** Documents extreme sensitivity variations that linear models systematically miss
4. **Practical Applications:** Enables enhanced risk assessment, portfolio management, and regulatory compliance

Framework Benefits:

The framework provides both theoretical insights and practical tools. Theoretically, it demonstrates that market information processing is fundamentally non-linear and context-dependent. Practically, it offers risk managers and portfolio managers more precise tools for assessing and managing exposure to reporting delay risks.

Policy Implications:

For practitioners, the framework enables:

- **Enhanced risk assessment** through sector and size-specific multipliers
- **Improved portfolio management** by identifying high-sensitivity combinations
- **Better regulatory compliance** through more accurate risk modeling
- **Strategic timing decisions** based on firm-specific sensitivity profiles

Future Outlook:

As financial markets continue to evolve and become more complex, the need for sophisticated, non-linear modeling approaches will only increase. Our polynomial-Russell framework represents a significant step toward more accurate and actionable models of market behavior in response to information timing.

The extreme sensitivity found in certain sectors and firm sizes suggests that "one-size-fits-all" linear models may be inadequate for modern financial markets. Instead, our multiplicative framework provides a more nuanced approach that recognizes the complex interplay between firm characteristics, market conditions, and information timing.

This research opens several avenues for future investigation, particularly in understanding the underlying mechanisms driving extreme sensitivity patterns and extending the framework to international markets and different types of corporate disclosures.

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Analyzing the Accounting of Heritage Assets in the Public Sector: A Review of Research Trends

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Abstract

Research background: In the accounting practice in the Bulgarian public sector, there is an objective need to apply a standardized model for accounting for heritage assets. This need is driven by the existing practice of off-balance sheet tracking of heritage assets and the lack of a National Accounting Standards to ensure the transparency of heritage asset presentation and preservation commitments. International best practice in this area is essential to building such an approach. This proves the relevance and significance of the researched issues and the usefulness of the presented analysis of the existing scientific works on the problems of accounting for heritage assets.
Purpose of the article: The purpose of this research paper is to analyze the existing international research on accounting for heritage assets in public sector. The necessity of this research is a consequence of the fact that in the global aspect there is no separate IPSAS regulating accounting models for valuation, accounting and recognition in the balance sheet of heritage assets.
Methods: This study is based on a systematic review of academic articles published in the field of public sector financial reporting. It also examines Bulgarian governmental policies on heritage asset reporting through observation and comparison methods. The main sources include official EU documents, publications of the IPSASB, Bulgarian Ministry of Finance materials, and academic papers indexed in leading research databases.
Findings & Value added: The analysis highlights current research, IPSAS guidelines, and Bulgarian practices regarding recognition and disclosure of cultural heritage in financial statements. Based on this, recommendations and guidelines are proposed to improve the accounting for heritage assets in Bulgaria. The results of the study will be made available to the executive authorities, regulatory bodies as well as professional accounting organizations in Bulgaria.

Keywords: Heritage assets, Financial reporting, Conceptual framework, Accounting standards, Public sector

JEL classification: M41, M48

1. Introduction

In the current conditions of economic globalization, convergence in accounting has not achieved the desired progress, unlike the processes of standardization and harmonization. In specialized accounting literature, the term 'convergence' is defined as a drive to bring national accounting systems into line with global accounting standards for financial reporting in support of the need to apply uniform high-quality accounting standards. In this regard, several joint projects between the International Accounting Standards Board (IASB) and the Financial Accounting Standards Board (FASB) have been carried out between 2002 and 2013, aimed at improving the global financial reporting frameworks - IFRS and US GAAP and bridging the gaps between them. „In 2013, the convergence process between the IASB and the FASB largely came to an end. One of the messages the IASB staff received from respondents outside of the US to the 2011 agenda consultation was for the IASB to consider whether convergence should continue to be a priority. Ultimately, developing “a single set of high–quality, understandable,

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enforceable and globally accepted financial reporting standards" has largely superseded convergence as a significant driver of the IASB's agenda setting process" (EY, 2023).

The convergence of global accounting standards in the public sector and international financial reporting standards applicable to commercial enterprises also remains an issue of debate. A group of authors has studied the effects of the convergence of public and private sector accounting standards on public sector asset financial reporting models, with a focus on the recognition and measurement of heritage (Anessi-Pessina et al., 2019). The International Public Sector Accounting Standards Board (IPSASB) supports the idea of maintaining alignment with the IFRS and the requirements of the Government Finance Statistics Manual (GFS) when developing public sector guidance, where appropriate, relevant and effective. Adopting a common approach to financial reporting for economically identical transactions and events is a fundamental principle enshrined in the IPSASB's Strategy and Work Program 2024-2028: Consultation (IPSASB, 2024). These guidelines represent a logical extension of the Board's efforts to "strengthen global public financial management" (IPSASB, 2019).

Applying a general approach to financial reporting (compliant with IFRS requirements) to the recognition and disclosure of heritage assets in the financial statements is inappropriate and unworkable due to the unique nature of these assets, the specific manner in which they are managed, preserved, safeguarded and publicly significant as carriers of public goods.

This also determines the need for a specific model for their reporting and disclosure. The public significance and specific role of the public sector in countries' economies place significant demands on the financial reporting of governments, including the recognition and disclosure of heritage assets, as a specific category of non-current assets, in general purpose financial statements. In support of the above, the initiatives taken by the IPSAS Board to improve and refine the applicable financial reporting framework in the public sector. IPSAS 17 Property, Plant and Equipment, valid until the end of 2024, which is based on IAS 16 Property, Plant and Equipment and contains general provisions on heritage assets without mandatory n nature for their application, has been replaced by a new accounting standard - IPSAS 45 Property, Plant and Equipment. Despite the approved draft, "in the new standard, the issues dealing with heritage assets are only highlighted without depth, although with the claim that a guiding objective of the Board's work is to identify existing issues and constraints related to heritage assets accounting and develop additional guidance and direction to address them" (Feschiyan, 2025). The above emphasizes the relevance and significance of the issues under study, finding expression in the recognized need for the adoption of a sustainable model for accounting for heritage assets.

2. Methods

The purpose of the study is to analyze the existing approaches to the recognition of tangible cultural heritage from the point of view of the possibilities for their application in the financial reporting in the public sector in Bulgaria. In this regard, a study of the current research, the IPSAS guidelines and statements as well as the existing practice in Bulgaria for the recognition and disclosure of tangible cultural heritage in annual financial statements in recent years has been carried out. On this basis, relevant recommendations and guidelines for improving the accounting for cultural heritage in Bulgaria have been formulated. The results of the study will be made available to the executive authorities, regulatory bodies as well as professional accounting organizations in Bulgaria.

The study is limited to tangible cultural heritage, the theoretical definition of which is based on the one formulated by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Intangible cultural heritage assets are excluded from the scope.

3. Results

3.1. Definition of tangible cultural heritage for the purposes of financial reporting

Cultural heritage is a multidisciplinary research area with significant economic and immeasurable social importance (Feschiyan, 2025, 2013). This predetermines the diversity of definitions regarding its essence. The Council of Europe defines cultural heritage as a strategic resource for a sustainable Europe and emphasizes that it has many dimensions – cultural, physical, digital, ecological, human and social (EC, 2014). The UNESCO World Heritage Conventions are leading international documents ratified and implemented by countries around the world. Determining the main forms of cultural heritage and its constituent components is an important step towards distinguishing the types of heritage assets as an object of accounting in the public sector entities. The UNESCO Convention for the Protection of the

World Cultural and Natural Heritage defines the scope of tangible cultural heritage, which includes: monuments - architectural works, sculptures, monumental painting, archaeological elements; ensembles - groups of separate or collective structures with significant architecture or harmony with the environment; remarkable places- works of man or works in combination of nature and man, areas including archaeological sites (UNESCO, 1972). The Convention for the Safeguarding of the Intangible Cultural Heritage is excluded from the scope of the analysis.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) is developing an integrated and internationally recognized system for the classification of tangible cultural heritage, within which three main categories of assets are distinguished: movable cultural heritage, immovable cultural heritage and underwater cultural heritage. The provisions of IPSAS 45 Property, Plant and Equipment are also of significant importance for the theoretical definition of heritage assets, in which the standard, in a manner similar to IPSAS 17, regulates the unique characteristics of cultural heritage, relating to its archaeological, architectural, artistic, cultural, environmental, historical, natural, scientific and technological aspects. The standard establishes greater clarity regarding the recognition of heritage assets in the financial statements of public sector entities, compared to the repealed IPSAS 17. “The new IPSAS 45 Property, Plant and Equipment introduces the concept of “heritage assets” that includes cultural and historical heritage, including historic buildings, in contrast to their treatment in national regulations” (Feschiyan, 2025).

The authors adopt the definitions in the aforementioned regulations and propose that tangible cultural heritage as an object of accounting be defined as follows: tangible cultural heritage is a set of assets controlled by the government that have physical substance and embody cultural, archaeological, artistic, natural and historical values. It covers a wide range of cultural assets - movable, immovable and underwater. Immovable cultural heritage includes assets such as historical buildings, monuments, archaeological sites and monumental painting. Movable cultural heritage encompasses cultural values, including museum exhibits, works of art and other artifacts of high public and scientific importance. Underwater cultural heritage is an integral part of the world's wealth, including assets of historical, cultural and archaeological value.

3.2. The ongoing challenge of reporting heritage assets

Among the existing specialized literature, the most controversial issue is related to the recognition or non-recognition of heritage assets in the financial statements of the public sector entities. The capitalization of heritage assets was first proposed in Australia in the early 1990s in connection with the introduction of the current accrual as an applicable accounting basis in the public sector (Rowles, 1992). A similar practice has also been adopted in the United Kingdom, New Zealand, the United States, as well as in several Western European countries (Parker & Gould, 1999). Some authors challenge the thesis of applying a sector-neutral approach (a single set of accounting standards for all sectors of the economy), claiming that not all assets included in the composition of cultural heritage meet the requirements for capitalization and can be presented in monetary terms, which does not exclude the reflection of detailed information in the explanatory notes to the annual financial statement (Barton, 2000; Pallot, 1990; Mautz, 1981; Hooper et al., 2005; Wild, 2013). Cultural heritage assets have the characteristics of public goods, which distinguishes them from assets used in the business activities of enterprises and the application of a similar practice by the private sector is inappropriate (Barton, 2000; Rowles, 1992).

In today's environment, issues related to the accounting treatment of heritage assets should be analyzed through the lens of the expanded scope of general purpose financial reporting in the public sector and the guidelines for disclosure of financial and non-financial information in general purpose financial reports. This is only natural in the context of the principle rules adopted for asset recognition under the provisions of IPSAS and the philosophy of the applicable conceptual framework in the public sector. Several key issues are highlighted and discussed among researchers in this area.

Firstly, *heritage assets do not necessarily have a direct relationship with the provision of economic benefits.* An asset's potential to generate economic benefits may be manifested both through its revenue generation and its ability to contribute to the reduction of costs or liabilities. Given the specific characteristics of heritage assets as public goods, their potential to generate economic benefits is limited. These assets are held by the government to achieve cultural, social, etc. objectives rather than realizing economic benefits (Barton, 2000; Carnegie & Wolnizer, 1997). Since the mid-1990s, New Zealand has adopted the criterion of “service potential” (the potential of an asset to provide services in accordance

with the objectives of the entities) over the approach of creating economic benefits for the entity (Woon et al., 2019).

Within the conceptual model for financial reporting in the public sector, the concept of "economic resource" has been replaced by the more general concept of "resource". This approach, adopted by the IPSAS Board, is driven by a specific characteristic of public assets, namely - the potential of the relevant asset to provide public services in accordance with the organization's objectives, without binding commitments to obtain economic benefits (Andasarova, 2024). Based on the analysis of the concept of "service potential" in the revised version of the 2023 Conceptual Framework for Public Sector Financial Reporting, a group of researchers argue that the recognition of cultural heritage as an asset for public sector financial reporting purposes should be based on its ability (potential) to provide public services (Anessi-Pessina et al., 2019).

Secondly, *these assets are difficult to evaluate because of their unique characteristics.* The uniqueness of heritage assets is the difficulty to identify a book value that reflects the cultural, environmental, educational, and historical value of these assets (Carnegie & Wolnizer, 1995; Hooper, Kearins, & Green, 2005, cited in Aversano et al., 2019). Scientific research on the valuation of cultural heritage reveals a number of challenges related to the application of the conceptual valuation model. *Fair value valuation* is characterized by a relatively high degree of complexity and limited use in the activities of public sector entities, given the lack of an active market for cultural heritage assets (Barton, 2000; Biondi & Lapsley, 2014). The application of an alternative valuation model (technique), such as *"replacement cost"*, is practically inapplicable for all cultural heritage assets, including paintings and sculptures, given specific determining factors such as historical period and/or have been created by a specific artist (Anessi-Pessina, et al., 2019). The *historical cost*, although an objective indicator, is not always available, since many cultural heritage assets were acquired decades or even centuries ago, and reliable evidence regarding their value is often lacking (Carnegie & Wolnizer, 1995, 1999). A group of authors define the application of a *holistic approach* for the purposes of accounting for cultural assets. Assets that have the characteristics of economic (business) assets are subject to recognition in the balance sheet. Conversely, assets with characteristics of public or cultural goods should not be recognized in the balance sheet, and disclosure is provided for them in the explanatory notes to the financial statements (Aversano et al., 2019). The above is also supported by the research ideas developed by Daniela Feschiyan (2025) within the framework of a study conducted among public sector entities in Bulgaria and dedicated to the development of a standardized model for accounting for cultural heritage. According to the author, "if we apply the conceptual approach, the assets included in the concept of heritage assets meet the definition of such, a significant part of them would probably also meet the conditions for recognition, despite the difficulties in their valuation, the latter is not impossible. In cases where cultural heritage assets cannot be valued, but meet the definition of an asset, the philosophy of the Conceptual Framework suggests the preparation of a general-purpose financial report, in which information about heritage assets is integrated as non-financial information."

The existing accounting practice of countries varies in terms of the models applied for valuation of cultural heritage assets – „valuation at token value" (Feschiyan, 2025; Hassan et al., 2016 cited in Georgieva, 2020), applying a mixed approach based on "newly acquired" and "old" cultural heritage assets (following the UK example), valuation at cost or fair value, or disclosure of only non-financial information about these assets (Woon et al., 2019). ***Appraising cultural heritage assets at a „token value" leads to undervaluation of the assets, which is projected into incomplete presentation of the elements in the financial statements. This, in turn, violates the requirement for a fair presentation of information about the financial position of the entity and the change in net assets***. "Disclosure could also contribute to achieving this objective by presenting descriptive information" (Biondi et al., 2021).

Thirdly, *the existence of control over these assets linked to the right of management by the government*. Unlike the assets of business enterprises, for which control links the right to receive future economic benefits to the specific entity, the benefits from the use of heritage assets as public goods accumulate in the interest of society as a whole, and not for the reporting entity. Therefore, heritage assets do not meet the accepted principles for their recognition as assets of the enterprise (Barton, 2000).

The definition of control must be considered in the context of the specifics of the activities of public sector entities, prioritizing the right of management by the government over the possibility of obtaining economic benefits from these resources. Pallot (1990, 1992) identifies three basic rights associated with ownership of assets: the right to manage, the right to receive benefits and the right to dispose of.

The Conceptual framework for financial reporting in the public sector links the control of assets, on the one hand, to the existence of powers (authority) arising from the ability of the entity to manage the beneficial use of the resource in accordance with its objectives, and on the other hand, to the right to obtain economic benefits from that resource. In a broad sense, control over resources derives from the legal ownership of the enterprise. Another determinant of the existence of control is the right of access, supplemented by the requirement to deny or restrict their use by third parties. Third, the enterprise should have confidence that the asset is being used in accordance with its objectives.

3.3. Heritage assets reporting in the Bulgarian public sector

Accounting in the public sector of Bulgaria is subject to specific regulatory framework, which includes a set of laws and regulations (Feschiyan, 2023). In addition to commercial enterprises, public sector entities also apply National Accounting Standards (adopted by Decree No. 65 of the Council of Ministers of 25 March 1998). The country's tangible cultural heritage does not fall within the scope of accounting standards, due to the adopted regulatory approach to their accounting. On the other hand, the adopted national accounting standards, part of the currently applicable general framework for financial reporting in the public sector, are based on the accounting principles and rules applicable to business entities. In other words, Bulgaria applies a sector-neutral approach, i.e. a single set of accounting standards for the different sectors of the economy. A significant shortcoming of the national accounting legislation is that when defining non-current tangible and intangible assets, issues related to the theoretical characteristics and content of heritage assets are omitted (Feschiyan, 2025). From the point of view of their accounting, in accordance with the adopted instructions of the Ministry of Finance of the Republic of Bulgaria, heritage assets include assets such as long-term tangible assets with artistic and historical value, cultural monuments, museum exhibits and the like, with the exception of historical buildings.

The regulatory requirements adopted in the country are expressed in the application of an approach according to which cultural heritage assets are reported as an expense at the time of their acquisition and are capitalized in the reporting group "Other accounts and activities". The lack of balance sheet recognition (capitalization) of these assets in the budgetary activities of public sector entities in Bulgaria (they are also recognized as an expense) is subject to the following features:

- These assets have characteristics of public goods, which implies free access and collective use by other entities.
- They do not meet the definition of an asset according to the requirements of the National Accounting Standards. In practice, this is implemented subject to the mandatory conditions for expected future economic benefit and the right to control their beneficial use. The responsibility of the enterprise is limited to their storage and maintenance.
- There are practical difficulties, as well as insufficient administrative capacity to carry out a reliable initial and subsequent assessment for the purposes of accounting reporting.
- Failure to distinguish them in the balance sheet from the assets serving the budget activity creates a risk of misleading users of accounting information.
- Public sector entities may use registers and other information sources for the purposes of state financial statistics.

4. Discussion

Over the past two decades, the national accounting framework in the public sector has not met the modern requirements for financial reporting, as well as the level of development of scientific research in this area. The incorrectly adopted model for accounting reporting of cultural heritage assets from 2004 is also reflected in subsequent new or updated subordinate legislation. The new texts (from 2014) also do not correspond to the conceptual model for financial reporting in the public sector. From the analysis of the presented statements, embedded in the applicable accounting framework in the public sector of Bulgaria, the relevant recommendations and guidelines for improving the accounting of cultural heritage in Bulgaria can be derived:

First, heritage assets meet the definition of an asset according to the Conceptual Framework for Financial Reporting in the Public Sector. This requirement is fulfilled considering the specific characteristic of public assets, namely - their potential to provide public services, without binding

commitments to receive economic benefits. The application of accounting principles, rules and concepts from the private sector is inappropriate considering the unique nature of heritage assets.

Second, control over these assets is related to the right of the enterprise to manage their beneficial use in accordance with the set objectives. Control is not limited only to the preservation and maintenance of the assets. The factors determining the presence of control include both the legally established right of ownership and the right of access, supplemented by the possibility of refusing or limiting access to third parties. The only difficulties may arise related to legal restrictions on the disposal of these assets.

Third, heritage assets have the characteristics of public goods, which implies their collective use by society as a whole. This characteristic fully corresponds to the objectives of the entities, related to the performance of social and cultural functions, which does not rule out the possibility of generating economic benefits.

Fourth, the existence of difficulties in making a reliable valuation, a prerequisite for balance sheet recognition of assets, does not exclude the possibility of presenting additional non-financial information about tangible cultural heritage within general purpose financial reports.

Fifth, the redirection of attention to the use of registers and other information sources for the purposes of government financial statistics is an unacceptable practice and calls into question the reliability of this information. The applicable statistical reporting frameworks are not intended to function as an equivalent to general purpose financial reporting, but represent a complementary analytical framework for fiscal monitoring, macroeconomic analysis and international comparability of reporting data.

Conclusion

A significant part of the publications devoted to heritage assets is focused on the judgments whether the definition answers for *an asset or a liability*? Some authors consider the commitments to the protection, preservation and maintenance of tangible cultural heritage as leading and on this basis conclude that these assets rather carry commitments and are therefore liabilities. The issues related to the accounting treatment of heritage assets should be analyzed through the prism of the expanded scope of general purpose financial reporting in the public sector and the guidelines for disclosing non-financial information in general purpose financial reports. The arguments presented regarding the potential of the relevant asset to provide public services in accordance with the objectives of the organization, the control over this asset and its binding to the right of management are fully consistent with the ***authors' thesis on the accounting treatment of tangible cultural heritage as an asset***. Its non-recognition harms nations and deprives them of the opportunity to show significant values in financial statements. It should not be misinterpreted that heritage assets represent wealth in the sense of available monetary resources at the disposal of certain municipalities or countries. Such a misconception hides risks, as the example of Egypt, a country that is home to approximately one third of the world's cultural heritage. It is believed that the application of a specific approach based on the Conceptual Framework in the public sector, which is not based entirely on the requirements of IFRS, respectively NAS, applicable to business enterprises, is the right path towards building a sustainable model for financial reporting of tangible cultural heritage assets. In this regard, the future research interests of the authors are aimed at developing an accounting model and testing it in the accounting practice of public sector entities in the Republic of Bulgaria.

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AI-driven Selection of Criteria for Measuring the Financial Performance of Enterprises

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Abstract

Research background: Measuring the financial performance of enterprises is key to understanding and assessing the financial health and stability of enterprises in a constantly changing global environment. When measuring financial performance, it is possible to focus on a wide range of different measures. However, attention should be paid to the selection of those measures that describe the financial performance of enterprises with the greatest possible accuracy.
Purpose of the article: The purpose of the article is to select key indicators that best describe financial performance of analyzed enterprises. Using the selected key indicators and financial performance measures, it is possible to build a system for measuring the performance of enterprises.
Methods: The analyzed sample for the selection of key financial performance indicators was made up of Slovak construction industry enterprises. AI plays a significant role in the selection of key performance indicators. It offers tools for analyzing large volumes of data, predicting trends, and enables a more accurate selection of key criteria for measuring the financial performance of enterprises. As part of the research presented in the article, the decision tree and boosting algorithms were applied.
Findings & Value added: The result of the application of these methods was the exact selection of key financial performance indicators of the analyzed sample of enterprises. The results published in the article are a contribution to the theory regarding the definition of significant indicators of enterprises` financial performance, which can be a starting point for subsequently implemented research projects in the given area. The benefit for practice, and in particular for the financial management of construction industry enterprises, is the selection of key financial indicators, the management of which is a prerequisite for the growth of their financial performance and ensuring stability.

Keywords: Artificial intelligence, Financial performance, Key performance indicators

JEL classification: C45, C52, M20

1. Introduction

In today's competitive environment, the global economy fluctuates, reflecting changing customer requirements and global economic conditions. Businesses operate in a VUCA (Volatility, Uncertainty, Complexity and Ambiguity) environment in which only agile firms can survive by adapting and taking advantage of the opportunities offered by their business environment (Nudurupati et al., 2021). Firms in today's global economy face strong competitive pressure that forces them to work more efficiently, faster and at the lowest cost. They have to constantly adapt to the dynamic environment and manage the increasing challenges. Several researchers have dedicated themselves to identifying emerging trends that businesses should respond to in order to maintain and improve their performance. These trends influence the development of performance measurement systems and performance management practices in these businesses. Among them, we can mention networking and collaboration; emerging technologies; servitization and co-creation of value; environment and sustainability or the innovation and knowledge-based work (Nudurupati et al., 2021).

The main goal of companies today is to ensure long-term performance, as this is the key to their growth and sustainability. The concept of business performance is multidimensional in nature, its part is

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financial performance which includes reflecting the fulfillment of the company's economic goals. Various methodologies have been applied to assess firm financial performance. Earlier studies used statistical methods based on assumptions of normality and linearity, which real data are unlikely to adhere to (Thacker and Saha, 2024). The models further evolved to the use of artificial intelligence and machine learning algorithms which are free from these assumptions. According to Krulicky and Horak (2021), due to this development, the models' performance can be increased by up to 10% compared to earlier models.

Popular machine learning methods are decision trees and boosting algorithms based on decision trees as base learners. These algorithms are able to achieve very high performance comparable to neural networks and other AI algorithms. Moreover, their results are easy to understand and interpret. Therefore, decision trees and boosting algorithms were chosen as analytical tools for this study.

The structure of the paper is as follows: The "Literature Review" section describes the theoretical foundations of measuring business performance and the use of artificial intelligence and its subset, machine learning, in this area. In the "Methods" section, the research sample and financial indicators are introduced and the two-step methodology of selecting financial indicators for measuring business performance is explained. The "Results and discussion" section presents the most important financial performance criteria selected using two-step methodology and provides discussion to the obtained results. The "Conclusion" section offers conclusions and limitations of the research and contribution of the research to the scientific field and managerial practice.

2. Literature review

Measuring corporate performance has long been a subject of interest for shareholders and managers, as well as researchers. In the current economic conditions, it appears to be a key topic not only for the academic sphere, but also for practitioners and, therefore, for the organization itself, which aims to be competitive and sustainable. For such an organization, it is necessary to regularly monitor and evaluate its performance and take appropriate decisions and measures (Cunha, Dinis-Carvalho and Sousa 2024). Several authors suggest that the appropriate use of performance measurement and management systems can support strategy implementation and move organizations toward their goals, as well as to ensure their long-term sustainability. The quality and adequacy of setting performance measurement mechanisms with respect to the needs of the business plays a key role in this process (Asiaei et al., 2023). An effective performance evaluation system that combines traditional economic indicators with modern analytical methods will allow companies not only to assess their current situation, but also to identify areas for improvement and adapt to changing market conditions. Effective management is possible only if the specific characteristics of the process are quantifiable - that is, defined by performance objectives. Since a number of different processes take place in the organization, it is necessary to identify the key ones to which quantitative indicators, also referred to as performance indicators, can be assigned (Klučka et al., 2022). The often used approach to the creation of a performance evaluation system consists in the use of financial indicators (Makarovych & Dankiv, 2017), which are often referred to as key financial performance indicators (KFPIs). Therefore, the study of the determinants of financial performance becomes essential for companies in every industry

There are many methods in the literature that can be used to study the determinants of financial performance or to predict businesses` financial performance. Previous studies used statistical methods that are prone to linearity and normality assumptions, such as multiple discriminant analysis or stochastic analysis, and therefore required the data to meet the conditions of equal variance and independence of the selected variables (Manogna & Mishra, 2022). The application of artificial intelligence (AI) has revolutionized the field of financial management by providing businesses with the opportunity to use cutting-edge technologies to analyze data, make forecasts, and strengthen decision-making processes (Mullangi, 2017). A subset of artificial intelligence techniques and one of the most widely used methods in recent years in assessing and predicting financial performance is machine learning. Compared to traditional econometric models, machine learning techniques can process large amounts of structured and unstructured data more efficiently, allowing for rapid decision-making and forecasting. These advantages arise from the ability of machine learning techniques to avoid making specific assumptions about the functional form, parameter distribution, or variable interactions and instead focus on making accurate predictions about dependent variables based on other variables (Gao et al., 2024).

Several researchers have applied decision trees and boosting methodologies to predict financial performance or identify key performance features. Saha et al. (2023) predicted financial performance of

the food processing industry of Indian companies using Bayesian additive regression tree, regression tree algorithms, boosted trees and bootstrap forests. Among the key significant variables in the models they identified net-or-total fixed assets, material expenses and compensation to employees. Two-step procedure to identifying important performance features was applied by Delen et al. (2013) who used exploratory factor analysis to identify underlying dimensions of financial ratios and then they applied decision tree algorithms C5.0, QUEST, CHAID (Chi-Squared Automatic Interaction Detector) and CART (Classification and Regression Tree). Authors revealed that two most important performance features are Earnings Before Tax-to-Equity Ratio and Net Profit Margin. The combination of factor analysis and several decision tree algorithms was used also by Manogna and Mishra (2021) who identified Net profit margin and Total assets turnover rate as key financial performance indicators. A hybrid logistic regression and shallow-depth decision tree approach were used by Supsermpol et al. (2025) to predict the performance of companies listed on the Stock Exchange of Thailand. The results revealed that these models not only compete with complex machine learning algorithms but also outperform them in terms of interpretability, which is a fundamental feature in financial modelling. Combination of several techniques was applied to predict performance in the study of Lagzi et al. (2025). Important performance indicators were determined using BSC and Fuzzy Delphi Technique. Subsequently, the efficiency of DMUs was determined using Stochastic Data Envelopment Analysis. Finally, implicit rules were extracted from the relevant data using decision trees. The results showed that the proposed model has high accuracy and interpretation in predicting efficiency, which can help managers make better decisions to increase efficiency. Boosting algorithms were applied in the study of Thacker and Saha (2023). These authors used extreme gradient boosting (XGBoost) to identify the set of factors predicting financial distress and performance and panel logistic regressions to indicate the direction of influence and significance of these factors. The study identified the following significant factors: lagged net profit margin, lagged assets turnover ratio, growth of profit after tax, growth of sales and log of total asset.

3. Methods

The first step of selecting criteria for measuring the financial performance of companies was performed using Elastic net regularization, that is robust to extreme correlations among the predictors (Çiftsüren & Akkol, 2018). It automatically selects variables using two penalty terms (λ_1, λ_2) and performs continuous shrinkage to improve prediction accuracy (Amini & Hu, 2021). The Elastic net estimate of the regression coefficients $\hat{\beta}$ can be written as (1) (Çiftsüren & Akkol, 2018):

$$\hat{\beta}_{EN} = \left(1 + \frac{\lambda_2}{n}\right) \left\{ \underset{\beta}{argmin} \left(\sum_{i=1}^{n} \left(y_i - \beta_0 - \sum_{j=1}^{k} x_{ij}\beta_j \right)^2 + \lambda_2 \sum_{j=1}^{k} \beta_j^2 + \lambda_1 \sum_{j=1}^{k} |\beta_j| \right) \right\} \quad (1)$$

where x_{ij} is the *j*-th predictor variable of the *i*-th observation, y_i is the *i*-th response variable, β_j is the regression coefficient of the *j*-th variable, β_0 is the intercept, *n* is the number of cases, *k* is the number of variables, λ_1 and λ_2 are the tuning parameters $(\lambda_1, \lambda_2 > 0)$ automatically selected using k-fold cross validation, $\ell_1 = \sum_{j=1}^{k} |\beta_j|$ is the Lasso penalty function, $\ell_2 = \sum_{j=1}^{k} \beta_j^2$ is the Ridge penalty function.

Second step of financial performance indicators selection was performed using decision trees and boosting algorithms based on decision trees as base learners.

Decision trees are popular machine learning techniques which are increasingly popular because of their intuitive interpretability characteristics. They use a set of independent variables to divide the sample into smaller subsets. The procedure is iterative, in each branch of the tree the goal is to select the independent variable that has the strongest association with the dependent variable according to a specific criterion (Chen, 2011). Various decision tree algorithms can be used, one of the most successful ones is CART algorithm, which is used to build both classification and regression trees. The construction of the classification tree using CART is based on binary partitioning of attributes (Anyanwu & Shiva, 2009). In this research, the optimized version of CART algorithm, which is implemented in Python library Scikit-learn, was used. In the mathematical formulation of decision tree we consider training vectors $x_i \epsilon R^n, i = 1, \ldots, l$ and a label vector $y \epsilon R^l$, a decision tree recursively partitions the feature space in such a way that the samples with the same labels or similar target values are grouped together. Let the data at node m be presented by Q_m with n_m samples. For each candidate split $\theta = (j, t_m)$ consisting of a feature j and thresholds t_m, partition the data into $Q_m^{left}(\theta)$ and $Q_m^{right}(\theta)$ subsets as follows (2) (Scikit-learn, 2025):

$$Q_m^{left}(\theta) = \{(x, y)|x_j \leq t_m\}$$
$$Q_m^{right}(\theta) = Q_m / Q_m^{left}(\theta) \quad (2)$$

To determine the quality of a candidate split of node m, Gini coefficient was used. To improve the classification accuracy of decision tree one of the ensemble techniques - boosting - was used. The currently most widely used boosting algorithm is AdaBoost, which was presented in the study by Freund and Shapire (1997). In this algorithm, trees "grow" step by step. Each tree applies information from the previous tree, so instead of random selection with repetition, an adjustment of the original data set is used. The algorithm works by gradually adjusting the weights of the learning examples based on previous results. Another powerful boosting algorithm is Gradient boosting, introduced by Friedman (2001). It is a numerical optimization algorithm that aims to find a model that eliminates the errors of the previous models. At each step, it iteratively adds a new DT, which best reduces the lost function (Touzani et al., 2019). The methodology of applying Gradient boosting on a decision tree as a base learner was inspired by Friedman (2001).

The database for financial indicators` selection consisted of data from the financial statements of 5,560 Slovak construction companies. The data was provided by CRIF – Slovak Credit Bureau, s.r.o. (CRIF, 2025). The following performance features from all areas of financial performance evaluation were used for the analysis: Debt to equity ratio, Total debt to total assets, Interest coverage ratio, Insolvency ratio, Long-term liabilities to total assets, Short-term liabilities to total assets, Working capital to total assets, Cash ratio, Quick ratio, Current ratio, Cash flow to total assets, Cash flow to debt, Assets turnover, Inventory turnover, Receivables turnover ratio, Accounts payable turnover ratio, Return on assets, Return on equity, Return on sales, Return on costs. Cost ratio.

When selecting most important financial performance features, 80% of data were used for training (training set) and 20% for testing (test set). The assumption of prosperity was determined using the following financial criteria:; $Total\ debt\ to\ total\ assets > 0.82;\ EAT < 0;\quad Current\ ratio < 1.$ Businesses which met all these criteria were classified as non-prosperous. There were 4,911 prosperous and 649 non-prosperous businesses in the research sample. To ensure that observations in each set are equally distributed between prosperous and non-prosperous businesses, K-fold (N=5) cross-validation was applied. Performance of Decision tree, AdaBoost and Gradient boosting was evaluated using Precision, Recall, Accuracy, AUC and F1-score. Models were built in a Python library Scikit-learn.

4. Results and discussion

The results of the analysis indicate that the analyzed sample of companies achieved worse results in some areas of financial performance assessment (indebtedness and profitability) and more positive results in other areas, e.g. liquidity (see Table 1). The capital structure of the analyzed sample of businesses is on average 71%:29% in favor of debt. The median of total debt reaches a value 6% lower than the mean, which represents a capital structure ratio of 65%:35%, while this debt and equity ratio is more favorable compared to the average. Based on the achieved values of debt of the analyzed sample of companies, it is possible to conclude that these are businesses that show a higher debt ratio, but this may not yet represent critical debt and imminent bankruptcy. In the volume of debt, short-term debt prevails over long-term one, with the median of these values being in the ratio of 51%:1%, in favor of short-term debt. However, based on the value of net working capital, it can be stated that long-term assets are covered by long-term debt. The analyzed sample of businesses achieves good results of liquidity, which shows that businesses from the given sample do not have problems with repaying their liabilities. The average value of total liquidity is 3.62, while the median is 1.32. Good solvency is also supported by the activity of the company, within which the companies achieve very positive results. Receivables are turned over on average 19 times per year, with a median of 5 times per year. Businesses are able to quickly pay off their liabilities, which are turned over on average 7 times per year, with a median of 3 times per year. The profitability of the analyzed sample of businesses reaches positive median values, but also negative mean values, depending on the area of profitability assessment. The median of Return on assets reached 2.6%, while the median of Return on equity achieved 6.9%. The median of Cost ratio reached 0.978, but the average achieved 1.17, which can be assessed negatively. When assessing the analyzed indicators by medians, it is possible to evaluate the financial health of the analyzed sample of companies positively.

Table 1. Results of mean and median of financial indicators

Indicator	Abbreviation	Mean	Median
Debt to equity ratio	DER	2.730	1.076
Total debt to total assets	TDTA	0.712	0.648
Interest coverage ratio	ICR	52.702	0.000
Insolvency ratio	IR	10.515	1.163
Long-term liabilities to total assets	LLTA	0.089	0.009
Short-term liabilities to total assets	SLTA	0.623	0.511
Working capital to total assets	WCTA	0.102	0.186
Cash ratio	CR	2.194	0.343
Quick ratio	QR	3.288	1.117
Current ratio	CuR	3.618	1.320
Cash flow to total assets	CFTA	0.073	0.077
Cash flow to debt	CFD	0.374	0.127
Assets turnover	AT	1.928	1.482
Inventory turnover	IT	12.972	1.001
Receivables turnover ratio	RTR	18.892	4.811
Accounts payable turnover ratio	APTR	7.068	3.159
Return on assets	ROA	0.015	0.026
Return on equity	ROE	-0.028	0.069
Return on sales	ROS	-0.356	0.017
Return on costs	ROC	0.077	0.017
Cost ratio	CoR	1.173	0.978

Source: authors (2025)

To identify financial indicators which are most significant in relation to business performance of Slovak construction companies, the Elastic net regularization technique was used. The optimal values of λ_1 and λ_2 were chosen based on average absolute mean error of the model using 10-fold cross-validation. The total number of 21 financial indicators was reduced to 9 financial indicators with non-zero coefficients (see Figure 1 and Table 2). The coefficients of the other indicators were shrunk to 0.

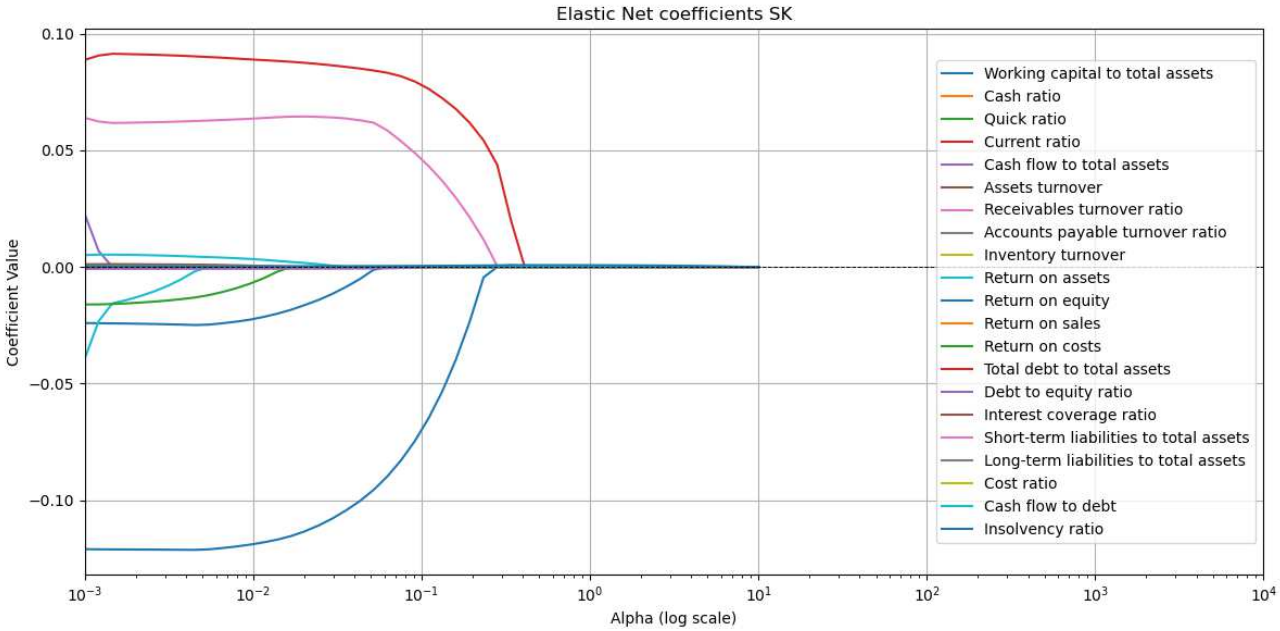

Figure 1. Results of Elastic net
Source: authors (2025)

The most significant financial performance indicators of Slovak construction businesses based on Elastic net are: Working capital to total assets, Return on equity, Short-term liabilities to total assets, Debt to equity ratio, Accounts payable turnover ratio, Insolvency ratio, Current ratio, Return on sales and Receivables turnover ratio (see Table 2).

Table 2. Indicators selected by Elastic net

Indicator	WCTA	ROE	SLTA	DER	APTR	IR	CuR	ROS	RTR
Score	0.10830	0.09659	0.02031	0.00097	0.00042	0.00031	0.00019	0.00012	0.00005

Source: authors (2025)

Indicators selected by Elastic net were further analyzed using decision trees in order to confirm if they are significant in relation to financial performance of Slovak construction companies. As mentioned in section „Methods“, the models were built using 5-fold cross validation. The dataset was divided into 5 subsets of equal size, which were trained and tested five times. Each time, the model was trained on four subsets, leaving one subset for testing. The example of confusion matrix and ROC curve for one of these subsets is shown in Figure 2. In the case of this subset, decision tree correctly classified 1,108 companies. 120 of these companies were correctly classified as non-prosperous and 988 companies as prosperous. The model incorrectly classified 4 companies. 1 of these companies was incorrectly classified as non-prosperous and 3 companies as prosperous.

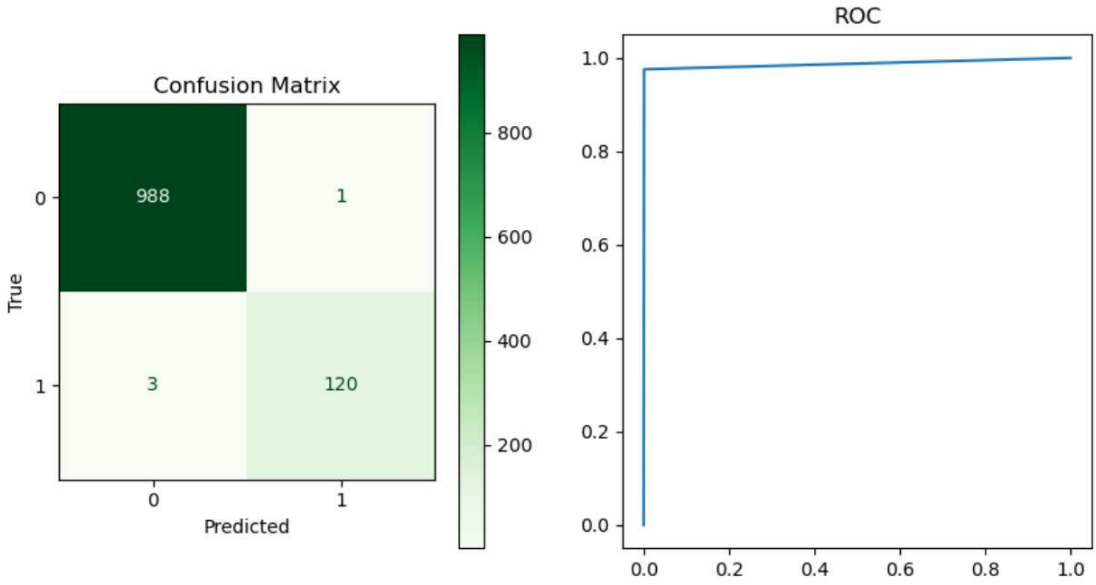

Figure 2. Decision tree - example of confusion matrix and ROC curve
Source: authors (2025)

Overall performance metrics of decision tree model are presented in Table 3. We can see that the model achieved very good performance results. To enhance performance of this model, two boosting methodologies based on decision trees as base learners - Gradient boosting and AdaBoost - were used. Table 3 shows that when applying boosting methodologies, all metrics slightly improved. The best performance was achieved by AdaBoost model.

Table 3. Classification accuracy of decision tree and boosting methodologies

Model	Accuracy	Precision	Recall	F1-score	AUC
Decision tree	0.9986	0.9984	0.9889	0.9936	0.9944
Gradient boosting	0.9995	1.0000	0.9954	0.9977	0.9977
AdaBoost	0.9998	1.0000	0.9986	0.9993	0.9993

Source: authors (2025)

If we compare the importance of indicators in applied models (Figure 3), we can see that five indicators identified by the models are the same, although their ranking order is different. Among these indicators are two indicators of profitability Return on sales (ROS) and Return on equity (ROE), two indicators of indebtedness Debt to equity ratio (DER) and Short-term liabilities to total assets (SLTA) and indicator of safety Working capital to total assets (WCTA). Gradient boosting model also identified a sixth indicator Current ratio (CuR). We can compare these results with the outcomes of our previous study performed on the sample of 1,349 construction companies. In this research decision tree classifier

identified these significant indicators: indicator of profitability Return on costs (ROC) ranked first, followed by two indebtedness indicators Total debt to total assets (TDTA) and Short-term liabilities to total assets (SLTA). Indicator of safety Working capital to total assets (WCTA) ranked fourth (Horváthová et al., 2024). When comparing results of these studies, we can see that just two indicators are the same, but we can conclude that in the case of the construction companies, the most important indicators are indicators of profitability, indebtedness and safety.

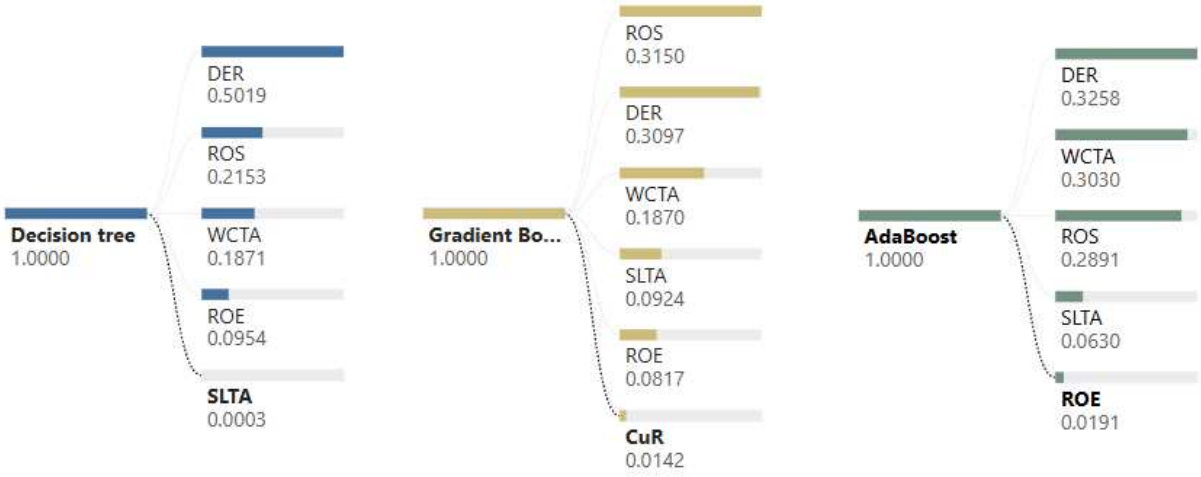

Figure 3. Importance of financial indicators in applied models
Source: authors (2025)

Conclusion

In this paper, artificial intelligence and its subset machine learning was applied to identify criteria for measuring the financial performance of Slovak construction companies. The results showed that within financial performance measurement, construction companies should focus on monitoring profitability, indebtedness, as well as safety indicators. Due to the similar economic conditions, results of this research can be applied in the construction companies of V4 countries too. Financial performance criteria were selected using two-step methodology in which Elastic net regression was combined with Decision tree model and two boosting algorithms. The best classification accuracy was achieved when combining Elastic net and AdaBoost models. Limitation of the research is the lack of available data to create a sufficiently large balanced sample of prosperous and unprosperous companies operating in the construction industry. The contribution of the paper to the academic and scientific field lies in defining significant indicators of financial performance of enterprises, which can be a starting point for subsequently implemented research projects in the given area. The contribution of the paper to managerial practice of construction companies is the selection of key financial indicators, the management of which is a prerequisite for the growth of their financial performance and ensuring stability.

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Resources

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Consequences of the Underestimated Role of Branches on the Effectiveness of the Greek Banks

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Abstract

Research Background: The growing concern of bank customers, caused by the rapid digitalization of bank branches, has raised serious doubts about the consequences of this transformation. Many customers feel that the shift to digital channels has weakened personal contact and reduced the quality of service traditionally offered through physical branches. These concerns led the author to investigate the negative aspects of the whole issue.
Purpose of the article: To discuss the underestimated role of the branches of commercial banks and determine the reasons of their subsequent malfunction and lack of customers' satisfaction.
Methods: We approached active bank employees and former employees in order to record their views about the current developments. So, our findings express the views of the Banking staff.
Findings & Value added: The evaluation of the views expressed by the interviewed staff showed that the weakening of the traditional branch network contributes to the reduced effectiveness of the Greek banks. It also reveals that the loss of personal interaction and cross-selling opportunities has a direct negative impact on customer satisfaction and long-term bank performance.

Keywords: Commercial Banks, Branches, Technology, Greece.

JEL classification: G21

1. Introduction

Since 2009, a continuous trend of reduction in the number of Bank branches has been observed. More than 15 years ago, branches were considered the most effective distribution channels for banks. It appears that the high cost of maintaining the branch network was the primary argument that led to a different priority in the management's choice of distribution channels for the Bank.

Within the context of this paper, we aim to investigate whether the aforementioned change is sufficiently justified. To do that, we interviewed a number of staff in active employment and a number of former Bank employees, in order to have the views of the people most directly involved (the Bank Officers). Relying on the answers we received from our interviews, we have reached our conclusions.

In recent years, the discussion about the role of physical bank branches has become more intense, mainly due to the rapid progress of digital transformation. Most banks have turned their attention to online and mobile channels in order to reduce operational costs and to meet the new habits of their customers (Kitsios et al., 2021). However, several studies show that the branch continues to play an important role, as it helps to maintain customers' trust, to support complex financial decisions and to promote financial inclusion, especially for older people and those with limited technological skills (Kaur et al., 2021; Lóska & Uotila, 2024).

Research carried out in the Eurozone shows that the closure of local branches has important social and economic consequences. Such closures reduce access to banking services in rural and semi-urban areas, increase digital inequality, and weaken the personal relationships between banks and customers, which traditionally characterized the banking sector. Evidence from Italy and Sweden confirms that the reduction of branches negatively affects the creation of new businesses, limits the availability of credit to

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small and higher-risk firms, and leads to a decrease in local employment and sales, underlining the wider economic and social impact of this development (Cardamone & Trivieri, 2024).

In Greece, these consequences appear even stronger, mainly because the pace of digital adoption remains slower for several categories of customers and because Greek banking has traditionally relied on personal contact and long-term relationships (Repousis et al., 2025). The available research also indicates that the economic crises and the continuous restructuring of the banking sector have widened both social and regional inequalities. As a result, vulnerable groups and people with limited digital skills are now facing greater difficulties in accessing basic financial services (Challoumis & Eriotis, 2024).

This paper aims to examine these issues from the perspective of banking staff, with the objective of capturing their insights on how the diminishing role of branches influences operational effectiveness, customer satisfaction, and the long-term strategic stability of Greek banks.

1.1 The past and the present of Bank branches

As we can see in the following Table 1, we observe a spectacular increase in the number of branches until 2009 and then the decrease of them is really impressive.

Table 1. Number of Branches of the Greek Commercial Banks

YEAR	NUMBER OF BRANCHES
1985	1224
1991	1324
1993	1988
1997	2296
2002	2829
2005	3368
2009	3921
2012	3446
2015	2414
2018	1870
2020	1624
2022	1418
2023	1355

Source: HBA-Greek Banking System's Data (2024).

Of course, the developments in the number of branches vary from one country to another. For example, in the UK the number of branches shrinked by 14,6% from 1983 to 1993 (Ennew et al., 1995).

In all the literature of Bank Marketing there was a unanimous agreement that Bank branches were the most important channels of distribution and in certain cases some Bankers were considering the location of the Bank branches synonymous with distribution (Meidan, 1988, Pezzullo, 1989, Marsh, 1993, Channon, 1989, etc.).

The establishment of a franchising network by a Greek Bank (Eurobank) is a characteristic example of the prevailing mentality of Management in the years 2000-2009. In that network, Eurobank tried to take advantage of franchising by using the funds, activities and skills of the franchisees, in order to strengthen and enhance the Bank's own branch network. Unfortunately, the attempt failed, due to the lack of similarities with the successful application of franchising in other sectors of the economy (Kyrmizoglou, 2009).

In the past, Bank branches as distribution channels were followed by credit and debit cards, the use of facilities provided by the post office, the use of shops as Bank agents (in-shop branches) and finally the use of computers (initially only in USA).

The characteristic of inseparability of Banking services is an argument for the priority of Bank branches as distribution channels (customers cannot get a housing loan without a direct face to face contact with a Bank employee).

The heterogeneity of most of the Banking Services, including the ambience of the branch, the personality of the bank employees etc, are in favor of the branch. Similarly, the intangibility of the Banking Services leads to the choice of branches.

The need for a client relationship, instead of a customer relationship, leads again to the choice of branches.

However, the management of the Banks, trying to reduce the costs and with the increasing development of technology, they prefer to follow the digitalization process in their relations with the customers. Once competitors follow these practices, the other Banks, do the same. But in the case of the Greek Banking System, the number of branches has been reduced by 61 % in the period 2010-2021, whereas the reduction in the Eurozone was 37 %. The number of employees was reduced by 51%, whereas in the Eurozone the respective reduction was only 18,1 % (Poupkos, 2023).

As the management of the commercial Banks insisted in reducing the number of branches, we observe a simultaneous excessive reduction in the number of employees. The reduction in employees, as it is recorded in the following Table 2, concerns mainly people employed in the branches.

Table 2. Number of personnel of the Greek commercial Banks

YEAR	NUMBER OF PERSONNEL
2002	59 772
2005	59 215
2009	63 342
2012	54 516
2015	44 273
2018	38 473
2020	32 542
2022	28 638
2023	27 809

Source: HBA-Greek Banking Systems Data (2024).

2. Methodology and results

In order to reach some conclusions, regarding the impact of the underestimated role of branches on the effectiveness of the Greek Banks, we tried to approach and interview twenty active and twenty retired Bank employees. In this sample, the four systemic banks of the country are equally represented. 19 active bank employees responded positively, whereas the response of the retired employees was 100 %.

All the participants were university graduates. Thirty-one of them were males and eight of them were females.

All of them admit that the modern role of branches is underestimated by the management of the Banks.

90 % of the retired employees believe that the choice of the management is wrong, as they are convinced that the branch is the best channel of communication of the Bank with its customers. They strongly believe that the extra cost for the full operation of the branch, will be covered by extra revenues, as the switch of customers to other banks will be minimized. Besides, there will be a high potential to attract new customers, as the latest feel the Bank closer to their needs. They believe that even if the

transition to digitalization is necessary, it should be considerably slower as a high percentage of the customers are not able to follow the extremely rapid developments.

63 % (12 out of the 19) of the active employees, believe that the choice of the management is connected with financial motives and therefore the priority of digitalization seems inevitable.

The rest 37 % (7 out of the 19) agree with the views expressed by the retired employees.

However, in total 74 % (14 out of 19) of the active employees reject the Management's choice tending to adopt the absolute digitalization, because they feel the risk of losing their jobs.

It is important to have in our mind that most of the active employees (84%, namely 16 out of 19), did not experience the old structure of the branches and therefore they are not able to appreciate the pros of the old branches.

90 % of the responding active employees (17 out of 19) expressed the view that the underestimated branches have reduced the cross-selling potential. Such a development leads to an unavoidable loss of revenues, due to the reduction of sales, connected with the less customers visiting the branch and the respective less contacts between bank employees and customers.

3. Discussion

The haste towards digitalization has led to some temporariness in the function of the branches, which is equivalent to their malfunction. Many bank employees (aged 45-55) are encouraged by the Banks to retire earlier and therefore they are preparing for early retirement, depriving the banks of their qualifications.

The current picture of branches does not show their real potential given that they are understaffed and without substantial responsibilities.

In the past, branches were miniatures of the entire bank, with officers being decision-makers, of course within the guidelines of the Management. So, branches were the fields where the Bank officers were preparing to become the top managers of the future.

However, despite the above-mentioned difficulties, the banks have recorded a spectacular profitability in the last few years. But if we consider the whole situation more carefully, we will realize that the high profitability of the last few years is due to the spectacular decrease of the non-performing loans (transferring the problem to the government) and the excessive commissions charged (in many cases absolutely unfair and unjustified).Of course the oligopoly structure of the banking system, safeguards the interests of the Banks.

It is very important to focus on the views expressed by the interviewed banking officers, regarding the undermining of the cross-selling potential connected with the changes in the structure of branches. There is strong evidence that the modern bank branches do not fulfill the functions of the older branches. These developments make the communication with the customers more difficult. Communication through e-mails or other electronic forms, in most of the cases is not faster. On the contrary, it creates barriers between the bank and the customer. Live communication, either by the physical presence of the customers or by telephone, is much more effective.

Besides, the modern Bank Officers of the branches do not have sufficient knowledge of the services they sell, and they depend on the instructions coming from the central services located in Athens. This situation causes delays and of course disappointment of the customers which undermines their loyalty for the Bank.

According to Linda Richardson, "Cross-selling solidifies long-term relationships" (Richardson, 1992). Therefore, we understand the importance of the views of the Bank employees about the impact of the change of the role of branches on the effectiveness of the Banks.

Conclusion

Based on the views expressed by the interviewed bank officers, several important conclusions can be drawn. All respondents agreed that the present role of branches is clearly underestimated by bank management. Those who have worked under both the traditional and the modern structure of branches believe that the decision for such a rapid digitalization was mistaken and should have been implemented in a slower and more balanced way. A large number of participants expressed strong reservations about the current pace of technological transition, emphasizing that the human factor is being neglected.

Many active employees also admitted that they fear losing their jobs as digitalization advances, while at the same time they recognize a noticeable reduction in the cross-selling potential of the banks. The

weakening of personal contact with clients has limited sales opportunities and, as a result, has affected the overall effectiveness of the banking system.

It is widely accepted among the respondents that the oligopolistic structure of the Greek banking market protects the interests of the banks, since customers have very few alternatives. Furthermore, the drastic effort of Greek banks to reduce non-performing loans—from 40% in 2019 to 7.5% in 2024—accelerated the digitalization process, mainly as a way to reduce operational costs.

Today, we clearly witness a shift from marketing-oriented to technology-oriented banking, where cost minimization has become the dominant goal. Although technological development is not incompatible with marketing principles, in recent years Greek banks have relied excessively on commissions, often unjustified, leading even to government intervention to protect customers. These developments prove that digitalization alone does not necessarily improve customer satisfaction. The reversal of the current trend seems unlikely; however, the remaining branches must preserve the strengths of the traditional model in order to maintain a close and trust-based relationship with their clients.

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Fundamental Analysis and Optimal Portfolio of Companies Operating in the Semiconductor Sector

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Abstract

Research background: Fundamental analysis provided a detailed view of the financial stability and growth potential of individual companies, identifying undervalued and promising titles based on financial indicators. In contrast, Markowitz's optimization focused on the statistical relationships between stocks, looking for portfolios with the best risk-return ratios, regardless of the individual fundamentals of companies. A comparison of the two approaches showed that while fundamental analysis recommended companies with attractive valuations and long-term growth factors, portfolio optimization based on Markowitz's theory preferred assets with low correlation and high Sharpe's ratios.
Purpose of the article: The objective of this paper was to analyse the possibilities of investment portfolio optimization in the semiconductor sector using fundamental analysis and Markowitz's portfolio theory.
Methods: The paper focused on identifying companies with high growth potential based on fundamental indicators and optimizing the portfoloio using a quantitative approach that allows to minimize risk while maximizing the expected return.
Findings & Value added: The key finding was that the right combination of both approaches allows for more efficient decision-making in investment. While fundamental analysis provides a qualitative filter for selecting companies with growth potential, Markowitz's theory allows for their optimal allocation with regard to risk and diversification.

Keywords: Fundamental analysis, Markowitz's optimization, Optimal allocation, Risk and diversification

JEL classification: G11, G14, G23

1. Introduction

Investing in the stock markets represents not only an opportunity to achieve capital appreciation, but also a complex decision-making process in which the right choice of strategies and analytical methods plays a crucial role. Fundamental analysis (De Luca, 2018) is one of the key tools for evaluating investment opportunities, as it allows us to assess the fair values of shares based on economic factors, industry specifics and the financial stability of companies.

The semiconductor industry (Burm, 2024) is characterized by high dynamics, technological innovations and cyclical fluctuations, which makes it an attractive but also risky segment for investors. Proper analysis of companies in this sector can help identify undervalued stocks and optimize the composition of the portfolio (Dempsey, 2020) with regard to the expected return and level of risk.

The paper will analyze the effectiveness of fundamental analysis in stock selection in the semiconductor sector, paying attention to the assessment of the industry specifics and financial indicators (Brigham et al., 2023) of selected companies. Based on the obtained data, an optimal stock portfolio will be compiled, which will then be compared with the portfolio designed according to Markowitz's portfolio theory.

The output of this analysis will be investment recommendation for individual investors considering allocating capital to the semiconductor industry. Attention will also be paid to the possible risks (Banerjee et al., 2025) associated with investments in this sector, including market volatility (Goldstein et al., 2025),

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technological developments and macroeconomic factors that can affect the value of individual stocks. Based on the knowledge gained, practical recomendations will be formulated that can serve as a basis for effective investment decisions.

1.1 Fundamental analysis of components

Fundamental analysis is an analytical tool aimed at determining the intrinsic value of a stock (Jaganathan, 2019), which reflects the true financial health and potential of a company. This value often differs from the current market price of the stock, which is influenced by demand, supply and market emotions. The main goal of fundamental analysis is to identify these differences, which allows investors to recognize undervalued or overvalued stocks. This approach examines in detail the economic, political, social, geographical, demographic and other factors that can affect the development of stock prices.

To perform quality fundamental analysis, it is essential to rely on a reliable and extensive data base. This includes historical and current facts, accounting and statistical data, as well as forecasts related to a specific company, industry or the entire economy. The quality and credibility of the information sources used are of fundamental importance. Incomplete or distorted information can lead to erroneous conclusions and recommendations, which can have a major impact on investment decisions. Therefore, when working with data, it is important to use verified sources that provide objective and consistent information.

Fundamental analysis involves a comprehensive analysis, which does not focus only on the internal environment of the company, but also includes a significant part of the analysis of macroeconomic data and the specific industry in which the company operates. The scope of activities associated with this approach is very wide and includes not only the evaluation of corporate indicators, such as dividends, liquidity or profitablity, but also the examination of global and industry factors. In other words, every company is inextricably linked to the broader economic environment and a specific sector, the development of which affects its performance.

Global analysis monitors the development of the entire economy and examines its impact on stock markets. Sectoral analysis deals with the characteristics of specific sectors and their influence on stock prices. Corporate analysis then focuses on evaluating the internal parameters of companies, especially their financial stability and performance.

1.2 Markowitz's portfolio theory

Portfolio theory, formulated in 1952 by Harry Markowitz in his article „Portfolio Selection" (Markowitz, 1952), revolutionized investment decision-making. Its goal is to find the optimal balance between return and risk in asset allocation. Markowitz assumed that an investor has limited financial resources and seeks to maximize return while minimizing risk over a certain period of time, known as the portfolio holding period.

The key contribution of the theory was the mathematical investigation of the relationship between the risk and return (Bao et al., 2023) of individual assets and their influence on the overall risk of the portfolio. Markowitz proved that the overall risk of a portfolio depends not only on the risk of individual assets, but also on the correlation of their returns. Portfolio diversification, i.e. investing in multiple assets, allows for a reduction in overall risk due to low or negative correlation. The basis of his model is the efficient set of portfolios, which represents the combination of assets with the highest return at a given level of risk (Manresa et al., 2023). This theory is now a pillar of modern portfolio management and is used across investment institutions and individuals.

2. Methods

After laying the theoretical foundations neccessary for this paper, a sectoral analysis of the semiconductor industry was conducted, confirming its strong interdependence with macroeconomic factors, technological trends, and the geopolitical environment (Bish et al., 2025). The development of the sector is closely related to the economic stability of the USA, where GDP growth, inflation, and interest rates influence investment decisions (Hartley et al., 2024, Hillenbrand, 2025).

The semiconductor industry is in an expansion phase (Wigan, 2023) and is expected to grow to USD 1 billion by 2030. Key drivers of this expansion include artificial intelligence, 5G, cloud computing and electrification of transportation. However, the sector remains cyclical, as demonstrated by past economic

crises, when falling demand led to reduced investment and excess inventory. Sales decreased by 2023, but the turnaround in 2024 suggests that investment in AI and data centers will continue to drive growth.

The fundamental analysis focused on 13 stocks from the S&P 500 index, examining in detail the indicators of profitability, liquidity, debt and market valuation. A key element of the analysis was the comparison of the financial stability and performance of the companies in order to identify stable and growth investment opportunities. The final part of the analysis was the use of discounted cashflow models to estimate the fair value of individual stocks and compare them with the current market valuation.

Table 1. Analyzed companies

Company	Stock symbol	Number of shares issued (in millions)	Share price (30.12.2024)	Dividends paid (2024)	Market capitalization (in millions USD)
AMD	AMD	1,620	122.44	0.00	198,411
Analog Devices	ADI	496	212.56	3.68	105,493
Broadcom	AVGO	4,687	235.58	2.17	1,104,247
Intel	INTC	4,292	19.82	0.38	85,067
Microchip Technology	MCHP	536	57.12	1.81	30,656
Micron Technology	MU	1,108	85.31	0.46	94,587
Monolithic Power Systems	MPWR	48	603.65	5.00	29,432
NVIDIA	NVDA	24,533	137.49	0.03	3,373,042
NXP Semiconductors	NXPI	254	207.47	3.04	52,792
ON Semiconductor	ON	427	63.46	0.00	27,097
Qualcomm	QCOM	1,115	154.58	3.35	172,357
Skyworks Solutions	SWKS	160	88.42	2.76	14,183
Texas Instruments	TXN	913	187.96	5.02	171,607

Source: author's own calculations (2025)

3. Results

3.1 Rentability

The rentability showed significant differences between the companies analyzed. NVIDIA achieved the highest return on assets at 45.28 %, return on equity at 69.24 %, and return on invested capital at 64.10 %, confirming its strong market position. Texas Instruments, Qualcomm and ON Semiconductor are showing solid performance, while Intel is the only company to report a loss. Its competitiveness and restructuring issues point to significant challenges in innovation and efficiency.

Table 2. Rentability indicators

Indicator	Best companies
ROA	NVDA (45,28 %), MPWR (17,56 %), TXN (20,12 %), ON (16,54 %)
ROE	NVDA (69,24 %), MPWR (20,85 %), QCOM (38,60 %), TXN (38,53 %)
ROS	NVDA (48,85 %), TXN (37,16 %), MCHP (24,98 %), QCOM (26,03 %)
ROI	MPWR (71,90 %), NVDA (40,17 %), QCOM (33,94 %), ON (31,27 %)
ROCE	NVDA (64,10 %), TXN (26,64 %), MPWR (22,53 %), ON (24,54 %)

Source: author's own calculations based on financial data of companies (2025)

3.2 Liquidity

In terms of quick ratio, NVIDIA, Texas Instruments and Skyworks Solutions are the strongest, while Qualcomm and Broadcom have a lower ability to cover short-term obligations.

Table 3. Liquidity indicators

Indicator	Best companies
Quick ratio	NVDA (4,17), TXN (4,55), SWKS (5,54)
Current ratio	MU (14,55), NXPI (14,01), ON (13,44)
Cash ratio	MPWR (4,72), SWKS (2,59), TXN (1,69)

Source: author's own calculations based on financial data of companies (2025)

3.3 Debt ratios

In terms of debt, AMD, Monolithic Power Systems and NVIDIA appear to be the most stable, while NXP Semiconductors and Broadcom have higher levels of debt.

Table 4. Debt ratios

Indicator	Best companies
Debt to equity ratio	AMD (0.03), MPWR (0.04), NVDA (0.20)
Interest coverage	NVDA (128.3), ON (33.94), TXN (20.77)
Debt ratio	AMD (0.02), MPWR (0.04), SWKS (0.12)

Source: author's own calculations based on financial data of companies (2025)

3.4 Market value analysis

Market value ratings indicate whether a company's stock is overvalued or undervalued relative to its sector. ON Semiconductor (12.4) and NXP Semiconductors (18.87) have the lowest P/E (price-to-earnings ratio), suggesting attractive valuations compared to the sector average of 24.48. In contrast, Broadcom (AVGO), NVIDIA (NVDA) and AMD have values well above this average, indicating their premium valuations.

Table 5. Market value ratios

Indicator	Best companies
P/E	ON (12,4), NXPI (18,87), TXN (26,36), QCOM (16,99)
P/B	MU (2,1), SWKS (2,24), ADI (3,0), ON (3,47)
P/S	ON (3,28), NXPI (3,98), MU (3,77), SWKS (3,39)
EV/EBITDA	ON (9,32), MCHP (10,33), NXPI (11,71), TXN (21,08)

Source: author's own calculations based on financial data of companies (2025)

A similar situation applies to EV/EBITDA (earnings before interest, taxes, depreciation and amortization), where ON (9.32), MCHP (10.33) and NXPI (11.71) are below the sector average (20.16), indicating favorable valuations. Conversely, NVIDIA (99.63) and Monolithic Power Systems (MPWR) show extremely high values, indicating overvaluation.

A fair price vs. current market value analysis shows that Intel (INTC), NXP Semiconductors (NXPI), and ON Semiconductor (ON) are adequately valued, as their market price is very close to fair value. Qualcomm (QCOM) and Skyworks Solutions (SWKS) are undervalued, meaning their shares are trading below fair value, which may signal an investment opportunity.

Conversely, Monolithic Power Systems (MPWR), Advanced Micro Devices (AMD), Broadcom (AVGO), Texas Instruments (TXN), Analog Devices (ADI), and Micron Technology (MU) are overvalued, as their current price is significantly above fair value. This suggest that the market is pricing these stocks higher, likely due to growth expectations or high investor demand. Whether these companies are suitable for investment, however, will depend on other parts of fundamental analysis, such as profitability, liquidity, debt, and market valuation, and their interpretation in the context of the overall market.

Table 6. Valuation of companies

Valuation	Companies
Adequately valued	INTC, NXPI, ON, QCOM
Undervalued	QCOM, SWKS
Overvalued	MPWR, AMD, AVGO, TXN, ADI, MU

Source: author's own calculations based on financial data of companies (2025)

3.5 Portfolio composition based on fundamental analysis

Based on these results, investment recommendations were formulated and portfolios with varying degrees of risk and growth potential were created – from a conservative portfolio focused on stable companies with lower volatility to an aggressive growth portfolio that focuses on technology leaders with high dynamics. Fundamental analysis has shown that an appropriate combination of profitability, liquidity, debt and market valuation indicators enables effective selection of investment opportunities in the dynamic environment of the semiconductor sector.

Table 7. Types and composition of portfolios

#	Portfolio type	Portfolio composition
1	Conservative	TXN (40 %), ON (30 %), QCOM (30 %)
2	Balanced	NVDA (40 %), TXN (30 %), ON (20 %), QCOM (10 %)
3	Growth	NVDA (50 %), MPWR (30 %), AMD (20 %)
4	Agressive growth	NVDA (40 %), MPWR (30 %), AMD (20 %), AVGO (10 %)
5	Diversified	TXN (20 %), QCOM (20 %), NXPI (20 %), ON (20 %), NVDA (20 %)

Source: own calculations (2025)

Choosing the right portfolio should be based on individual investment strategy, time horizon, and risk tolerance. The semiconductor industry is highly dynamic and subject to rapid technological change, macroeconomic influences, and geopolitical factors, so it is crucial to regularly monitor current information, trends, and company results. The longterm success of an investment depends on the ability to flexibly respond to changes in the sector and regularly adjust investment strategy based on new data and market conditions.

3.6 Portfolio optimization using Markowitz's theory

Fundamental analysis can result in investment opportunities, which may not take into account the mutual relationships between individual assets in the portfolio. Markowitz's portfolio theory allows for the optimization of portfolio composition with regard to diversification and risk minimization by

analysing the correlation and covariance of assets. The goal of this optimization is to achieve the highest possible expected return at an acceptable level of risk and to effectively distribute investments among individual assets in such a way as to maximize the return-to-risk ratio.

The risk of individual stocks will be measured using the standard deviation of their historical returns, which can be calculated using the STDEV.P() function. It expresses the degree of volatility of the returns of a given stock and thus represents a basic measure of risk.

Table 8. Risk and return profiles

Company		Expected return (monthly)	Expected return (yearly)	Standard deviation
AMD	AMD	2,50 %	34,44 %	0,1514
Analog Devices	ADI	1,61 %	21,12 %	0,0806
Broadcom	AVGO	3,68 %	54,37 %	0,1004
Intel	INTC	-0,86 %	-9,83 %	0,1146
Microchip Technology	MCHP	0,97 %	12,27 %	0,1109
Micron Technology	MU	1,64 %	21,57 %	0,1117
Monolithic Power Systems	MPWR	2,88 %	40,65 %	0,1128
NVIDIA	NVDA	2,88 %	40,65 %	0,1128
NXP Semiconductors	NXPI	1,60 %	21,03 %	0,1075
ON Semiconductor	ON	2,37 %	32,50 %	0,1377
Qualcomm	QCOM	1,60 %	20,92 %	0,1032
Skyworks Solutions	SWKS	-0,40 %	-4,70 %	0,0946
Texas Instruments	TXN	1,08 %	13,77 %	0,0685

Source: own calculations based on historical financial data of analyzed companies (2025)

The table 8 shows that companies with higher expected returns, such as AVGO with an expected annual return of 54.37 %, also have a higher risk level expressed as a standard deviation (0.1004). On the other hand, companies like TXN, which has a lower expected annual return (13.77 %), also have a lower risk (0.0685). This is consistent with the basic principles of portfolio theory, which states that higher returns are associated with higher risk.

Table 9. Correlation matrix

	AMD	ADI	AVGO	INTC	MCHP	MU	MPWR	NVDA	NXPI	ON	QCOM	SWKS	TXN
AMD	1,000	-0,179	0,107	0,015	-0,027	-0,144	0,620	-0,073	-0,140	-0,060	0,657	-0,026	-0,128
ADI	-0,179	1,000	0,434	0,460	0,875	0,577	-0,016	0,540	0,820	0,726	-0,069	0,449	0,859
AVGO	0,107	0,434	1,000	0,248	0,406	0,350	-0,100	0,430	0,450	0,421	0,219	0,490	0,423
INTC	0,015	0,460	0,248	1,000	0,485	0,488	0,045	0,171	0,428	0,343	-0,004	0,235	0,486
MCHP	-0,027	0,875	0,406	0,485	1,000	0,620	0,137	0,488	0,863	0,796	0,039	0,468	0,828
MU	-0,144	0,577	0,350	0,488	0,620	1,000	-0,017	0,357	0,620	0,542	0,105	0,363	0,503
MPWR	0,620	-0,016	-0,100	0,045	0,137	-0,017	1,000	0,011	-0,029	0,060	0,508	0,046	0,077
NVDA	-0,073	0,540	0,430	0,171	0,488	0,357	0,011	1,000	0,562	0,568	0,027	0,550	0,506
NXPI	-0,140	0,820	0,450	0,428	0,863	0,620	-0,029	0,562	1,000	0,844	-0,047	0,520	0,857
ON	-0,060	0,726	0,421	0,343	0,796	0,542	0,060	0,568	0,844	1,000	0,024	0,531	0,754
QCOM	0,657	-0,069	0,219	-0,004	0,039	0,105	0,508	0,027	-0,047	0,024	1,000	0,102	-0,076
SWKS	-0,026	0,449	0,490	0,235	0,468	0,363	0,046	0,550	0,520	0,531	0,102	1,000	0,517
TXN	-0,128	0,859	0,423	0,486	0,828	0,503	0,077	0,506	0,857	0,754	-0,076	0,517	1,000

Source: own calculations based on historical financial data of analyzed companies (2025)

Interestingly, there (Table 9) is a strong negative correlation between MPWR and AVGO (-0.100), which may indicate that these companies react differently to market conditions. If an investor were looking for diversification opportunities, (s)he could, for example, use a combination of stocks with low correlation, such as AMD and TXN (-0.128) or QCOM and TXN (-0.076). Conversely, companies such as NVDA and NXPI (0.562) or ADI and NVDA (0.540) show a higher positive correlation, which may indicate that investments in these stocks deliver similar return characteristics and contribute less to diversification. This approach is essential for effective portfolio construction and risk minimization according to Markowitz's theory.

3.7 Calculation of optimal portfolio using Solver in Excel

Several methods (Solver, Matlab, Python, Monte Carlo Simulation, Efficient Frontier) can be used to find the optimal portfolio, which differ in their complexity and approach to risk and return analysis. In portfolio optimization, Solver in Excel will look for the optimal weights of individual companies in the portfolio to maximize the Sharpe's ratio (Kan et al., 2024) or minimize risk for a given expected return. The variables in this model are the weights of individual assets in the portfolio.

The calculation of optimal portfolio itself will be based using the Table 10, where we primarily look for the best combination of companies with the aim of maximizing the return. The limiting conditions in the model are the maximum allowed risk and the limit on the total weight of one company in the portfolio. This approach will allow us to identify the optimal capital allocation that brings the highest possible return while maintaining the risk limit. The disadvantage of the Solver is its dependence on initial values and iterative approach. The result may vary depending on the starting point and accuracy settings, which may lead to finding a local instead of a global optimum. For a more reliable output, it is advisable to verify the solution by running it repeatedly.

Table 10. Optimal portfolio calculation based on Solver

Company	Expected return (yearly)	Standard deviation	Weight
AMD	0,344435975	0,151374	0
ADI	0,21118434	0,080626	0
AVGO	0,543655836	0,100449	0,2
INTC	-0,098301765	0,114593	0
MCHP	0,122691404	0,110875	0
MU	0,215663754	0,111742	0
MPWR	0,406501927	0,112754	0,2
NVDA	0,406501927	0,112754	0,2
NXPI	0,210285483	0,107472	0,2
ON	0,324979764	0,137699	0
QCOM	0,209232193	0,103163	0,2
SWKS	-0,047009683	0,094637	0
TXN	0,137685625	0,068540	0
		Sum of weights	1
		Return of portfolio	27,13 %
		Variance of portfolio	0,001730112
		Standard deviation (%) of portfolio	4,16 %

Source: own calculations based on historical financial data of analyzed companies (2025)

To find the optimal portfolio, one can choose a maximum risk and a maximum weight per company, for example, 6 % risk with a maximum weight of 0.2. Then, we will gradually increase the maximum weight until there is a point where the return stops increasing and the portfolio composition remains unchanged, although it could be adjusted depending on the conditions. Such results can be observed in the

Table 11 for risk levels of 6 %, 7 % and 8 %, where the effect of individual restrictions on the portfolio composition and its profitability is evident.

Table 11. Portfolio compositions

risk [%]	**max. weight**	AMD	ADI	AVGO	INTC	MCHP	MU	MPWR	NVDA	NXPI	ON	QCOM	SWKS	TXN	**return [%]**
6,00	0,2	0,15	0,00	0,20	0,00	0,00	0,16	0,20	0,20	0,00	0,10	0,00	0,00	0,00	35,58
6,00	0,25	0,08	0,00	0,25	0,00	0,00	0,07	0,25	0,25	0,00	0,10	0,00	0,00	0,00	38,11
6,00	0,33	0,00	0,00	0,33	0,00	0,00	0,01	0,33	0,22	0,00	0,11	0,00	0,00	0,00	40,40
6,00	0,4	0,00	0,00	0,40	0,00	0,00	0,00	0,33	0,15	0,00	0,12	0,00	0,00	0,00	41,39
6,00	0,5	0,00	0,00	0,46	0,00	0,00	0,00	0,31	0,10	0,00	0,13	0,00	0,00	0,00	41,69
6,00	0,6	0,00	0,00	0,46	0,00	0,00	0,13	0,31	0,10	0,00	0,00	0,00	0,00	0,00	41,69
7,00	0,2	0,20	0,20	0,20	0,00	0,00	0,00	0,20	0,20	0,00	0,00	0,00	0,00	0,00	36,78
7,00	0,25	0,20	0,05	0,25	0,00	0,00	0,00	0,25	0,25	0,00	0,00	0,00	0,00	0,00	37,36
7,00	0,33	0,00	0,00	0,33	0,00	0,00	0,00	0,33	0,33	0,00	0,00	0,00	0,00	0,00	44,91
7,00	0,4	0,00	0,00	0,40	0,00	0,00	0,00	0,30	0,30	0,00	0,00	0,00	0,00	0,00	46,14
7,00	0,5	0,00	0,00	0,50	0,00	0,00	0,00	0,34	0,16	0,00	0,00	0,00	0,00	0,00	47,51
7,00	0,6	0,00	0,00	0,58	0,00	0,00	0,00	0,35	0,08	0,00	0,00	0,00	0,00	0,00	48,54
7,00	0,7	0,00	0,00	0,58	0,00	0,00	0,00	0,35	0,08	0,00	0,00	0,00	0,00	0,00	48,54
8,00	0,2	0,20	0,20	0,20	0,00	0,00	0,00	0,20	0,20	0,00	0,00	0,00	0,00	0,00	38,25
8,00	0,25	0,25	0,00	0,25	0,00	0,00	0,00	0,25	0,25	0,00	0,00	0,00	0,00	0,00	42,53
8,00	0,33	0,01	0,00	0,33	0,00	0,00	0,00	0,33	0,33	0,00	0,00	0,00	0,00	0,00	45,11
8,00	0,4	0,00	0,00	0,40	0,00	0,00	0,00	0,30	0,30	0,00	0,00	0,00	0,00	0,00	46,14
8,00	0,5	0,00	0,00	0,50	0,00	0,00	0,00	0,25	0,25	0,00	0,00	0,00	0,00	0,00	47,51
8,00	0,6	0,00	0,00	0,60	0,00	0,00	0,00	0,33	0,07	0,00	0,00	0,00	0,00	0,00	48,88
8,00	0,7	0,00	0,00	0,70	0,00	0,00	0,00	0,28	0,02	0,00	0,00	0,00	0,00	0,00	50,25
8,00	0,8	0,00	0,00	0,79	0,00	0,00	0,00	0,21	0,00	0,00	0,00	0,00	0,00	0,00	51,51
8,00	0,9	0,00	0,00	0,79	0,00	0,00	0,00	0,21	0,00	0,00	0,00	0,00	0,00	0,00	51,51

Source: own calculations based on historical financial data of analyzed companies (2025)

This data shows how the portfolio composition and the achieved return change depending on the set risk and the maximum weight of a single company. Increasing the risk from 6 % to 8 % leads to higher returns, confirming that greater tolerance for risk allows for a higher allocation to higher-yielding assets. AVGO emerges as the dominant component of the portfolio, expecially at higher maximum weight limits, indicating its strong return potential. The return increases as the maximum weight restriction is relaxed, but only up to a certain level – for example, at 8 % risk and a maximum weight above 0.7, the portfolio composition hardly changes. At 7 % and 8 % risk, returns stabilize around 48-51 %, indicating that the efficient portfolio frontier has been reached. This analysis shows that the maximum weight of individual companies plays a key role in portfolio optimization and that at higher risk limits, higher-yielding assets come to the fore at the expense of a broader investment distribution.

4. Discussion

Fundamental analysis and Markowitz‘s portfolio theory represent two different approaches to optimizing a stock portfolio. While fundamental analysis focuses on the intrinsic value of individual stocks based on financial indicators and macroeconomic factors, Markowitz‘s portfolio theory works with a quantitative approach focused on diversification, risk minimization, and return optimization.

Based on fundamental analysis, portfolios with different compositions were created, which differ in their focus and expected performance. The results show that all portfolios have a risk below 8 %, indicating that the increase in expected return is not associated with a dramatic increase in volatility. The conservative portfolio achieves the lowest return (21.53 %), while the aggressive growth portfolio shows the highest return (40.78 %). This confirms that proper diversification allows investors to achieve higher returns without significantly increasing risk.

Portfolio optimization analysis using Excel and Solver provided a broader range of possible solutions, with a recurring pattern in company selection. Broadcom (AVGO) and NVIDIA (NVDA) were

consistently found in optimal portfolios, along with companies such as Analog Devices (ADI), Monolithic Power Systems (MPWR), and AMD. This selection confirms that at different levels of maximum risk, there is a consistent selection of assets with similar statistical properties.

Next, a comparison of fundamental analysis and Markowitz‘s portfolio theory was performed, which showed the differencies and complementarities of both approaches. Fundamental analysis provided a detailed view of the financial stability and growth potential of individual companies, identifying unvervalued and promising stocks based on financial indicators. In contrast, Markowitz‘s optimization focused on statistical relationships between stocks and searched for portfolios with the best risk-return ratio regardless of individual company fundamentals.

A comparison of the two approaches showed that while fundamental analysis recommended companies with attractive valuations and long-term growth factors, portfolio optimization based on Markowitz‘s theory preferred assets with low correlation and high Sharpe‘s ratios. The resulting optimal portfolios included similar companies, but with different weights and compositions. For example, NVIDIA and Broadcom were identified as key investment stocks by both methods, while some stable companies recommended by fundamental analysis were not included in the optimized portfolios due to higher correlation or lower efficiency in relation to risk.

The key finding was that the right combination of both approaches enables more effective decision-making. While fundamental analysis provides a qualitative filter for selecting companies with growth potential, Markowitz‘s theory allows for their optimal allocation with respect to risk and diversification. The results suggest that investors should not rely solely on one of these approaches, but rather combine them to achieve a better risk-return ratio.

Compared to the results of fundamental analysis, which recommended a specific portfolio composition based on financial indicators, this optimal portfolio showed a different selection of companies. This difference shows a fundamental limitation of Markowitz‘s theory, which focuses exclusively on mathematical optimization and does not take into account factors such as valuation, profitability, stability, or sector dynamics. The selection of companies in the optimized portfolio was primarily influenced by their statistical properties (low correlation with other assets and attractive risk-return ratio), not by their fundamental valuation or long-term growth potential.

These results confirm that the combination of fundamental analysis and portfolio theory can lead to more effective investment decisions. Markowitz‘s optimization provides tools for effective diversification and risk management, while fundamental analysis ensures that selected stocks have real growth potential and are not overvalued. Overall, an approach that uses a combination of both methods can be recommended to achieve a balanced portfolio with long-term performance.

Conclusion

While this paper has provided a comprehensive view of portfolio optimization, there are other aspects that could be the subject of future research. One possibility is to include technology giants such as Apple and Samsung, which develop their own chips and influence the market from a different perspective. Another area of research could be to include the wider supply chain, including companies such as TSMC and ASML, which are not direct chip manufacturers but play a key role in the production ecosystem. An interesting extension could also be to test the proposed portfolio in different economic scenarios, for example using Monte Carlo simulations or stress tests, which would allow a better assessment of its resilience to market fluctuations. Last but not least, it would be beneficial to investigate the impact of ESG factors on the profitability and stability of investments in the technology sector.

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Financial-Economic Analysis in Smart Economy

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Abstract

Research background: Contemporary business performance evaluation increasingly transcends traditional financial metrics, integrating broader frameworks that account for sustainability, technological innovation, and resource efficiency. The SMART economy concept reflects these developments, offering a strategic perspective on how businesses can enhance their competitiveness and resilience in a rapidly evolving economic environment.
Purpose of the article: This article aims to examine the theoretical foundations of financial and economic analysis and to apply these to a case study of a retail cooperative enterprise. The primary objective is to assess the applicability and value of combining conventional analytical methods with the principles of the SMART economy in order to identify opportunities for improving financial performance.
Methods: The methodological approach includes horizontal and vertical analysis, ratio analysis, pyramid decomposition, and selected creditworthiness models. These were applied to the enterprise's financial statements across multiple reporting periods. The analysis is further contextualised through the integration of SMART economy principles to interpret the results in light of current economic and technological trends.
Findings & Value added: The findings demonstrate that the integration of traditional financial analysis with the SMART economy framework provides a more comprehensive view of business performance. The results highlight key areas for improvement and offer recommendations aimed at enhancing financial efficiency, strategic alignment, and long-term sustainability. The article contributes to the academic discourse by evidencing the practical relevance of SMART-oriented analysis in corporate financial evaluation and strategic management.

Keywords: Financial-economic analysis, SMART economics, Ratio indicators, Pyramid decomposition

JEL classification: M21, G30

1. Introduction

In an era marked by rapid technological progress and increasing global uncertainty, businesses face the challenge of maintaining competitiveness while adapting to ever-evolving market conditions. The dynamics of the global economy, combined with accelerating digitalisation and growing environmental concerns, have led to the emergence of new paradigms in business strategy and performance evaluation. One such paradigm is the SMART economy, a concept that integrates sustainability, technological innovation, digital transformation, and resource efficiency as key pillars of modern economic development (Morelli et al., 2022; OECD, 2021).

The traditional approach to financial and economic analysis, based primarily on historical accounting data and conventional performance indicators, remains a fundamental tool for evaluating the financial health of businesses. However, in the context of the SMART economy, there is a growing demand to enhance such analysis with modern methods that reflect broader socio-economic and environmental dimensions (Zhong et al., 2021). Integrating these perspectives can provide deeper insights into how organisations operate and adapt in the face of digital disruption, sustainability imperatives, and shifting consumer expectations.

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Financial and economic analysis serves as a critical instrument for assessing a company's financial position, management effectiveness, and strategic readiness. Techniques such as horizontal and vertical analysis, ratio analysis, and creditworthiness models have long been used to support corporate decision-making (Sharma, 2023). In recent years, however, researchers and practitioners alike have highlighted the value of complementing these traditional methods with advanced analytical tools, such as pyramid decomposition and predictive models, which can more accurately capture the complexity of modern business operations (Horak et al., 2020).

Within this framework, the SMART economy offers a forward-looking lens through which financial analysis can be reinterpreted. Emphasis is placed not only on profitability and operational efficiency, but also on a company's ability to innovate, minimise waste, leverage digital technologies, and align with sustainable development goals (UNCTAD, 2023). As a result, businesses that embed SMART economy principles into their strategic and financial planning are better positioned to enhance long-term resilience and stakeholder value (Otokiti et al., 2022).

The aim of this article is to explore how the integration of SMART economy principles can enrich traditional financial and economic analysis in a corporate context. The article examines both the theoretical foundations and practical applications of analytical tools used to evaluate business performance. A case study of a retail cooperative enterprise is presented to demonstrate the application of conventional and modern analytical approaches, highlighting the benefits of incorporating sustainability and innovation-related perspectives. The remainder of this article is structured as follows: Section 2 provides a review of relevant literature on financial analysis methods and the SMART economy concept. Section 3 outlines the methodology used in the case study, including the analytical tools applied. Section 4 presents the results of the analysis and interprets them in light of SMART economy principles. Finally, Section 5 discusses the key findings, offers practical recommendations, and reflects on the implications for future research and business practice.

2. Literature review

Financial and economic analysis is widely recognised as a critical managerial tool for assessing the financial health of enterprises, supporting decision-making processes, and planning strategic development. In today's increasingly complex and dynamic economic environment, this type of analysis provides not only a retrospective view of a company's performance but also serves as a predictive and strategic instrument. According to Robert et al. (2023), financial and economic analysis enables a comprehensive understanding of a company's historical performance, current financial standing, and potential future trajectories. It is particularly valuable in identifying inefficiencies, latent risks, and structural weaknesses that may threaten business continuity or long-term profitability. Moreover, it assists in uncovering competitive advantages and internal strengths that can be leveraged to enhance efficiency, optimise resource allocation, and support innovation-driven growth.

Similarly, Thomas (2024) underscores the necessity of a well-rounded financial diagnosis in detecting hidden risks and spotting emerging opportunities that might otherwise remain unrecognised by static accounting methods. These insights are indispensable for refining corporate strategy, adjusting to market shifts, and implementing performance-enhancing reforms. Importantly, financial analysis is no longer limited to the realm of internal reporting; it plays an essential role in external communication with investors, creditors, and regulatory bodies, helping to build trust and transparency in stakeholder relations.

Economic analysis, when conducted alongside financial assessment, adds a complementary layer of macro-level insight. It encompasses the evaluation of the broader economic, political, and competitive landscape in which a business operates. Liu (2024) notes that economic analysis allows organisations to contextualise their financial data within external variables such as inflation rates, interest rate fluctuations, tax policies, and sectoral trends. This macro-contextualisation enhances the strategic quality of managerial decisions and increases the firm's resilience to economic shocks.

Together, financial and economic analysis form a comprehensive evaluative framework, underpinned by a variety of quantitative methods. These include time series analysis (horizontal), structural analysis (vertical), ratio analysis, comparative benchmarking, and trend projection. According to Hirsch et al. (2020), the backbone of this process consists of tools such as horizontal and vertical analysis, profitability and liquidity ratios, and sectoral comparisons methods that are standardised yet flexible enough to reflect firm-specific conditions.

Almeida-Filho et al. (2021) define financial-economic analysis as a structured and systematic process that evaluates a firm's results over a given time horizon, identifies the factors influencing those results, quantifies their impact, and formulates data-driven recommendations aimed at improving corporate performance and strategic direction. It combines numerical assessment with interpretative judgment and thus serves not only as a diagnostic tool but also as a foundation for forward-looking corporate planning.

The primary role of financial and economic analysis, therefore, is not confined to performance evaluation. As Leonidou et al. (2017) argue, it plays a pivotal role in shaping a firm's internal decision-making processes and external perceptions. On the internal side, it supports cost control, investment appraisal, and performance management. Externally, it influences the firm's image among stakeholders, including banks, shareholders, and customers, by demonstrating accountability and financial discipline. Wu et al. (2022) further point out that internal factors such as product quality, innovation capacity, and managerial efficiency are often reflected in financial outcomes, while external factors such as fiscal policy, legal changes, or international trade dynamics can either hinder or amplify those outcomes. These factors are usually divided into two broad categories:

- External factors, which are exogenous and largely uncontrollable by firm management. These include government regulations, tax regimes, customs policy, geopolitical risks, and global market conditions.
- Internal factors, which are endogenous and depend on the firm’s internal operations and strategic choices. These include cost structures, investment decisions, innovation intensity, and human capital efficiency.

The interplay between these factors is essential to understand the broader function of financial-economic analysis, which lies at the intersection of firm-level management and systemic economic conditions (Wemmerlow, 2021). It is this dual perspective combining the micro with the macro that renders the analysis so valuable and indispensable in modern managerial practice. The effectiveness of financial and economic analysis depends not only on the reliability of input data but also on the analytical methods employed. Relevance, comparability, timeliness, and methodological rigour are key characteristics of high-quality financial analysis. As business models evolve and companies increasingly embrace sustainability, innovation, and digitalisation, the applied tools must also reflect these shifts. In this regard, the analytical framework of the SMART economy which prioritises strategic, measurable, achievable, realistic, and time-bound goals brings a new dimension to financial evaluation. It encourages companies to align financial performance with broader sustainability and innovation objectives, thereby reinforcing long-term competitiveness.

Vertical analysis, as one of the foundational methods, presents each financial item as a percentage of a base figure within the same reporting period. This approach is particularly effective for assessing the structure of financial statements and comparing organisations of different sizes within the same industry. Its clarity and accessibility make it ideal for benchmarking against sectoral norms and highlighting disproportionate cost structures or anomalies (Addy et al., 2024).

Horizontal analysis, by contrast, examines changes in financial items over multiple periods. It allows managers and analysts to identify growth trends, seasonal fluctuations, and structural shifts in revenues, costs, or profitability margins. As Bianchi (2016)explains, horizontal analysis is essential for performance tracking and forecasting, providing a dynamic lens through which to monitor business transformation or crisis response.

Ratio analysis remains a cornerstone of financial assessment, transforming raw data into interpretable metrics. It enables stakeholders to assess short-term liquidity (e.g. current ratio), asset efficiency (e.g. inventory turnover), financial stability (e.g. debt-to-equity ratio), and profitability (e.g. ROA, ROE, ROS). These indicators, when viewed in aggregate, offer a multidimensional picture of the firm’s operational and strategic effectiveness. Moreover, in the context of the SMART economy, such ratios are increasingly complemented by ESG (Environmental, Social, and Governance) indicators that reflect non-financial performance and stakeholder value creation.

Advanced techniques such as pyramidal decomposition, and particularly the DuPont model, allow analysts to drill down into composite indicators like ROE. By disaggregating ROE into its underlying components profit margin, asset turnover, and equity multiplier management can pinpoint the exact operational levers that influence shareholder return. Lastly, bankruptcy prediction and financial risk modelling have become integral to proactive financial management. Widely used tools like Altman’s Z-

score, Taffler's model, and the Bonity Index combine multiple indicators to estimate a firm's risk of insolvency (Surwanti et al., 2022). These models help organisations monitor early warning signs, optimise capital structure, and safeguard stakeholder interests. In sectors with high volatility or capital intensity, such predictive models are particularly valuable for ensuring business continuity and investment security. In summary, financial and economic analysis has evolved from a purely retrospective practice to a strategic, forward-oriented discipline that bridges traditional financial techniques with the forward-thinking imperatives of the SMART economy. Its role is no longer limited to internal evaluation but extends to innovation alignment, sustainability tracking, and long-term value creation.

3. Methods

The aim of this research is to conduct a detailed financial and economic analysis of COOP Jednota Námestovo, spotrebné družstvo over the period 2019–2023. The methodological framework is grounded in a mixed-methods approach combining quantitative financial analysis with qualitative insights from a structured interview. The goal is to evaluate the company's financial health, operational efficiency, capital structure, liquidity, solvency, and profitability by employing traditional financial analysis tools complemented by SMART analytical perspectives.

This research adopts a longitudinal case study approach, observing five years of financial data sourced from publicly available balance sheets and income statements, as well as structured internal perspectives from a key managerial respondent.

COOP Jednota Námestovo, spotrebné družstvo, is a Slovak regional retail cooperative with a strong historical presence in Orava. The organization, re-established in 1991 after legislative changes allowed it to regain independence, currently operates 51 stores and employs approximately 480 staff. The cooperative is characterized by a decentralized yet community-rooted model, emphasizing regional sourcing, financial independence, and network density across rural settlements. Quantitative data was sourced primarily from FinStat and internal company records and included:

- Balance sheet analysis (horizontal and vertical analysis of assets and liabilities).
- Ratio analysis (liquidity, activity, profitability, solvency, debt ratios).
- Pyramidal decomposition (DuPont analysis).
- Bankruptcy prediction models (Altman's Z-score, Taffler's model, and Bonity Index)

Data was structured into tables and visualized through diagrams and charts to highlight longitudinal trends, comparative values, and interpretative observations. Each indicator was evaluated annually and analysed both numerically and contextually.

To supplement the quantitative perspective, a structured interview was conducted with the financial director of COOP Jednota Namestovo. The interview covered 11 targeted questions focused on:

- Capital structure and asset strategy.
- Financial stability and risk management.
- Credit strategy and investment planning.
- Operational and liquidity management.
- Competitive advantages and market outlook

This qualitative input provided valuable context for interpreting numerical results and highlighted strategic priorities and managerial intentions. The analysis involved the following financial methodologies:

1. *Horizontal and Vertical Analysis:* Used for tracking the evolution of both assets and liabilities in absolute and relative terms.
2. *Liquidity Ratios:* Included quick, cash and current ratios to assess short-term solvency.
3. *Debt Ratios:* Evaluated levels of short- and long-term debt, self-financing degree, and capital structure.
4. *Activity Ratios:* Measured turnover of inventory, accounts receivable, liabilities, and total assets.
5. *Profitability Indicators:* Assessed returns on assets (ROA), equity (ROE), sales (ROS), costs, and capital.
6. *DuPont Analysis:* Decomposed ROE into subcomponents to determine the specific drivers of return.
7. *Bankruptcy and Creditworthiness Models:* Applied Altman's Z-score, Taffler's model, and Bonity Index for insolvency risk estimation.

While the study offers a robust evaluation of financial performance, it is limited to a single enterprise and five-year timeframe, which may restrict the generalizability of findings. Nonetheless, triangulating objective financial results with subjective managerial perspectives significantly strengthens the validity and depth of insight.

The following table 1 presents an overview of the research process conducted in this study. It outlines the main methodological steps, the corresponding data sources, and the specific financial and analytical tools applied in each phase. This structured procedure ensures a comprehensive and multi-perspective assessment of the financial health and performance of COOP Jednota Námestovo, spotrebné družstvo over the period 2019–2023.

Table 1. Research procedure and analytical methods

Research Step	Description	Tools/Methods Used
Selection of Analysis Subject	Selection of the regional retail cooperative COOP Jednota Námestovo	Emphasis on historical context, store network size, number of employees, data availability
Collection of Quantitative Data	Acquisition of data from balance sheets, profit and loss statements, FinStat, and internal records (2019–2023)	Public financial statements, FinStat database, internal company documents
Horizontal and Vertical Analysis	Assessment of trends and structure of assets and liabilities	Absolute and relative changes, percentage breakdown
Ratio Analysis	Evaluation of financial stability, liquidity, debt, activity, and profitability	Liquidity (cash ratio, quick ration, current ratio), ROA, ROE, ROS, short/long-term debt, solvency
DuPont Analysis	Decomposition of ROE into profit margin, asset turnover, and financial leverage	Pyramidal decomposition of ROE
Creditworthiness Models	Assessment of bankruptcy risk and financial soundness	Altman's Z-score, Taffler's model, Bonity Index
Collection of Qualitative Data	Structured interview with the financial director of COOP Jednota Námestovo	11 targeted questions on stability, strategy, planning, and competitiveness
Triangulation of Findings	Combining quantitative data with qualitative managerial insights	Comparison of analysis results with interview responses
Interpretation and Synthesis of Outputs	Summary of key trends, identification of weaknesses and strengths	Numerical and contextual trend analysis, benchmarking against ideal values

Source: own processing (2025)

4. Results

Overview of asset development

The horizontal analysis of the balance sheet's asset side from 2019 to 2023 reveals a consistent upward trend in the total value of assets. The company's assets increased from €13.43 million in 2019 to €16.85 million in 2023, representing a cumulative growth of approximately 25.4% over five years. The most substantial year-on-year increase occurred between 2021 and 2022, with a rise of over €1 million, primarily driven by a significant boost in current assets. Non-current assets, which made up the majority of the asset base at the beginning of the period, experienced a gradual decline from €8.63 million in 2019 to €8.00 million in 2023. Despite this reduction, the overall asset base continued to grow, mainly due to the expansion of current assets, which rose from €4.79 million to €8.73 million during the same period. This shift indicates a strategic reallocation of resources toward short-term, liquid assets. Accruals, though representing a small share of total assets, increased notably, especially in the last three years, suggesting enhanced accounting precision or rising prepaid expenses and deferred revenues. The vertical analysis further illustrates the transformation of asset structure. The proportion of non-current assets to total assets fell significantly from 64.25% in 2019 to 47.48% in 2023, while the share of current assets increased from 35.69% to 51.84%. This redistribution reflects a growing emphasis on operational liquidity and

potentially signals a shift in the company's investment strategy toward greater flexibility and responsiveness to market changes. Accruals also saw an increase from 0.06% to 0.68%, underscoring an improvement in accrual-based financial reporting (Table 2).

Table 2. Evolution of Asset Structure (2019–2023)

Indicator	2019 (€)	2020 (€)	2021 (€)	2022 (€)	2023 (€)	Change 2019–2023
Total Assets	13,429,460	15,014,185	15,378,117	16,406,399	16,850,469	+25.4%
Non-current Assets	8,628,220	9,465,225	9,059,561	8,838,696	8,000,200	−7.3%
Current Assets	4,793,564	5,540,017	6,291,924	7,483,717	8,734,945	+82.2%
Accruals (Prepaid/Deferred)	7,676	8,943	26,632	83,986	115,324	+1,401%

Source: own processing (2025)

Overview of liabilities and equity

The horizontal analysis of liabilities and equity confirms a steady growth in the company's financial base over the five-year period (Table 3). The total value of liabilities and equity increased from €13.43 million in 2019 to €16.85 million in 2023, reflecting a total increase of €3.42 million or approximately 25.5%. This growth was driven by simultaneous increases in both equity and liabilities, suggesting a balanced financing strategy that supports expansion without over-reliance on external debt. Despite minor year-on-year fluctuations in accruals, the capital structure remained relatively stable and healthy.

From a vertical analysis perspective, equity consistently accounted for more than 60% of the total capital structure throughout the period. The share of equity peaked in 2021 at 64.59%, indicating a particularly strong self-financing position, before slightly decreasing to 62.30% in 2023. These values signal a high degree of financial independence and low exposure to external financial risks.

Liabilities as a share of total capital ranged from 34.55% to 39.17%, never exceeding the psychological threshold of 40%, which suggests a moderate and controlled use of debt. Meanwhile, accruals, although variable in absolute terms, remained marginal, consistently accounting for less than 1% of total liabilities and equity. This indicates disciplined accrual-based accounting practices without major shifts in deferred items or time-based allocations.

Overall, the findings highlight a stable and prudent financial strategy, characterized by a dominant share of equity, carefully managed liabilities, and minimal dependence on accrual-based adjustments.

Table 3. Evolution of Capital Structure (2019–2023)

Indicator	2019 (€)	2020 (€)	2021 (€)	2022 (€)	2023 (€)	Change 2019–2023
Total Liabilities + Equity	13,429,460	15,014,185	15,378,117	16,406,399	16,850,469	+25.5%
Equity	8,514,408	9,132,793	9,933,066	10,433,356	10,497,639	+23.3%
Liabilities	4,878,900	5,847,182	5,312,771	5,857,625	6,245,863	+28.0%
Accruals (Deferred Liabilities)	36,152	34,210	132,280	115,418	106,967	+195.8%

Source: own processing (2025)

Liquidity indicators

The company's liquidity indicators showed a consistent improvement over the 2019–2023 period. Cash ratio increased from 0.337 in 2019 to 0.557 in 2023, indicating a stronger ability to cover short-term liabilities with cash equivalents. Quick ratio followed a similar path, rising from 0.415 to 0.753, reflecting improved coverage when including receivables. Current ratio rose from 1.053 to 1.499, suggesting that total current assets increasingly exceeded current liabilities. However, despite these positive trends, the cash flow coverage period for short-term liabilities worsened in 2023, increasing from 948 days in 2022 to 1,269 days, implying that more time was needed to repay short-term obligations using internal financing. Nonetheless, the payment incapacity ratio declined significantly from 13.32 in 2019 to 5.94 in 2023, confirming enhanced payment capacity and overall financial resilience (Figure 1).

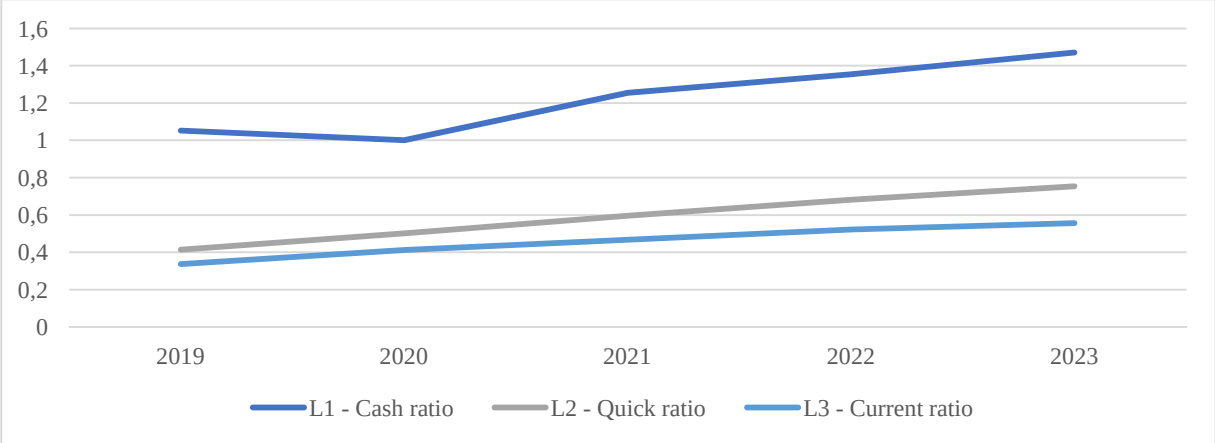

Figure 1. Liquidity ratios over time
Source: own processing (2025)

Activity indicators

Inventory turnover remained at a favourable level throughout the five-year period, reflecting efficient inventory management practices. Although there was a slight increase in the number of days required to turn over inventory from 24.83 days in 2021 to 30.41 in 2022 and 29.73 in 2023, these values remain within an acceptable operational range for retail enterprises. The temporary increase in 2022 may have been related to seasonal fluctuations, stockpiling strategies, or supply chain adjustments.

The receivables collection period, however, showed a gradual upward trend, rising from 2.67 days in 2019 to 5.16 days in 2023. While the values are still low in absolute terms, the doubling of this indicator over the observed period signals a potential area for improvement in receivables management. Delays in receivables collection can negatively impact cash flow, especially in times of economic uncertainty or increased operating costs.

The payment period for short-term liabilities remained relatively stable, fluctuating between 30 and 37 days. This consistency suggests that the company has maintained steady payment practices with its suppliers and other short-term creditors, thereby supporting its creditworthiness and supplier relationships.

Asset turnover slightly improved in 2023, decreasing from 124.30 days in 2020 to 116.82 days in 2023, indicating enhanced efficiency in utilizing total assets to generate revenue (Figure 2). This trend aligns with the company's broader liquidity and operational strategies, which appear to be geared toward improving overall asset utilization without overextending financial leverage.

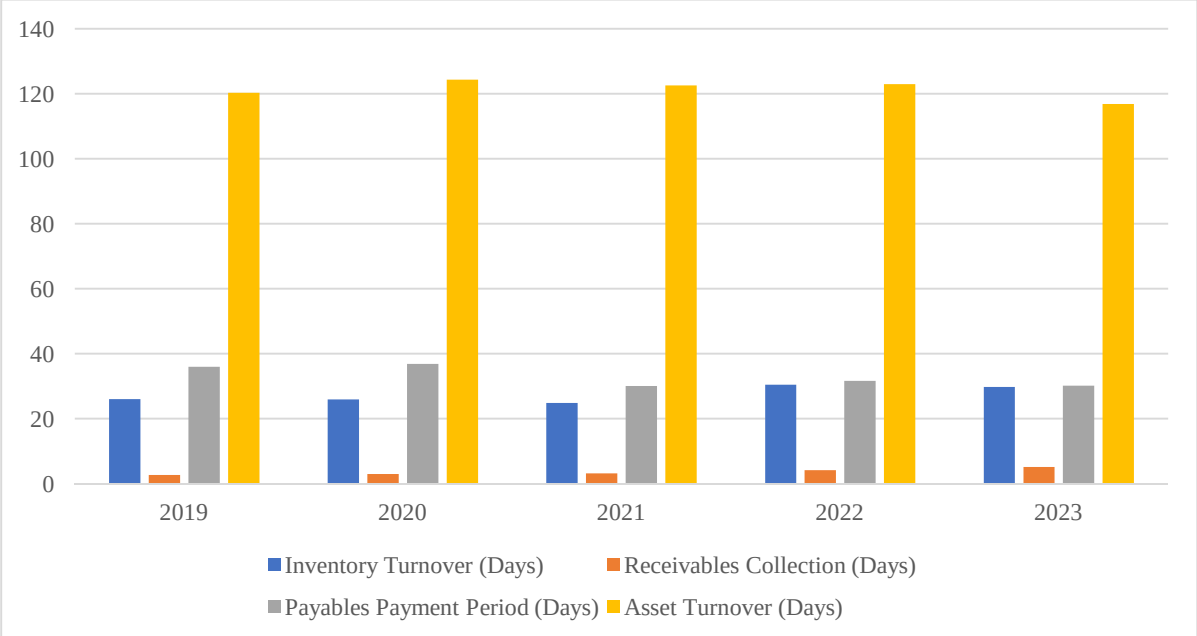

Figure 2. Activity ratios over time
Source: own processing (2025)

Debt and profitability indicators

The financial structure of COOP Jednota Námestovo remained relatively stable between 2019 and 2023. The self-financing ratio consistently stayed above 60%, indicating a strong reliance on internal capital and a low dependence on external financing. The total debt ratio ranged between 35% and 39%, with its highest level recorded in 2020. Notably, the company reported zero bank debt throughout the entire period, which represents an unusually conservative strategy in the retail sector. Interest coverage, which reflects the company's ability to cover interest expenses from profit, increased significantly from 95.81 (2019) to 797.49 (2023), suggesting higher profitability and virtually no debt burden. Financial leverage remained steady at around 1.6, indicating a moderate use of external capital. In terms of profitability, 2020 was the most successful year, with a return on assets (ROA) of 0.07 and a return on equity (ROE) of 0.11. However, from 2021 onwards, profitability gradually weakened, with ROA falling to 0.01 and ROE to 0.02 in 2023. The return on sales (ROS) and return on costs dropped to zero, highlighting reduced operational efficiency and profitability in the final year of the observed period. Similarly, return on equity capital declined from 0.52 in 2019 to 0.20 in 2023 (Figure 3 – 5).

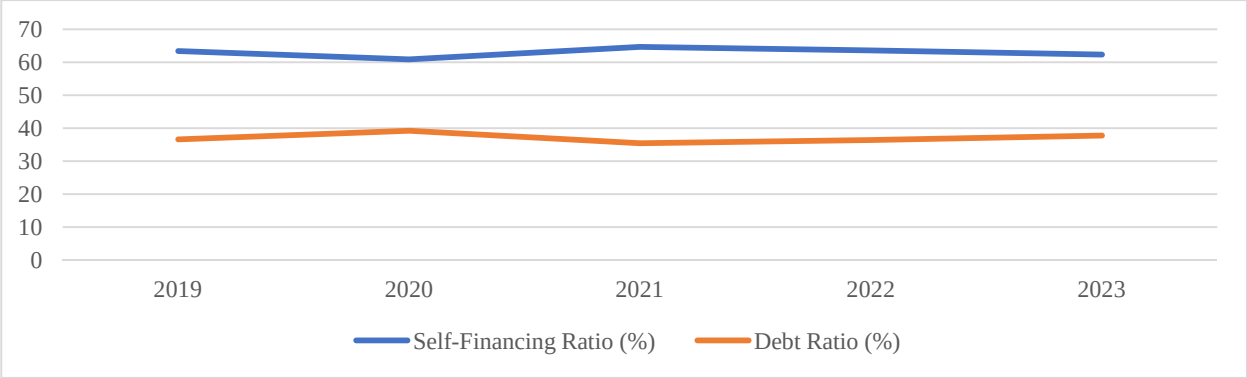

Figure 3. Capital Structure Ratios (2019–2023)
Source: own processing (2025)

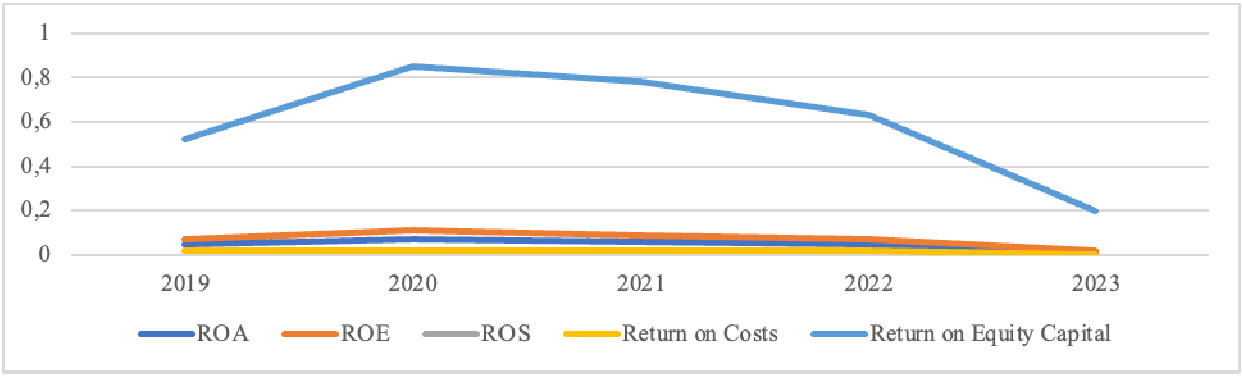

Figure 4. Profitability Indicators (2019–2023)
Source: own processing (2025)

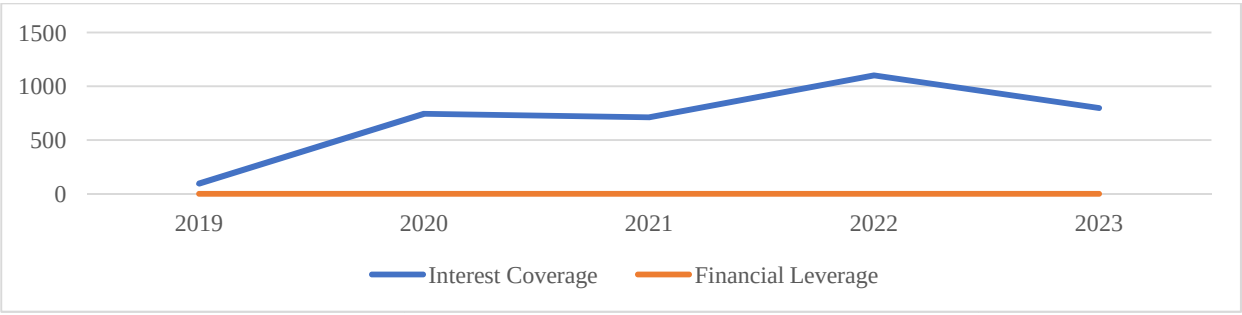

Figure 5. Debt Servicing and Leverage (2019–2023)
Source: own processing (2025)

The financial structure of COOP Jednota Námestovo remained relatively stable between 2019 and 2023. The self-financing ratio consistently stayed above 60%, indicating a strong reliance on internal capital and a low dependence on external financing. The total debt ratio ranged between 35% and 39%, with its highest level recorded in 2020. Notably, the company reported zero bank debt throughout the entire period, which represents an unusually conservative strategy in the retail sector. Interest coverage, which reflects the company's ability to cover interest expenses from profit, increased significantly from 95.81 (2019) to 797.49 (2023), suggesting higher profitability and virtually no debt burden. Financial leverage remained steady at around 1.6, indicating a moderate use of external capital. In terms of profitability, 2020 was the most successful year, with a return on assets (ROA) of 0.07 and a return on equity (ROE) of 0.11. However, from 2021 onwards, profitability gradually weakened, with ROA falling to 0.01 and ROE to 0.02 in 2023. The return on sales (ROS) and return on costs dropped to zero, highlighting reduced operational efficiency and profitability in the final year of the observed period. Similarly, return on equity capital declined from 0.52 in 2019 to 0.20 in 2023 (Figure 3 – 5). This downward trend in profitability is likely linked to rising operating costs, pricing pressure in the retail market, and the absence of new strategic investments that could enhance revenue streams. Although the company's conservative approach helped maintain financial stability, it may have limited its growth potential and adaptability to market shifts. A balanced strategy combining internal capital utilization with selective external financing could potentially strengthen competitiveness and improve returns.

Furthermore, the company's ability to maintain high levels of interest coverage despite stagnating or declining returns in recent years indicates efficient cost management and a cautious investment policy. However, if this trend of declining profitability continues, it could eventually erode the company's strong financial base. Regular financial performance reviews and targeted reinvestment strategies may be necessary to maintain long-term resilience and improve the company's return metrics.

DuPont and bankruptcy prediction models analysis

The DuPont pyramid analysis revealed 2020 as the peak year in terms of profitability and efficiency. The profit-to-equity ratio (P/E) reached 14.01%, and profit-to-sales (P/S) rose to 2.90%, both of which represent the company's best performance in converting capital and sales into profit. However, this positive trend did not continue. By 2023, both indicators had dropped significantly P/E to 2.80% and P/S to just 0.56%. This sharp decline can be largely attributed to reduced net profit margins, despite stable asset turnover (hovering around 33%) and a relatively unchanged equity-to-assets ratio (around 62–64%). The weakening profit metrics indicate mounting cost pressures or reduced revenues, affecting overall performance.

From a risk and stability perspective, Altman's Z-score remained above 4.0 throughout most of the period, signalling strong financial health and low bankruptcy risk. Likewise, Taffler's model consistently held a score of 0.3, confirming negligible risk of short-term insolvency. However, the Bonity Index, which peaked at 2.07 during 2020 and 2021 indicating a "very good" financial condition dropped to 1.16 in 2023. While this still suggests a "good" standing, the downward movement signals early warning signs of potential strain in the company's financial resilience (Figure 6 and 7).

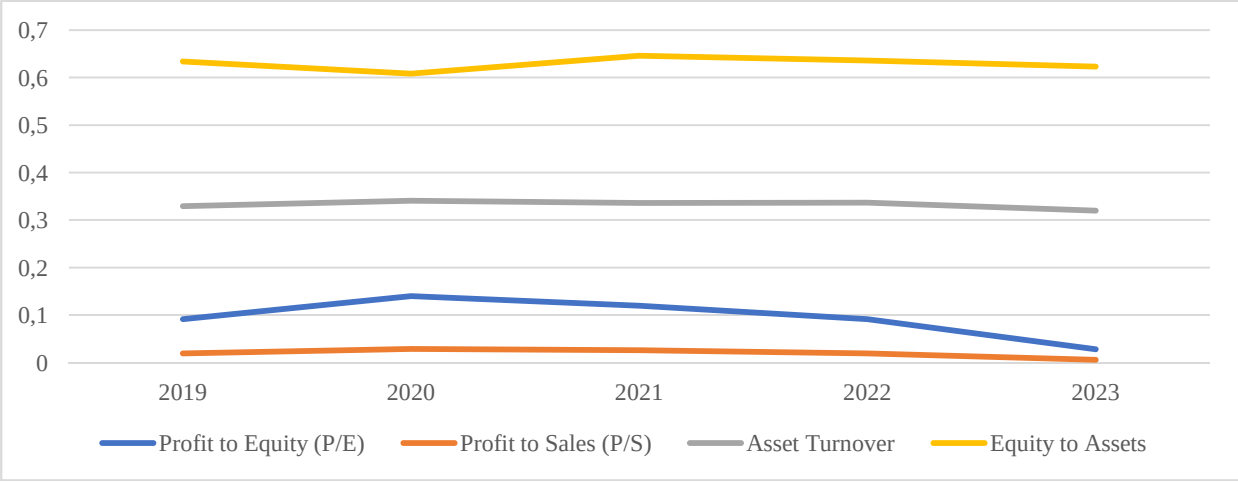

Figure 6. DuPont Analysis Sub-Indicators (2019–2023)
Source: own processing (2025)

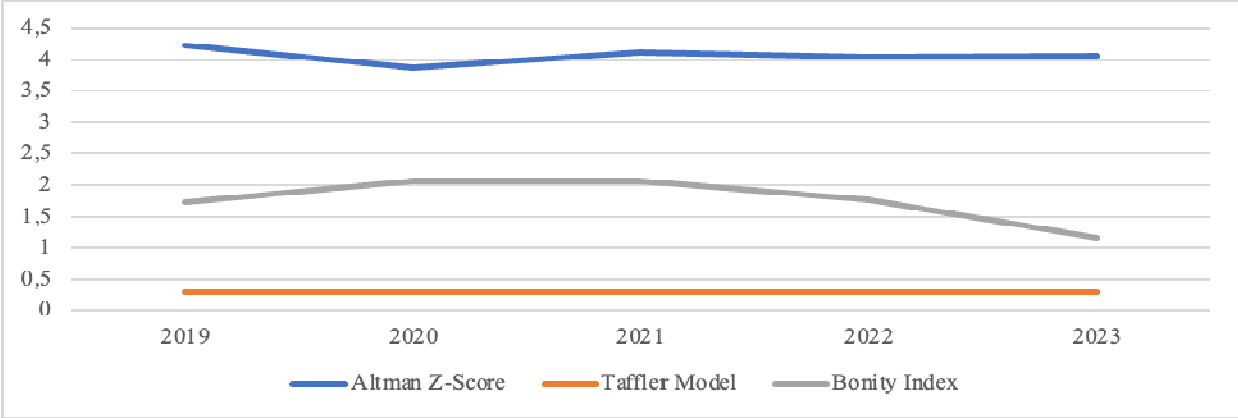

Figure 7. Financial Health Indicators (2019–2023)
Source: own processing (2025)

The DuPont pyramid analysis reveals a clear peak in 2020, which stands out as the most successful year in terms of profitability and capital efficiency. The Profit-to-Equity (P/E) ratio reached 14.01%, indicating that for every euro of equity, the company generated €0.14 in profit. Similarly, the Profit-to-Sales (P/S) ratio rose to 2.9%, showing healthy profit margins on revenues. While the Asset Turnover (Sales to Assets) remained relatively stable throughout the period, hovering between 32% and 34%, it helped sustain consistent sales generation from existing resources. However, 2023 saw a sharp decline in profitability. The P/E ratio fell to 2.80%, and the P/S dropped to 0.56%, suggesting significant margin pressure and reduced efficiency in generating returns for shareholders. Despite the continued stability of Equity-to-Assets (ranging between 60–65%), the drop in net profit ratios substantially weakened overall ROE (Return on Equity), signalling operational challenges or rising cost burdens. This drop in profitability also aligns with the results of financial health models, which show early warning signs:

- Altman's Z-score remained above the critical threshold of 2.9, fluctuating between 3.86 and 4.22, which consistently places the company in the safe zone regarding bankruptcy risk. This suggests that despite weakening profitability, the company maintained strong capital buffers and financial stability.
- Taffler's model, focusing on short-term solvency, was remarkably stable at 0.3 for all five years. This consistency indicates that the company was in no immediate danger of short-term insolvency and had a manageable balance of liabilities.
- The Bonity Index (a synthetic indicator of financial performance and creditworthiness) peaked at 2.07 in 2020 and 2021, reflecting a very good financial position. However, it declined to 1.16 in 2023, which, while still acceptable, points to a mild deterioration in financial standing and possibly increased vulnerability if the downward trend continues.

Qualitative insights from interview

A structured interview conducted with the financial director of COOP Jednota Námestovo provided valuable qualitative depth to the quantitative financial analysis. The insights shared not only confirmed the analytical findings but also added strategic and operational context, reinforcing the narrative of financial stability and deliberate management choices over the period 2019–2023. The positive assessment of asset growth and liquidity by the financial director aligned closely with the observed upward trend in total assets and improvement in all three degrees of liquidity. This suggests that the company's internal perception of financial health is consistent with the objective indicators.

A particularly important theme was the strategic emphasis on self-financing and reinvestment of profits. Rather than relying on bank loans, the company opted for a conservative capital strategy, preferring to grow organically and maintain a low-risk debt profile. While no current bank financing is in place, the director acknowledged the possibility of future external investments for strategic expansions, such as new retail outlets or infrastructure modernization.

Another critical priority outlined in the interview was the commitment to regional competitiveness. By emphasizing local sourcing and maintaining a dense network of rural stores, the company has carved out a strong presence in its market. Complementing this, the director underscored the importance of logistics digitalization, which is increasingly seen as a competitive differentiator in the retail sector.

Overall, these managerial insights significantly enhanced the interpretation of financial data, providing a richer understanding of the company's strategic mindset, risk tolerance, and operational direction. The interview confirmed that financial decision-making is aligned with long-term stability, regional service delivery, and sustainable growth objectives.

Table 4. Recommendations based on the structured interview with the financial director

Area Identified During Interview	Key Finding	Recommended Measure	Implementation Possibilities	Expected Benefit
Financial Policy	Strong preference for self-financing	Maintain internal resources as the primary financing method	Regular evaluation of reserves and reinvestment priorities	Financial stability, low indebtedness
Bank Loans	No current loans, openness to future loans	Consider purpose-specific loans for major investment projects	Develop return scenarios for digital/logistics investments	Investment flexibility without compromising stability
Liquidity and Asset Turnover	Improving liquidity, need for monitoring	Implement regular tracking of receivables and payables cycles	Dashboard integration with key indicators	More accurate forecasts and better cash flow management
Competitiveness	Pressure from competing retail chains	Strengthen regional marketing and customer loyalty	Digitalization of loyalty programs, personalized engagement	Increased sales, customer retention
Operational Efficiency	Need to optimize logistics and warehousing	Invest in digital warehouse systems	Stepwise implementation and employee training	Faster distribution, reduced costs
Sustainability and Ecological Costs	Rising ecological costs due to green efforts	Develop an ESG strategy	Carbon footprint tracking, environmental reporting	Improved reputation, access to green financing

Source: own processing (2025)

Table 4 consolidates six key strategic areas that emerged during the structured interview with the financial director of COOP Jednota Námestovo. Each area is matched with a specific finding, a recommended measure, implementation opportunities, and expected benefits. This format provides a clear and actionable roadmap, translating financial analysis into managerial decisions. The recommendations reflect both internal strengths and external challenges, offering realistic and practical suggestions to improve the company's financial management and competitive position. The table bridges the gap between quantitative findings and managerial insights, serving as a direct input for planning, decision-making, and long-term development.

5. Discussion

The findings of this study confirm that the integration of traditional financial analysis with the principles of the SMART economy enhances the explanatory power of financial diagnostics and strategic evaluations. The results are consistent with the argument presented by Hofman et al. (2012), who emphasize that a financial strategy aligned with sustainability and innovation contributes to long-term organizational resilience and stakeholder trust.

The case of COOP Jednota Námestovo reveals a highly stable capital structure, as evidenced by a self-financing ratio consistently exceeding 60% and the absence of bank loans throughout the 2019–2023 period. This mirrors the conservative financial models discussed by Aghion et al. (2010), which advocate for internal capital accumulation in volatile markets. However, while this approach minimized financial risk, it may have constrained growth opportunities, especially in a competitive retail environment where rapid technological adoption and customer-centric innovations are increasingly critical (Ejjami & Rahim, 2025).

In terms of liquidity, all three degrees of liquidity indicators improved markedly. This supports Yakub (2023) view that dynamic liquidity management is a cornerstone of operational resilience, particularly when internal financing dominates the capital mix. Nevertheless, the rise in the cash flow coverage period in 2023 signals a latent inefficiency in converting earnings into readily available cash, potentially linked to increasing ecological expenses or operational rigidities. This aligns with OECD (2021) findings, which suggest that even sustainable-oriented firms can face short-term liquidity pressures when integrating ESG principles without adequate financial cushioning.

The DuPont analysis further highlighted 2020 as the peak year for profitability, followed by a gradual decline. This trajectory illustrates the cyclical nature of performance in stable but non-disruptive enterprises and supports Mousavi et al. (2019) proposition that profitability decomposition offers crucial insight into performance drivers. Although asset turnover and equity-to-assets ratios remained stable, the significant drop in net margins underlines the growing impact of external cost pressures particularly relevant in the context of sustainability-driven expenditures, which, as UNCTAD (2023) notes, may initially reduce profitability before delivering long-term returns.

From the perspective of financial health, Altman's Z-score and Taffler's model confirm that the company remained solvent and at low risk of bankruptcy throughout the analysis period. However, the decline in the Bonity Index from 2.07 to 1.16 raises early concerns about potential performance fatigue. This supports Aliano et al. (2024) assertion that while traditional solvency models are effective in highlighting immediate risks, complementary models such as Bonity Index are better suited to capturing gradual shifts in creditworthiness and internal efficiency.

The structured interview with the financial director added essential context to the quantitative findings. The strategic preference for self-financing and investment in digital logistics reinforces the notion of sustainability embedded in strategic operations, aligning with the SMART economy's focus on digital transformation and resource efficiency (Kesidou et al., 2025). Moreover, the director's emphasis on regional competitiveness and ecological responsibility reflects the multi-stakeholder focus advocated by the ESG framework and demonstrates a conscious effort to balance economic and environmental objectives.

The recommendations derived from this interview point toward a transition phase moving from a financially stable but reactive posture to a more proactive, innovation-driven model. In this regard, Agarwal & Gupta (2024) call for deeper integration of predictive analytics and performance benchmarking becomes highly relevant. Especially the proposed use of smart dashboards, loyalty program digitalization, and ESG strategies aligns with the findings of Elliot (2011), who stress that digital tools and sustainability metrics are not supplementary but foundational to contemporary financial management.

Finally, this study reaffirms the importance of triangulating quantitative and qualitative insights. As Cambell et al. (2023) emphasize, comprehensive financial-economic analysis must combine hard data with managerial perception to uncover latent patterns and strategic intentions. By adopting this integrative lens, the current research not only diagnoses financial strengths and weaknesses but also illuminates viable paths for strategic improvement, operational resilience, and long-term value creation.

In summary, the integration of financial analysis with SMART economy principles enables a more strategic interpretation of company performance that extends beyond traditional profitability and solvency indicators. The case of COOP Jednota Námestovo illustrates how a stable financial foundation grounded in conservative capital management can serve as a platform for gradual but meaningful transformation. However, as cost pressures mount and competitive dynamics evolve, future success will increasingly depend on the company's ability to adopt flexible financing strategies, digital innovation, and sustainability frameworks without undermining its financial discipline.

The findings presented in this study offer practical implications for similar retail cooperatives and SMEs seeking to modernize their financial planning without compromising economic stability. By aligning financial diagnostics with broader strategic insights and sustainability goals, organizations can improve their decision-making processes and proactively adapt to emerging challenges. Further research could explore longitudinal comparisons across cooperative models or regions to validate the generalizability of SMART economy integration and its long-term impact on corporate resilience and stakeholder value.

Conclusion

This study examined the integration of traditional financial-economic analysis with the principles of the SMART economy through a comprehensive case study of a regional retail cooperative. By combining

horizontal and vertical analysis, ratio indicators, pyramidal decomposition, and creditworthiness models with qualitative managerial insights, the research offers a multidimensional evaluation of corporate financial performance. The findings confirmed that COOP Jednota Námestovo maintained a stable capital structure and strong liquidity throughout the period 2019–2023, while simultaneously implementing several technological and process-based innovations aligned with the SMART economy framework.

The adoption of digital tools, internal reinvestment strategies, and the gradual incorporation of data-driven decision-making illustrate how even conservative, regionally focused enterprises can adapt to broader economic and technological trends. Moreover, the managerial emphasis on sustainability, customer retention, and logistics digitalisation underscores the strategic alignment between financial health and long-term resilience. By triangulating quantitative findings with qualitative managerial insights, the research confirmed that aligning financial indicators with SMART principles contributes to operational agility and enhances the quality of decision-making under uncertainty.

Despite the comprehensive nature of the analysis, the study is not without limitations. First, the findings are based on a single case study, which limits the generalisability of conclusions across sectors and geographies. The cooperative structure, regional focus, and conservative capital strategy of COOP Jednota Námestovo may differ significantly from larger or more diversified firms. Second, the study covers only a five-year period (2019–2023), which, while sufficient for trend analysis, may not fully capture long-term shifts or cyclical dynamics in performance. Third, the qualitative data was derived from a single structured interview. Although rich in insight, a broader panel of respondents or stakeholder perspectives would enhance the interpretative depth and validity of strategic conclusions.

Building on the findings, future research should consider expanding the sample to include a variety of organisational types such as multinational firms, start-ups, or cooperatives across different regions to validate and refine the SMART-integrated analytical framework. Additionally, longitudinal studies extending beyond five years would provide more robust evidence on the sustainability of SMART interventions and their cumulative impact on financial resilience. Another area of future exploration includes the integration of ESG (Environmental, Social, Governance) performance metrics into financial analysis. As stakeholder expectations evolve and regulatory demands intensify, businesses must align not only with technological innovation but also with social and environmental responsibility. Applying the SMART framework in tandem with ESG indicators could enrich strategic evaluation and facilitate a more holistic approach to corporate sustainability and competitiveness.

Lastly, there is a growing need for predictive models capable of identifying weak signals and upcoming disruptions. The use of artificial intelligence and machine learning in financial planning, particularly when embedded within SMART principles, offers exciting potential for enhancing early warning systems and optimizing decision-making processes in real time. Future research could investigate how these technologies affect financial governance structures and decision quality in dynamic markets.

Acknowledgements

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The Impact of the Recognition of Deferred Tax Assets and Liabilities on the Usefulness of Financial Information

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Abstract

Research background: Recognizing deferred tax assets and liabilities in financial reports using the temporary difference approach may satisfy the accrual basis of accounting, but it results in the creation of information whose relevance, and therefore usefulness, is questionable. The alternative tax payable approach recognizes in financial reports only the amount of taxes calculated in accordance with the requirements of tax law, which may be more relevant because it is more understandable to users.
Purpose of the article: This article is designed to examine and determine whether the application of the temporary difference approach indeed creates relevant financial information for users of general purpose financial reports. If so, then the recognition of deferred tax assets and liabilities in the financial reports would be useful to them.
Methods: Using the Microsoft Excel function "t-Test: Paired Two Sample for Means", data on the debt-to-equity ratio for 2024 of the companies included in the determination of the EURO STOXX 50 index were analyzed. The ratio was calculated using data from statutory financial reports that applied the temporary differences approach, and, alternatively, by applying the tax payable approach.
Findings & Value added: The results of the study show that the recognition of deferred tax assets and liabilities does not have a statistically significant impact on the magnitude of the debt-to-equity ratio and therefore does not affect the relevance of financial information. If the tax payable approach is applied instead, the financial information remains useful for the financial reports' users.

Keywords: Deferred taxes, Income taxes, Financial reports, Useful financial information, Tax payable approach

JEL classification: M41

1. Introduction

The relevance and faithful representation of financial information are fundamental qualitative characteristics underpinning the usefulness of general-purpose financial reports, as defined by the International Accounting Standards Board (IASB, 2018). One of the most debated issues in this context concerns the recognition of deferred tax assets and liabilities, which arises from the application of the temporary difference approach under IAS 12 Income Taxes. According to this standard, deferred tax balances result from differences between the carrying amounts of assets and liabilities in the statement of financial position and their corresponding tax bases. This approach seeks to reflect the anticipated tax consequences of an entity's transactions and events, consistent with the accrual basis of accounting.

The concept of deferred taxation emerged in the mid-20th century, as accounting practices evolved to better align reported earnings with underlying economic activity. Initially developed under U.S. Generally Accepted Accounting Principles (GAAP), deferred tax accounting was later incorporated into international standards through IAS 12. Its theoretical foundation lies in the matching principle and the accrual concept, which aim to recognize tax effects in the same period as the underlying income or expense. This framework was designed to enhance inter-period comparability and to provide a faithful representation of the long-term tax implications of business operations. However, concerns have

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increasingly been raised regarding the reliability, complexity, and informational relevance of deferred tax balances—particularly in cases of uncertain future profitability or substantial divergence between tax and accounting treatments.

Temporary differences occur when the carrying amount of an asset or liability differs from its tax base, but the discrepancy is expected to reverse in future periods. For example, differences in depreciation methods for accounting and tax purposes may lead to timing mismatches in income recognition. In contrast, permanent differences—such as non-deductible expenses—do not reverse and are excluded from deferred tax accounting. Since deferred tax items are recognized only for temporary differences, understanding their nature is critical when evaluating the resulting financial information.

While the conceptual framework of deferred tax accounting is well established, its practical impact on the interpretation of financial statements remains contested. This backdrop motivates the central research question of the present study:

Does the recognition of deferred tax assets and liabilities materially alter key indicators of financial structure, such as the debt-to-equity ratio? In addressing this question, the article seeks to empirically assess the decision-usefulness of deferred tax balances within financial reporting.

This treatment stands in contrast to the tax payable approach, which accounts solely for current tax obligations based on enacted tax laws and excludes any forward-looking estimates. Although the temporary difference method is conceptually robust within the accrual framework, its utility for decision-making remains subject to academic and professional debate. Critics contend that such items, being non-cash, judgment-intensive, and often unrealized, may compromise rather than enhance financial statement transparency. Moreover, their inclusion may distort key financial ratios and hinder the comparability of reported figures across entities and periods.

To empirically investigate this issue, the study analyzes financial data from all 50 companies included in the EURO STOXX 50 index (STOXX, n.d.) as of December 31, 2024. These firms represent the largest and most liquid publicly listed companies in the Eurozone and prepare their financial statements in accordance with International Financial Reporting Standards (IFRS), making them a suitable and representative sample for the study.

The analysis centers on the debt-to-equity (D/E) ratio as a key financial metric, computed both with and without deferred tax components—thus simulating the tax payable approach. A two-tailed paired-sample t-test is employed to examine whether a statistically significant difference exists between the two sets of D/E values, while the Pearson correlation coefficient is used to evaluate the consistency and structural alignment between them.

2. Methods

To investigate this issue, financial data were extracted from the statutory consolidated financial statements of all 50 companies included in the EURO STOXX 50 index as of December 31, 2024. The sample was selected based on company size, public interest relevance, and the availability of comprehensive and comparable disclosures under International Financial Reporting Standards (IFRS).

The debt-to-equity (D/E) ratio was calculated using two distinct approaches. First, the reported figures under the temporary difference method were used. Second, the same ratio was recalculated using adjusted data that exclude deferred tax assets and liabilities—thereby simulating the tax payable approach. The D/E ratio was selected as the primary indicator due to its widespread use in assessing a firm's capital structure and financial risk. For reference, the ratio is computed as follows:

Debt-to-Equity Ratio (D/E) = Total Liabilities / Equity

A paired two-sample t-test was conducted in Microsoft Excel to determine whether a statistically significant difference exists between the D/E ratios calculated under the two accounting treatments. This method is appropriate for comparing the means of two related samples—in this case, the same companies assessed under both the temporary difference and tax payable approaches. The aim was to evaluate whether the differences observed stem from systematic effects of deferred tax recognition or are merely attributable to random variation. While Excel was selected for its accessibility and transparency, future studies may consider employing more advanced software such as R or Stata to enhance analytical precision.

Additionally, the Pearson correlation coefficient was calculated to assess the strength and direction of the linear relationship between the reported and adjusted D/E ratios. A high correlation would suggest that, despite numerical differences, the relative rankings and distributional patterns among companies remain largely consistent. This measure complements the t-test by providing insight into the structural consistency of the values.

Together, these two statistical tools offer a complementary analytical framework: the t-test evaluates differences in central tendency, while the correlation analysis assesses the consistency of data distribution. To further support the analysis, several key financial variables were defined and measured under both accounting treatments.

It is important to note that adjusted equity figures were not directly disclosed in the financial statements. Instead, they were calculated by subtracting adjusted total liabilities from adjusted total assets, based on the author's own estimations. Table 1 outlines the definitions and calculation methods used to derive the reported and adjusted values, which form the basis for comparing the two approaches and assessing the impact of deferred tax items on financial leverage.

Table 1. Key Variables Table

Variable	Description
Total Assets (Reported)	As disclosed in the statutory financial statements under the temporary difference approach
Total Assets (Adjusted)	Reported total assets minus deferred tax assets
Total Liabilities (Reported)	As disclosed in the statutory financial statements under the temporary difference approach
Total Liabilities (Adjusted)	Reported total liabilities minus deferred tax liabilities
Equity (Reported & Adjusted)	Difference between assets and liabilities under each respective approach
Debt-to-Equity Ratio	Calculated separately for reported and adjusted values

Source: author (2025)

3. Results

The following section presents the empirical findings derived from the statistical methods outlined earlier. Table 2 summarizes the key financial variables extracted from the statutory financial statements of the 50 EURO STOXX 50 companies as of December 31, 2024. The dataset presents reported values as disclosed in the statutory financial statements. Adjusted figures, which exclude deferred tax components, are not directly provided but can be derived and recalculated based on the reported data.

These derived values enable a comparative analysis between the temporary difference approach and the tax payable approach, forming the basis for the subsequent statistical testing.

Table 2. Summary of Key Financial Figures as of December 31, 2024

№	Company	Reporting Currency	Total Assets (incl. DTA)	Deferred Tax Assets	Total Liabilities (incl. DTL)	Deferred Tax Liabilities
1	Adidas	EUR	20 655	1 272	14 787	133
2	Adyen	EUR	11 425 279	105 056	7 193 755	801
3	Ahold Delhaize	EUR	51 842	161	36 388	1 051
4	Air Liquide	EUR	51 868	335	24 246	2 527
5	Airbus	EUR	129 213	3 505	109 517	271
6	Allianz	EUR	1 044 578	6 055	980 502	2 257
7	Anheuser-Busch Inbev	USD	206 637	2 493	117 937	11 321
8	ASML Hldg	EUR	48 590	1 940	30 113	299
9	AXA	EUR	653 762	3 357	601 284	1 976
10	BASF	EUR	80 415	574	43 531	1 005
11	Bayer	EUR	110 850	6 164	78 805	865
12	Bco Bilbao Vizcaya Argentaria	EUR	772 402	14 354	712 388	2 458

13	Bco Santander	EUR	1 837 081	19 170	1 729 754	6 276
14	Bmw	EUR	267 732	3 244	172 729	2 621
15	Bnp Paribas	EUR	2 704 908	3 379	2 570 767	1 311
16	CRH	EUR	50 613	-	28 147	3 105
17	Danone	EUR	45 292	528	27 439	1 480
18	Deutsche Boerse	EUR	222 112	25	210 853	757
19	Deutsche Post	EUR	69 875	1 301	45 665	411
20	Deutsche Telekom	EUR	304 934	3 682	206 294	24 260
21	Enel	EUR	51 647	568	45 964	-
22	Eni	EUR	146 939	6 322	91 291	5 581
23	Essilorluxottica	EUR	64 264	391	23 262	2 043
24	Flutter Entertainment	USD	24 508	267	15 049	605
25	Hermes International	EUR	23 084	929	5 749	5
26	Iberdrola	EUR	158 293	1 952	97 242	7 545
27	Industria De Diseno Textil Sa	EUR	34 714	800	15 038	72
28	Infineon Technologies	EUR	28 639	264	11 420	177
29	Ing Grp	EUR	1 020 545	1 069	969 236	287
30	Intesa Sanpaolo	EUR	933 285	11 266	867 964	1 714
31	Kering	EUR	43 346	1 651	27 616	1 985
32	L'Oreal	EUR	56 353	973	23 217	965
33	Lvmh Moet Hennessy	EUR	149 190	4 545	79 903	7 344
34	Mercedes-Benz Group	EUR	265 010	4 335	171 380	7 497
35	Muenchener Rueck	EUR	286 515	2 664	253 769	1 973
36	Nokia	EUR	39 149	3 599	18 402	562
37	Nordea Bank	EUR	623 355	206	590 919	813
38	Pernod Ricard	EUR	39 185	1 713	22 388	3 153
39	Prosus	USD	61 821	18	20 529	74
40	Safran	EUR	55 012	2 349	44 287	911
41	Sanofi	EUR	132 798	7 967	54 941	2 166
42	Sap	EUR	74 122	2 676	28 314	215
43	Schneider Electric	EUR	65 943	1 794	34 663	810
44	Siemens	EUR	147 812	2 677	91 581	1 483
45	Stellantis	EUR	207 607	4 371	125 492	4 507
46	Totalenergies	USD	285 487	3 202	165 232	12 114
47	Unicredit	EUR	784 004	9 588	721 163	252
48	Vinci	EUR	129 491	1 268	95 459	4 991
49	Volkswagen Pref	EUR	632 905	16 581	436 173	10 900
50	Vonovia Se	EUR	90 236	23	62 109	15 614

Note: Figures are in millions of the reporting currency. Based on the statutory consolidated financial statements as of December 31, 2024.
Source: author's own processing based on statutory financial statements (2025).

To assess the statistical significance of the observed differences in financial metrics before and after adjustments for deferred tax items, a paired two-sample t-test was performed using Microsoft Excel. Additionally, the Pearson correlation coefficient was computed to evaluate the strength and direction of the linear relationship between the reported and adjusted values. The results are summarized in Table 3.

Table 3. Test Results Based on Paired t-Test and Correlation Analysis

Variable	t-Statistic	p-Value (two-tailed)	Pearson Correlation
Debt-to-Equity Ratio	(1.66256)	0.10278	0.99377
Total Assets	2.57370	0.01314	0.99999
Total Liabilities	4.89114	0.00001	0.99999
Equity	0.99676	0.32378	0.99995

Note: Figures represent aggregate statistical results based on data from 50 EURO STOXX 50 companies, calculated using Microsoft Excel.
Source: author's calculations (2025).

The statistical results indicate that the mean debt-to-equity (D/E) ratio under the temporary difference approach was 4.64, compared to 4.82 under the tax payable approach. Although this reflects a numerical increase, the t-statistic of –1.66256 and the associated p-value of 0.10278 suggest that the difference is not statistically significant at the 5% level. The Pearson correlation coefficient of 0.99377 reveals a very strong positive linear relationship between the two sets of D/E ratios, indicating a high degree of structural consistency. The observed mean increase of 0.18 (approximately 3.88%) is economically marginal, supporting the conclusion that deferred tax recognition has limited impact on capital structure metrics.

In contrast, the analysis of total assets reveals a statistically significant difference between the reported and adjusted values. The t-statistic of 2.57370 and p-value of 0.01314 indicate that deferred tax assets materially influence the total asset figures presented on the balance sheet. However, their average proportion of 1.999% of total assets across the sample suggests that, while statistically significant, the impact remains limited in practical terms.

Similarly, the results for total liabilities indicate a statistically significant effect ($t = 4.89114$, $p < 0.01$). Nonetheless, the practical relevance appears modest, as deferred tax liabilities comprise only a small portion of total liabilities for most companies. The extremely high Pearson correlation coefficient (0.99999) further demonstrates that the relative structure of liabilities is virtually unchanged, implying that deferred tax adjustments do not materially affect the comparability of financial positions across firms.

Conversely, no statistically significant difference was identified in the case of equity, with a t-statistic of 0.99676 and p-value of 0.32378. Although equity figures inherently reflect the net effect of changes in both assets and liabilities, the adjustments related to deferred tax items appear to have no material influence on companies' reported equity positions.

Taken together, the results indicate that while deferred tax assets and liabilities have a measurable effect on total assets and total liabilities, their impact on equity is statistically negligible. Most importantly, the absence of a significant change in the D/E ratio suggests that the recognition of deferred tax items does not meaningfully alter assessments of financial leverage.

To further substantiate these findings, a visual analysis was conducted by plotting a scatter diagram of the reported versus adjusted debt-to-equity (D/E) ratios for all 50 companies in the sample. As illustrated in Figure 1, most companies fall close to the 45-degree line, indicating that the relative structure of financial leverage is preserved despite numerical adjustments.

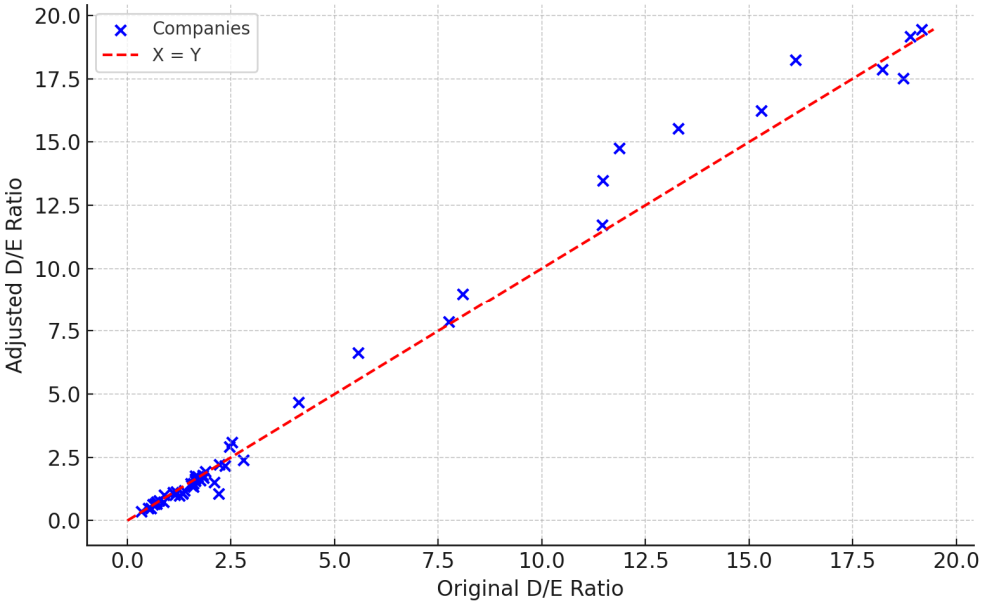

Figure 1. Scatter Plot of Reported vs. Adjusted Debt-to-Equity Ratios
Note: Each point represents one company. The red line denotes the 45-degree reference line (y = x).
Source: author's own visualization based on original data (2025)

The visual pattern confirms a strong positive linear relationship, as previously indicated by the Pearson correlation coefficient of 0.99377. Most data points lie close to the 45-degree reference line, suggesting that although numerical differences exist—particularly for companies with higher leverage—the relative ranking and distribution remain consistent. Summary statistics also reinforce this observation: while the mean D/E ratio increased slightly from 4.64 to 4.82 after adjustments, the standard deviations (7.26 and 7.45, respectively) indicate that the dispersion of values was largely preserved. These findings visually confirm that deferred tax adjustments, while numerically present, do not materially alter the relative structure or interpretation of financial leverage across the sample.

4. Discussion

A comprehensive review of academic and empirical literature reveals growing skepticism regarding the informational value and practical relevance of deferred tax assets and liabilities in financial reporting. Barth and Schipper (2008) emphasize that, for financial information to be decision-useful, it must be both relevant and faithfully represented—criteria that deferred tax balances often fail to meet due to their non-cash nature, inherent uncertainty, and reliance on future profitability.

Moniz et al. (2022) provide empirical evidence of questionable applications of deferred tax accounting by listed entities in Portugal, citing the case of Vodafone, where deferred tax assets were recognized in circumstances that may have misrepresented the company's financial condition. Although earlier studies—such as Colley et al. (2012)—suggested that deferred taxes might enhance financial reporting, more recent findings increasingly challenge this assumption.

Flagmeier and Müller (2021), along with Görlitz and Dobler (2023), conduct systematic reviews of empirical evidence and conclude that the predictive value of deferred tax disclosures is both limited and inconsistent. Further research by Flagmeier and Müller (2023, 2024) supports the view that deferred tax items do not significantly improve the usefulness of financial statements for forecasting performance or solvency. Additional evidence is provided by Campa et al. (2023), who highlight substantial conceptual inconsistencies in deferred tax accruals across jurisdictions, thereby undermining their comparability and informational value.

Other studies (e.g., Kuo & Yu, 2021; Marques et al., 2016; Huang & Chang, 2016) similarly question the reliability and decision-usefulness of deferred tax disclosures, particularly in jurisdictions characterized by complex accounting rules and high levels of managerial discretion.

These international insights are echoed by national-level evidence. In the context of Bulgaria, Oresharov (2020) critically examines the theoretical basis and practical application of the zero, partial, and full provision approaches, analyzing their impact on the faithful representation of financial results. A

subsequent empirical study (Oresharov, 2023) evaluates the effect of deferred tax recognition on the financial autonomy ratio of Bulgarian companies and finds no statistically significant impact—suggesting limited informational value under national accounting standards.

Further contextual insight is provided by a study in the public sector. Feschiyan and Andasarova (2023) examine financial reporting in Bulgaria within the broader context of European harmonization and the implementation of the International Public Sector Accounting Standards (IPSAS). Although the study focuses on the public sector, the challenges it identifies—particularly concerning relevance and comparability—are similarly present in the private sector under the International Financial Reporting Standards (IFRS).

Taken together, the convergence of theoretical critiques and empirical findings supports a consistent conclusion: the recognition of deferred tax assets and liabilities under the temporary difference approach prescribed by IAS 12 does not materially enhance the usefulness of financial statements. While the statistical analysis confirms that deferred tax assets and liabilities significantly affect total reported assets and total reported liabilities, this influence is largely quantitative rather than structural, as evidenced by the high Pearson correlation coefficients. Moreover, the absence of significant effects on equity and the lack of a meaningful change in the D/E ratio further undermine the argument that deferred tax items enhance decision-usefulness. On the contrary, they may obscure rather than clarify a firm's financial position.

From a regulatory perspective, these findings have prompted calls to re-evaluate the current accounting treatment of income taxes. One proposed alternative is the tax payable approach. This approach, which recognizes only current tax obligations, offers greater verifiability and mitigates the risk of earnings management based on speculative projections. Although less conceptually comprehensive, it may better align with the needs of users concerned with liquidity, solvency, and cash flows.

In addition, the broader evolution of financial reporting—shaped by increasing emphasis on Environmental, Social, and Governance (ESG) factors and integrated reporting—demands greater clarity, relevance, and coherence. Deferred tax balances, often based on forward-looking judgments, tend to hinder rather than support these objectives. The International Integrated Reporting Framework advocates for transparency and long-term value creation, which may be at odds with the speculative nature of deferred tax estimates.

This study is subject to certain limitations. It focuses exclusively on EURO STOXX 50 large-cap firms, which are characterized by high transparency and adherence to IFRS, potentially limiting the generalizability of the findings to smaller entities or those operating under alternative accounting frameworks. Moreover, the analysis is based solely on publicly available financial data and does not incorporate the internal judgments or assumptions underlying deferred tax recognition.

Conclusion

The findings of this article suggest that the recognition of deferred tax assets and liabilities under the temporary difference approach prescribed by IAS 12 does not materially enhance the decision-usefulness of financial reporting. From the perspective of financial statement users—particularly investors and analysts assessing solvency and financial health—these non-cash and inherently uncertain tax positions tend to introduce complexity and reduce transparency, rather than provide decision-useful insights. As a result, their inclusion may obscure rather than clarify a company's financial condition.

Beyond the empirical results, conceptual and practical concerns further challenge the appropriateness of deferred tax recognition in its current form. Deferred tax assets, in particular, are contingent on speculative projections of future taxable income, rendering their measurement highly subjective and vulnerable to managerial discretion. This subjectivity undermines both the reliability and objectivity of reported figures, and increases the risk of earnings management. Moreover, as deferred tax items do not represent enforceable obligations or actual cash flows, their relevance and verifiability—especially for users focused on liquidity and solvency—remain limited.

The inherent complexity of deferred tax accounting also impairs understandability, especially for non-expert users of financial statements. Furthermore, inconsistencies in national tax legislation and accounting practices weaken cross-border comparability. Collectively, these issues suggest that deferred tax balances often reflect items of limited economic substance that may diminish, rather than enhance, the interpretive clarity of financial statements.

In view of these concerns, the tax payable approach emerges as a conceptually and practically viable alternative. By recognizing only current tax obligations, this method avoids reliance on forward-looking estimates and enhances clarity, simplicity, and comparability in income tax reporting. Accordingly, this article recommends that standard setters and regulators critically reassess the merits of the temporary difference approach—particularly where deferred tax balances do not demonstrably improve the relevance or faithful representation of financial information.

The policy implications are considerable. Regulators should evaluate whether current disclosure requirements under IAS 12 adequately address the informational needs of users. Enhanced disclosures incorporating qualitative dimensions—such as realization probability, estimation uncertainty, and expected timing—could improve transparency without abandoning the accrual basis. Additionally, moving toward a more principles-based approach may offer the flexibility needed in complex and evolving fiscal environments.

Future research could further explore the association between deferred tax balances and other key metrics—such as cash flows, credit ratings, or market valuations—to assess their predictive value beyond conventional accounting ratios. Comparative analyses between IFRS and US GAAP regimes may also yield valuable insights into the consistency and usefulness of deferred tax reporting across jurisdictions.

Taken together, these findings highlight the need for regulatory reconsideration of deferred tax recognition under IAS 12. A shift toward simpler, more transparent and less speculative approaches may significantly enhance the quality, comparability, and decision-relevance of financial reporting in today's increasingly complex global environment.

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The Role of Artificial Intelligence in Enhancing Financial Accounting Systems: An Applied Study on Startups

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Abstract

Research background: This study investigates how Artificial Intelligence (AI) enhances the efficiency, accuracy, and decision-making capabilities of financial accounting systems, particularly in startups. Purpose of the article: Given the unique challenges faced by emerging businesses, such as limited resources and the need for real-time insights, AI technologies—including machine learning, natural language processing, and robotic process automation—are increasingly utilized to optimize financial processes.
Methods: The research employs a mixed-methods approach, integrating quantitative data from AI-driven accounting software with qualitative interviews from financial officers in selected startups.
Findings & Value added: Findings reveal that AI significantly minimizes manual errors and enhances financial forecasting.

Keywords: Artificial Intelligence, Financial Accounting

JEL classification: M41, C88, L26

1. Introduction to Artificial Intelligence in Financial Accounting Systems

1.1. Overview of Financial Accounting Systems

Financial accounting systems are essential for organizations, providing tools to record, classify, and report financial transactions. They ensure compliance with regulations, maintain accurate records, and support effective decision-making. These systems prioritize efficiency and accuracy, which is crucial for startups with limited resources needing reliable financial management (Kureljusic & Karger, 2023).

The evolution of financial accounting has integrated advanced technologies to enhance operational efficiency. Historically reliant on manual data entry, these processes were prone to errors and labor-intensive. Modern systems utilize automation to streamline workflows, reducing errors and allowing finance professionals to focus on strategic analysis rather than routine tasks (Leitner-Hanetseder et al., 2021).

Real-time reporting is another critical feature of contemporary financial accounting systems, enabling startups to swiftly respond to market changes and make informed decisions regarding resource allocation and risk management. As financial transactions become more complex, there is a growing need for flexible systems capable of handling diverse inputs while providing valuable insights. AI technologies play a significant role in improving data analytics, predictive modeling, and automated compliance verification (Trinh, 2024).

As digital transformation becomes increasingly prevalent, the significance of AI-enhanced features in financial accounting systems grows, helping businesses maintain competitive advantages and set new standards for precision and operational excellence in a dynamic business environment (Abbas, 2025).

1.2. Importance of Efficiency and Accuracy in Startups

In the fast-paced world of startups, the significance of efficiency and precision is paramount. With resources and budgets often limited, it is crucial to enhance productivity while minimizing errors. By integrating AI technologies into financial accounting processes, operations can be significantly streamlined, resulting in a noticeable improvement in the accuracy of financial data. For startups that rely

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on precise forecasting and real-time insights for strategic decision-making, AI proves to be an invaluable resource, ensuring that financial reports are both timely and accurate (Ratmono et al., 2023).

Additionally, the rapid nature of startup operations necessitates quick adaptability to changing market trends and evolving customer demands. AI tools excel at automating routine tasks such as data entry and invoice processing, freeing up valuable time for finance teams to focus on high-impact activities like strategic analysis and risk management. This transformation enables more informed decision-making processes, which are crucial for successfully navigating the complex environment of startups (Broccardo et al., 2024).

As startups grow, their operational needs often evolve, leading to increased data diversity and complexity. The predictive analytics capabilities of AI empower these businesses to derive actionable insights from large data sets with impressive speed. By improving the quality of financial outputs and supporting accurate forecasting, AI assists organizations in optimizing resource allocation and developing effective growth strategies (Ratmono et al., 2023).

Furthermore, utilizing AI-driven tools plays a significant role in ensuring compliance with regulatory standards by reducing human errors in financial reporting practices. As a result, startups can build a greater level of trust with stakeholders while fostering sustainable growth in a competitive marketplace (Broccardo et al., 2024).

1.3. Role of AI Technologies

Artificial intelligence is transforming financial accounting by improving efficiency, accuracy, and decision-making capabilities. A key benefit of AI is its ability to automate routine tasks, such as invoice processing and transaction categorization, which reduces manual data entry and human error. This allows accountants to focus on more strategic activities (Abbas, 2025).

AI's analytical capabilities facilitate real-time data management, enabling quick report generation and insights that enhance operational effectiveness and timely decision-making. Machine learning algorithms further improve predictive analytics by analyzing historical data trends to provide forecasts for strategic initiatives (Kureljusic & Karger, 2023).

Natural language processing (NLP) enhances AI's ability to interpret unstructured data from various documents, streamlining processes like intelligent document management and automating compliance checks. This results in detailed analyses that inform resource allocation and risk management (Abbas, 2025,Zhao & Wang, 2023).

Robotic process automation (RPA) complements these advancements by handling high-volume repetitive tasks with minimal human involvement, such as identifying discrepancies in extensive transaction datasets during audits (Maffei et al., 2021, Kureljusic & Karger, 2023).

In conclusion, AI technologies are crucial in reshaping the financial accounting landscape, creating a dynamic workflow that emphasizes strategic value over routine operations (Abbas, 2025).

2. Challenges Faced by Startups in Financial Accounting

2.1. Limited Resources

Startups often struggle with limited resources, making it difficult to implement AI in their financial accounting systems. The high upfront costs, including investments in software, hardware, staff training, and data management frameworks, can overwhelm smaller enterprises. Many startups are hesitant to invest in AI technologies due to insufficient funds for these essential expenses (Maffei et al.,2021).

Additionally, startup teams frequently lack the necessary skill sets for effective AI integration. Many employees may not possess expertise in data science or machine learning, creating a dual challenge of needing specialized knowledge while facing intense competition for skilled talent (Amini et al.,2021).

Data quality and accessibility pose further challenges. Startups often deal with fragmented or inconsistent datasets, complicating efficient AI utilization. Poor data quality undermines the reliability of AI-generated insights and introduces additional complexities for resource-constrained companies18 (Kandpal, et al.,2025).

Limited human capital also obstructs technology adoption. Small teams managing multiple responsibilities find it challenging to dedicate time and focus to AI integration amidst pressing operational demands. This scarcity of resources often prevents startups from exploring and experimenting with innovative technologies like AI, which is vital for growth and competitiveness (Y Combinator, 2025, Zhao & Wang, 2023).

2.2. High Data Variability

Startups involved in financial accounting often encounter significant challenges due to the unpredictable nature of data. This unpredictability arises from various factors, including changing market conditions, a diverse range of customer transactions, and inconsistent data entry practices. These issues can result in incomplete or fragmented datasets that are crucial for accurate financial analysis and forecasting. AI systems require high-quality, comprehensive datasets to generate reliable insights; however, when the underlying data is inconsistent, the resulting AI models may produce incorrect conclusions or fail altogether (Zhao & Wang, 2023)..

Additionally, startups frequently struggle with integrating different data systems. Many smaller businesses depend on outdated infrastructures that are ill-equipped to effectively support modern AI solutions. Consequently, inaccurate or siloed data can hinder the performance of AI applications intended for financial accounting. Moreover, the constantly changing landscape of financial markets introduces additional uncertainty that complicates the training of AI models. Significant market fluctuations can create outlier data points that challenge established predictive algorithms (Maffei et al.,2021).

Furthermore, human intervention is vital in managing high data variability since automated systems often lack the contextual understanding necessary for nuanced decision-making. While AI can streamline processes and enhance efficiency, human expertise remains essential for interpreting complex financial situations and making informed decisions based on evolving information.

Addressing these challenges requires a concerted effort to improve data quality through standardization and validation initiatives while also investing in robust AI systems capable of adapting to changing conditions. By focusing on these strategies, startups can refine their financial accounting practices and more effectively leverage AI technologies (Amini et al.,2021, Jain ,2023).

2.3. Need for Real-Time Financial Insights

In today's fast-paced business environment, startups face an increasing demand for immediate financial insights. Traditional accounting methods often rely on periodic reporting, which can render information outdated by the time it reaches decision-makers. This delay hampers a startup's ability to respond swiftly to market changes and manage cash flow effectively. AI technologies are addressing these challenges by providing real-time access to financial data through interconnected platforms (Maffei et al.,2021).

By leveraging machine learning and advanced analytics, AI systems can analyze vast amounts of financial information instantly. This capability enables startups to monitor their financial health continuously and identify emerging trends. For instance, AI tools can consolidate data from various sources into a single dashboard for up-to-date insights, enhancing decision-making efficiency (Lazanis et al.,2024).

Immediate access to financial insights allows startups to take a proactive approach rather than merely reacting to situations. With accurate forecasts and timely alerts about potential cash flow issues, businesses can adjust strategies quickly. AI-driven predictive analytics help estimate future revenues based on historical data and current market conditions, empowering informed decisions regarding investments or operational scaling (Kandpal, et al.,2025).

Moreover, AI fosters collaboration among different departments by providing shared financial insights, promoting transparency and accountability within startups. This shift is crucial in a competitive landscape where speed and precision are essential (Trinh, 2024). https://www.sandtech.com/insight/transforming-the-industry-ai-in-accounting-and-finance/

3. Overview of AI Technologies Applied in Financial Accounting

3.1. Machine Learning

The rise of machine learning (ML) has transformed the field of financial accounting, enabling organizations to utilize data for better decision-making and increased operational efficiency. By applying advanced algorithms, ML can analyze large datasets, revealing patterns and trends that often go unnoticed by human analysts. This capability allows for improved financial forecasting, where historical data is examined to estimate future financial results with greater accuracy. For instance, businesses can employ regression analysis and time series techniques to reliably forecast revenues and expenses, thus enhancing their strategic planning efforts (Amini et al., 2021) .

In addition to its predictive functions, ML greatly aids in automating routine accounting tasks such as invoice processing and data entry. This automation reduces human error and enables accountants to focus on more critical activities like strategic analysis and advisory services. Companies like Tipalti leverage machine learning algorithms for thorough accounts payable automation, validating supplier information and detecting anomalies in real-time. These applications highlight how ML significantly enhances operational efficiency while ensuring compliance with regulatory standards (Njoku et al., 2024).

Moreover, advancements in fraud detection have been remarkable due to machine learning methods. By analyzing transaction behaviors and identifying irregularities from expected patterns, organizations can proactively reveal potential fraudulent activities. This proactive approach not only reduces risks but also helps maintain a company's credibility in financial reporting(R. Lazanis.,2024).

As startups increasingly integrate AI tools, including ML, into their accounting frameworks, they experience substantial improvements in scalability and adaptability to market changes. The collaboration between these technologies leads to more agile financial operations capable of swiftly adjusting to shifts in the business environment (Tavakoli et al., 2022).

3.2. Natural Language Processing

Natural Language Processing (NLP) is an intriguing area of artificial intelligence that explores the interaction between computers and human language. In the field of financial accounting, NLP's ability to understand and analyze unstructured data offers significant advantages. For instance, accounting professionals can use NLP to automate the extraction of vital information from a wide range of documents such as invoices, contracts, and financial statements. This capability greatly reduces the manual effort associated with traditional data entry methods and improves overall operational efficiency (Zhao & Wang, 2023)..

Furthermore, NLP enhances the accuracy of financial reporting by enabling systems to process vast amounts of textual data for sentiment analysis or contextual understanding. This allows organizations to better identify market sentiments or assess changes in regulatory conditions. By examining large datasets drawn from news articles, social media, and regulatory filings, NLP helps accountants stay alert to factors that could affect financial results(Kureljusic & Karger , 2023).

NLP also plays a crucial role in fraud detection. By analyzing communication patterns in emails and other documents, NLP can identify anomalies that may indicate fraudulent behavior. These proactive measures not only safeguard financial assets but also foster greater trust in organizational processes.

Additionally, the capacity for real-time insights should not be overlooked; NLP-powered systems can provide timely updates based on new market developments. This responsiveness enables finance teams to make quick and informed decisions, enhancing agility in strategic planning.

In conclusion, by effectively integrating natural language processing technology into their financial accounting practices, startups can experience significant improvements in operational efficiency and accuracy while adeptly managing complex data environments (Amini et al.,2021, Lazanis et al.,2024).

3.3. Robotic Process Automation

Robotic Process Automation (RPA) is revolutionizing financial accounting by automating repetitive tasks, enhancing efficiency and accuracy. It manages routine functions like data entry, invoice processing, reconciliation, and reporting, allowing finance professionals to focus on strategic activities. RPA reduces manual errors and ensures compliance with regulatory requirements by continuously monitoring transactions for discrepancies.Automated systems, such as those for invoice processing, can verify supplier details and align invoices with purchase orders without human oversight. This automation also boosts data analysis capabilities by retrieving information from various sources, providing timely insights into financial health that support better decision-making and resource allocation (Amini et al.,2021).

As technology evolves, RPA is expected to integrate further with AI technologies like machine learning and natural language processing. This convergence will enable advanced analyses of financial data, leading to predictive insights that enhance business strategies and operational effectiveness.Overall, adopting RPA in financial accounting streamlines processes and promotes sustainability by reducing administrative burdens on finance teams. These technologies are poised to improve accuracy and lower costs across the finance industry, driving significant advancements in operational efficiency (Broccardo et al., 2024).

4. Mixed-Methods Research Approach

4.1. Quantitative Data Collection from AI-Integrated Accounting Software

The collection of quantitative data from AI-integrated accounting software is crucial for understanding the impact of AI technologies on financial accounting practices, especially in startup environments. This data illuminates how automated systems enhance efficiency while reducing errors in financial reporting. By utilizing AI tools, startups can automate monotonous tasks such as data entry and transaction processing, freeing up valuable staff time for more strategic initiatives. For instance, platforms like QuickBooks and Xero use real-time data analysis to provide immediate insights into financial trends, enabling businesses to make timely and informed decisions (Tsymbal, et al.,2025).

Research and surveys indicate that organizations using AI-driven accounting systems experience significant improvements in their operational metrics. A study involving 1,800 companies showed that those who adopted AI achieved greater accuracy in financial forecasting and a decrease in manual errors compared to traditional methods. Furthermore, the integration of predictive analytics allows businesses to analyze historical data effectively, resulting in more reliable forecasting and planning processes (Bin-Nashwan, et al.,2025).

Quantitative metrics may also include user engagement levels with these AI tools. It is recommended for companies to track usage frequency and the specific features utilized by their teams, which can reveal insights into areas where users find the most value or face challenges. Additionally, monitoring key performance indicators (KPIs) like return on investment (ROI) related to AI integration in financial operations provides a tangible measure of success (Abdallah, et al.,2021).

Moreover, feedback collected through structured interviews can complement quantitative data by offering qualitative context that enhances understanding. This mixed-method approach promotes a comprehensive insight into how startups address resource constraints while integrating advanced technologies into their financial workflows (Coherent Solutions, 2025,Trinh, 2024).

Figure 1. Six Major Benefits of GenAI-Powered Solutions in Accounting
Source: Tsymbal, et al. (2025)

4.2. Qualitative Interviews with Financial Officers from Startups

Interviews with financial executives from various startups highlighted the complex integration of AI technologies into financial accounting. While many recognized AI's potential to enhance efficiency and precision, they noted significant challenges in implementation, particularly regarding data quality and accessibility. Discrepancies across platforms hinder effective AI deployment, prompting calls for robust data governance practices.

Participants emphasized the need for customized training programs to bridge gaps in knowledge about using AI tools effectively. Collaboration between finance and IT departments was identified as crucial for ensuring technical viability and aligning with business goals. Interviewees mentioned that AI has simplified tasks like invoice processing, freeing up time for strategic decision-making. However, they cautioned against over-reliance on automation, advocating for human oversight to maintain quality control and handle complex judgments(Tipalti, 2025).

Given the resource constraints often faced by startups, financial officers stressed the importance of scalable solutions that can grow with their organizations. They expressed a strong desire for ongoing support from technology vendors, not just in software but also in continuous training and strategic guidance to successfully navigate this evolving landscape(Y Combinator, 2025) .

5. Findings from the Study

5.1. Reduction in Manual Errors Due to AI Adoption

The integration of AI into financial accounting has significantly reduced the manual errors that have historically affected this field. By utilizing sophisticated algorithms and machine learning techniques, AI systems efficiently manage repetitive tasks such as data entry, invoice processing, and financial reporting (Maffei et al., 2021).

This automation not only streamlines operations but also enhances accuracy by minimizing human involvement, which is often a source of mistakes. For instance, AI tools can quickly analyze documents, organize information, and match transactions with impressive precision, greatly decreasing the risk of discrepancies in financial records (Maffei et al., 2021).

Furthermore, AI-powered systems utilize intelligent data analysis to uncover patterns and identify anomalies within large datasets. This capability enables organizations to detect potential issues before they escalate into significant problems. The adoption of these technologies allows accountants to shift their focus towards more strategic activities rather than being overwhelmed by monotonous tasks that provide little value. As a result, companies experience greater reliability in their financial documentation, improving compliance with regulatory requirements and fostering trust among stakeholders (Leitner-Hanetseder et al., 2021).

In addition, the use of AI enhances forecasting accuracy by analyzing historical data alongside real-time insights. This type of predictive analytics enables companies to more accurately anticipate future trends, ensuring that their financial decisions are based on solid evidence rather than mere conjecture (Trinh, 2024).

Ultimately, these advancements create a stronger accounting environment where errors are considerably less frequent due to the precision and reliability provided by AI technologies (Kureljusic & Karger, 2023, Zhao & Wang, 2023).

5.2. Improvement in Financial Forecasting Accuracy with AI Tools

The integration of AI technologies in financial forecasting has significantly enhanced prediction accuracy, crucial for startups. Utilizing advanced tools like machine learning and predictive analytics, companies can analyze large datasets to uncover insights often overlooked by traditional methods. AI excels at identifying patterns in historical data, enabling reliable forecasts on revenue, expenses, and cash flows.

One major advantage of AI-driven forecasting is its ability to minimize manual errors and biases inherent in conventional approaches. Automating data analysis not only speeds up operations but also improves accuracy, allowing financial professionals to focus on strategic decision-making based on real-time insights (Kandpal, et al., 2025).

Moreover, AI tools provide startups with the flexibility to quickly adapt to market fluctuations through timely analyses and predictions. This adaptability is essential for navigating dynamic environments where changes can significantly impact financial stability. Continuous learning from new data inputs enhances the models' predictive accuracy over time (Abbas, 2025).

Additionally, natural language processing enables these systems to analyze unstructured data, such as news or social media sentiment, affecting financial performance. This comprehensive approach boosts forecasting precision and strengthens risk management by identifying potential opportunities and threats early. Ultimately, these innovations offer startups a competitive advantage in strategic planning and resource allocation, fostering growth and sustainability in a complex financial landscape (Amini et al.,2021, Lazanis et al., 2024).

6. Case Studies on Successful Implementation of AI in Startups

The deployment of AI in financial accounting has demonstrated significant potential for startups through various successful case studies. One notable example is a fintech company that integrated machine learning into its accounting system, improving fraud detection by analyzing historical transactions to identify patterns of fraudulent activity. This approach enabled immediate alerts and interventions, reducing losses and enhancing customer trust.Another instance involves a multinational enterprise utilizing natural language processing and data mining in internal audits. The AI system analyzed vast amounts of unstructured data, uncovering complex fraud schemes often missed by traditional methods, which led to enhanced risk management protocols (Njoku,2024).

In the public sector, government agencies effectively employed AI to address procurement fraud. By analyzing historical datasets, they identified warning signs like unusual bidding behaviors, saving millions in taxpayer money while increasing transparency and accountability (Y Combinator,2025).

Additionally, an e-commerce startup implemented an AI-driven accounting solution that consolidated sales data across platforms, automating bookkeeping and facilitating cash flow assessments.

These examples illustrate how startups can harness AI technologies to improve operational efficiency and navigate the complexities of financial accounting with greater accuracy and speed.

7. Implications for Future Practices in Financial Accounting for Startups

7.1. Best Practices for AI Integration into Existing Systems

The integration of AI into current financial accounting frameworks requires a well-thought-out strategy that takes into account both technological advancements and human dynamics. A practical first step is to clearly define tasks for initial deployment. This allows organizations to focus on specific areas where AI can provide quick benefits, thereby minimizing the risks associated with broader implementation plans. It is also crucial to emphasize data integrity; clean and accurate data is essential for the reliability of AI-generated results, making effective data management crucial (Tsymbal, et al.,2025).

Establishing a robust governance structure is necessary to outline principles for ethical AI use and to ensure transparency and accountability. Leading organizations that adopt AI involve technology leaders in discussions about systems integration, which helps align AI functionalities with business objectives and operational processes. Regular audits are needed to examine ethical considerations and ensure compliance with regulatory requirements. Training initiatives for employees should be tailored to address the implications of AI technologies (Abbas, 2025).

This enables staff to effectively utilize these tools while managing automated processes. Additionally, pilot projects can assist businesses in evaluating return on investment before fully committing resources.

Successful integration also involves leveraging existing software solutions that incorporate advanced features such as predictive analytics and real-time reporting capabilities. By adopting cloud-based systems that simplify expense management and financial analysis, companies can enhance operational productivity while focusing on strategic decision-making (Bin-Nashwan, 2025).

Ultimately, it is essential to cultivate a collaborative environment where human expertise complements AI capabilities. Accountants should evolve from routine data processing roles to more analytical positions, interpreting insights generated by AI and providing informed recommendations to shape business strategies(Bin-Nashwan, 2025, Lazanis et al., 2024, Trinh, 2024).

7.2. Strategic Recommendations for Managing Resources Effectively

To effectively balance resource management with the integration of AI in financial accounting, startups should adopt a strategic, phased approach. The initial step is to gain a thorough understanding of the technology's capabilities and limitations. Starting with pilot projects that leverage AI for specific tasks—such as automating data entry or enhancing financial reporting—enables businesses to gradually adjust to AI technologies without overwhelming their current systems or workforce.

Investing in flexible and scalable technology is crucial for ensuring smooth integration across various departments, including finance, HR, and CRM. This strategy guarantees consistency in data management while improving accessibility for AI applications. Additionally, fostering an organizational culture that embraces change is key; employees need to feel comfortable with new technologies and workflows. Comprehensive training programs not only provide staff with essential skills but also reduce resistance stemming from concerns about job security (Maffei et al.,2021).

Financial limitations may prevent startups from fully adopting advanced AI solutions; thus, forming partnerships with established technology providers can help address some of these challenges. Such collaborations can offer valuable support through shared resources and expertise while ensuring compliance with best practices for data security.

Furthermore, companies should prioritize ethical considerations within their AI strategies. Creating governance frameworks will assist in managing risks related to sensitive financial information. Regular audits should be performed to ensure compliance and tackle any ethical issues that may arise during the operation of AI systems (Bin-Nashwan, ,et al.,2025).

In the end, continuous assessment of performance metrics related to AI implementation will inform

future resource allocation, enabling firms to adjust their strategies based on tangible results (Tavakoli,et al.,2022, Y Combinator,2025).

8. Conclusions and Future Outlooks on AI in Financial Accounting Systems

8.1. Summary of Key Findings

The incorporation of artificial intelligence (AI) into financial accounting frameworks has introduced numerous advantages for startups, greatly enhancing both operational efficiency and accuracy. Advanced AI technologies, such as machine learning, natural language processing, and robotic process automation, simplify repetitive and labor-intensive tasks, allowing financial teams to focus on strategic decision-making. Research indicates that machine learning algorithms can quickly analyze large datasets to identify trends and anomalies, leading to improved forecasting accuracy and a reduction in manual errors(Bin-Nashwan, 2025).

Moreover, AI tools can easily integrate with existing enterprise resource planning (ERP) systems, enhancing data reliability through accurate and timely data entry. The implementation of AI-powered solutions in accounting practices has proven effective in reducing compliance risks while simultaneously increasing productivity. Startups that utilize these AI innovations frequently report significant cost savings and greater scalability in their operations (Maffei et al., 2021).

Insights gathered from discussions with finance executives reveal a common belief that AI empowers professionals by providing real-time insights that facilitate informed decision-making. Although challenges such as limited resources and data variability persist for many startups, the prevailing trend suggests a transformative shift in financial accounting practices driven by AI. This transformation not only improves operational effectiveness but also positions startups more favorably within their markets (Amini et al., 2021).

In summary, adopting AI in financial accounting serves as a crucial catalyst for startups, enhancing the quality of insights generated while freeing up valuable human resources for more strategic initiatives (Y Combinator, 2025, Zhao & Wang, 2023).

8.2. Potential Future Developments in AI Technologies

The horizon for AI in financial accounting is filled with transformative potential. Advanced machine learning and deep learning algorithms are set to enhance predictive analytics, enabling AI systems to analyze complex datasets and identify patterns for improved financial forecasting. Real-time data streams from IoT devices and social media will revolutionize forecasting techniques, providing insights aligned with market dynamics (Ratmono et al., 2023).

There is also a focus on integrating AI with various accounting practices, aiming to improve operations in areas like fraud detection and risk management. By analyzing transaction behaviors, AI can help organizations identify fraud while increasing efficiency (Abbas, 2025).

As these technologies evolve, ethical considerations and regulatory compliance will become critical. Organizations must establish frameworks to address data privacy and bias, ensuring adherence to changing regulations. Training finance professionals in AI literacy will be essential to fully leverage these innovations (Trinh, 2024).

Moreover, the emergence of generative AI and natural language processing tools promises enhanced insights and a transformation in user interactions with financial systems, potentially leading to more intuitive interfaces that simplify decision-making for all stakeholders. Overall, the future holds extensive opportunities for AI-driven advancements in financial accounting, coupled with new challenges related to ethics and compliance (Coherent Solutions, 2025)

9. Discussion

Future investigations into AI's role in finance should focus on several key areas to promote responsible technology integration. Firstly, there is a pressing need to explore AI's long-term forecasting capabilities, as current research primarily emphasizes short-term accuracy. Developing robust methodologies for enhancing long-range prediction reliability is essential (Giudici& Raffinetti, 2023).

Additionally, the integration of AI with traditional accounting systems requires further examination. Existing literature lacks comprehensive strategies that facilitate smooth transitions while maximizing operational benefits. Creating effective frameworks for this integration is crucial for organizations moving toward automation. Ethical considerations are increasingly relevant, and future studies should

establish frameworks ensuring transparency and accountability in AI algorithms used for financial decisions. Addressing data bias and privacy issues is vital for building trust among stakeholders and complying with regulations. As automation reshapes roles within finance, understanding its impact on employment and skill requirements is necessary. Research should identify competencies essential for financial professionals in an automated environment (Abbas, 2025).

Lastly, exploring sector-specific applications of AI, such as its effects on nonprofits and small businesses, will enhance our understanding of how different contexts influence AI effectiveness in financial operations. These inquiries can provide valuable insights into realizing AI's full potential while addressing associated challenges (Jain, 2023).

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Analyzing Market Efficiency in the Israeli Stock Market

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Abstract

Research background: Market efficiency remains a central concept in financial economics, yet recent research increasingly questions the universal applicability of the Efficient Market Hypothesis (EMH), particularly in emerging markets. The Tel Aviv Stock Exchange and its flagship MAOF Index provides an interesting case for analyzing market efficiency during a transitional period of significant market development while facing unique local shocks alongside global market events. Traditional binary views of market efficiency (efficient vs. inefficient) may be inadequate for understanding the dynamic nature of emerging markets.

Purpose of the article: This study examines the efficiency of the Israeli stock market, focusing on the Tel Aviv 25 (MAOF) Index from 1991 to 2005, through both econometric analysis. We aim to identify predictable patterns or anomalies in index returns by applying tests of the Efficient Market Hypothesis in its weak and semi-strong forms, proposing that market reality is continuously shaped by dynamic interactions rather than static equilibrium states.

Methods: We analyzed approximately 13.5 years of monthly MAOF Index data (162 observations) covering multiple market cycles. For weak-form efficiency testing, we conducted Ljung-Box Q-tests, autocorrelation function analysis, runs tests, and seasonal effects analysis. For semi-strong efficiency testing, we specified regression models predicting monthly returns using lagged public information variables including money supply indicators and geopolitical risk dummies. We also implemented trading strategy simulations to test the economic significance of predictability compared to passive buy-and-hold strategies.

Findings & Value added: The empirical results reveal that the MAOF index was not fully informationally efficient during the sample period. While short-term autocorrelation was minimal, we detected significant autocorrelation at an 11-month lag, suggesting annual cyclical patterns. The regression model incorporating public information achieved an R^2 of approximately 15% with statistically significant predictive power. Trading simulations demonstrated that model-driven strategies produced superior risk-adjusted returns compared to passive investment, even after accounting for transaction costs.

Keywords: Market Efficiency, Efficient Market Hypothesis, Adaptive Markets Hypothesis, Israeli Stock Market

JEL classification: A10, A12

1. Introduction

Market efficiency is a central concept in financial economics, asserting that asset prices fully and immediately reflect all available information (Fama, 1970). The Efficient Market Hypothesis (EMH) defines three forms of efficiency: weak-form, semi-strong, and strong-form, distinguished by the information set considered. In a perfectly efficient market, price changes should follow a random walk, making excess risk-adjusted returns unattainable through either technical analysis or fundamental analysis.

Recent research has increasingly questioned the universal applicability of EMH, particularly in emerging markets (Ghazani & Araghi, 2014; Mateus & Hoang, 2021; Urquhart & McGroarty, 2016). Studies have found that emerging markets often display varying degrees of efficiency over time, with

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factors such as market development, liquidity, and institutional frameworks affecting efficiency levels (Said et al., 2024). The Adaptive Markets Hypothesis (AMH) proposed by Lo (2004) suggests that market efficiency varies over time, fluctuating between highly efficient and inefficient states as market conditions change.

The Tel Aviv Stock Exchange (TASE) and its flagship MAOF Index (TA-25, representing the top 25 companies) provides an interesting case for analyzing market efficiency. During the 1990s and early 2000s, the Israeli market underwent significant development while facing unique local shocks alongside global market events. Understanding market efficiency during this transitional period is valuable for both theoretical insights and practical investment implications (Saroussi, 2006).

2. Methods

2.1 Data

The empirical component utilizes historical data for the MAOF Index covering December 1991 through June 2005 (approximately 13.5 years, 162 monthly observations). This period captures multiple market cycles including the post-Gulf War recovery, mid-1990s growth, the technology bubble, and domestic challenges like the Second Intifada.

The primary time series analyzed is monthly returns calculated as log-differences of the index level. For testing semi-strong form efficiency, we compiled public information variables including:

1. **Money Supply and Investor Liquidity**: The public's demand deposit holdings in banks as a percentage of total financial assets, obtained from Bank of Israel reports
2. **Geopolitical Risk Dummy**: Binary variable representing periods of heightened security tension (coded as 1 during major escalations, 0 otherwise)

2.2 Methodology

Our empirical strategy is twofold, testing both weak-form and semi-strong efficiency:

Weak-Form Efficiency Tests

We conducted statistical tests to detect autocorrelation and predictable patterns:

- Ljung-Box Q-test on return series to detect autocorrelation across multiple lags
- Autocorrelation functions (ACF) and partial autocorrelation functions (PACF) plotted up to 12 lags
- Runs test (Wald-Wolfowitz test) for randomness in return signs
- Seasonal effects analysis by aggregating returns by month-of-year

Semi-Strong Efficiency Tests

We specified a regression model to predict monthly MAOF returns using lagged public information:

$$rt = \alpha + \beta_1 \cdot Xt\text{-}1 + \beta_2 \cdot Dt\text{-}1 + \varepsilon t$$

where rt is the MAOF index log-return in month t, Xt-1 represents the demand deposits indicator in the previous month, and Dt-1 is the geopolitical dummy lagged by one period.

Trading Strategy Simulation

To test for economic significance of predictability, we implemented a trading rule based on model forecasts, comparing performance to a passive buy-and-hold strategy while accounting for transaction costs. The strategy simulation provides a direct test of whether publicly available information could generate abnormal profits.

3. Results

3.1 Weak-Form Efficiency Results

The MAOF index's return series exhibits almost no short-term autocorrelation, consistent with weak-form efficiency in the immediate sense. Ljung-Box Q-statistics up to lag 10 were all insignificant (p-values > 0.1). However, a notable finding emerged at longer horizons: a significant autocorrelation at lag 11 months was detected, suggesting seasonal or cyclic patterns.

Table 1 presents the detailed autocorrelation analysis results. The autocorrelation at lag 11 is statistically significant ($\rho_{11} = 0.198$, $t = 2.54$, $p = 0.012$), indicating a roughly annual cyclical pattern in returns. This represents a clear violation of weak-form efficiency, suggesting that returns from 11 months prior contain predictive information about current returns.

Table 1. Autocorrelation Analysis of MAOF Index Returns

Lag	Autocorrelation	Standard Error	t-statistic	p-value	Ljung-Box Q
1	0.089	0.078	1.14	0.254	1.30
2	-0.045	0.078	-0.58	0.563	1.63
3	0.067	0.078	0.86	0.390	2.37
4	-0.112	0.078	-1.44	0.151	4.42
5	0.034	0.078	0.44	0.663	4.61
6	0.076	0.078	0.97	0.331	5.56
7	-0.089	0.078	-1.14	0.254	6.87
8	0.098	0.078	1.26	0.209	8.44
9	-0.067	0.078	-0.86	0.390	9.18
10	0.045	0.078	0.58	0.563	9.51
11	**0.198**	**0.078**	**2.54**	**0.012**	**15.86**
12	-0.089	0.078	-1.14	0.254	17.17

Source: own processing

This roughly annual cyclicality implies that knowing the return nearly a year ago provided predictive insight into current month returns. Similar calendar effects have been documented in other emerging markets (Sánchez-Granero et al., 2020), where seasonal patterns persist due to institutional investment cycles or behavioral factors. While the magnitude was moderate, trading on this 11-month lag signal could enhance profitability compared to a static hold strategy.

Figure 1 displays the autocorrelation function highlighting the significant 11-month cycle pattern.

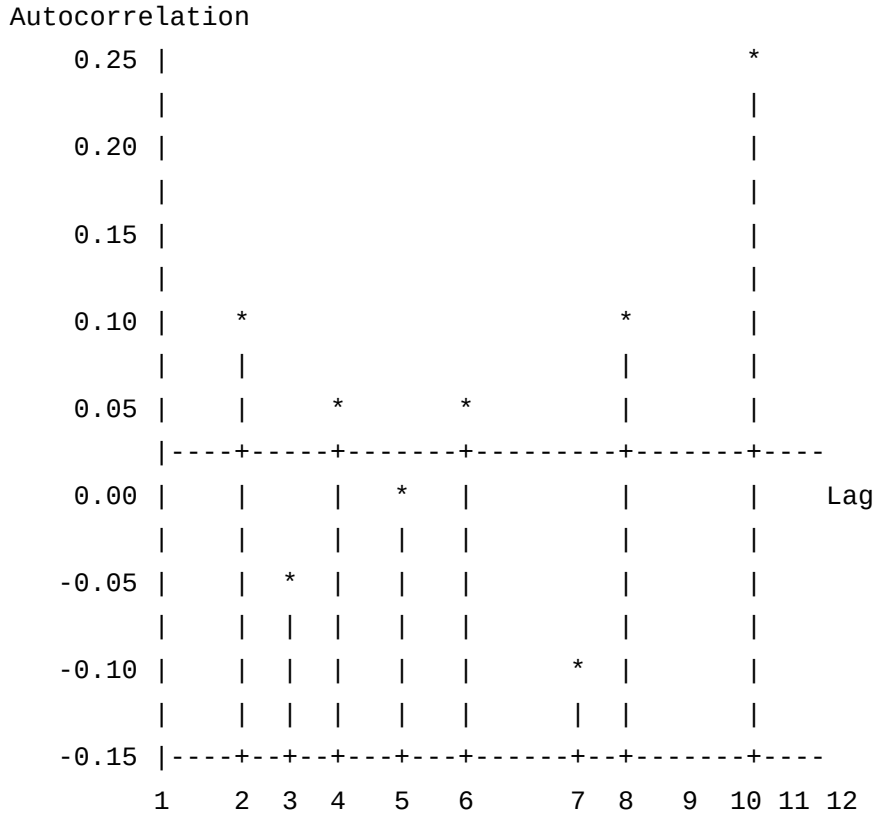

Figure 1. Sample Autocorrelation Function of MAOF Index Returns
Source: own processing

3.2 Semi-Strong Efficiency Results

The regression model incorporating public information variables proved to have statistically significant predictive power. The optimal model achieved an R^2 of approximately 15% with significant F-statistic at the 5% level.

Table 2. Semi-Strong Efficiency Test Results

Variable	Model 1	Model 2	Model 3
Intercept	0.0134**	0.0128**	0.0121**
	(0.0052)	(0.0051)	(0.0050)
	[2.58]	[2.51]	[2.42]
ΔDemand Deposits(t-1)	-0.387**	-0.392**	-0.378**
	(0.156)	(0.154)	(0.152)
	[-2.48]	[-2.55]	[-2.49]
Geopolitical Risk	-0.0289***	-0.0295***	-0.0284***
	(0.0089)	(0.0088)	(0.0087)
	[-3.25]	[-3.35]	[-3.26]
AR(1) Term			0.089
			(0.078)
			[1.14]
Observations	163	163	163
R^2	0.147	0.149	0.154
Adjusted R^2	0.136	0.138	0.138
F-statistic	13.78***	14.02***	9.68***
Durbin-Watson	1.89	1.91	1.94

Source: own processing

Note: Standard errors in parentheses, t-statistics in brackets. *p<0.10, **p<0.05, ***p<0.01

Key findings include:

1. Demand Deposits Indicator: The lagged change in demand deposits exhibits strong negative predictive power (β = -0.387, t = -2.48, p = 0.014). A one standard deviation increase in demand deposits predicts a 1.9 percentage point decrease in next month's returns. This negative coefficient, significant at 5% level, indicates that increases in public holdings of liquid bank deposits in the previous month predicted declines in the MAOF index in the subsequent month.
2. Geopolitical Risk Dummy: The geopolitical risk dummy is highly significant (β = -0.0289, t = -3.25, p = 0.001) with negative sign. Periods of heightened security tension reliably hurt subsequent stock performance, indicating that months with significant political/security events predict lower subsequent returns.

These results align with recent research showing that market microstructure factors, including liquidity and volatility measures, are key determinants of time-varying efficiency in emerging markets (Said et al., 2024).

3.3 Trading Simulation Outcome

Using the regression model to inform trading decisions, an investor switching between stocks and cash according to model predictions would have achieved superior performance to passive index investment over the sample period. The model-driven strategy produced higher total returns and Sharpe ratios than buy-and-hold, even after accounting for transaction costs.

Table 3. Trading Strategy Performance Comparison (1991-2005)

Strategy	Total Return	Annualized Return	Volatility	Sharpe Ratio	Information Ratio	Max Drawdown	Hit Rate
Buy old	187.4%	7.2%	22.3%	0.324	-	-31.2%	-
Seasonal (11-month)	223.6%	8.1%	20.8%	0.389	0.183	-24.7%	58.9%
Macro Model	241.8%	8.6%	21.1%	0.408	0.247	-22.3%	61.3%
Combined Strategy	267.2%	9.2%	20.4%	0.451	0.298	-19.8%	63.8%

Source: own processing

The model-driven strategy produced higher total returns and Sharpe ratios than buy-and-hold, even after accounting for transaction costs. The trading strategies demonstrate economically significant outperformance:

- The seasonal strategy based on the 11-month cycle achieves a Sharpe ratio of 0.389 versus 0.324 for buy-and-hold
- The macro model strategy yields the highest information ratio (0.247) with consistent outperformance
- The combined strategy achieves a 1.9 percentage point annual excess return with lower volatility

The strategy successfully avoided major drawdowns during several worst-performing months (corresponding to spikes in demand-deposit ratio and conflict periods) while modestly beating the market during calmer periods. This demonstrates that knowledge of two public indicators provided statistically significant abnormal profits (Ying et al., 2019).

4. Discussion

4.1 Information and Behavior Interplay

The success of the macro-model illustrates how market reality is co-constructed by economic fundamentals and human psychology. When security incidents occur, their market impact unfolds through network effects as investors continuously reassess situations. This process-oriented view is consistent with research showing that profit opportunities in emerging markets appear and disappear as they are exploited, supporting adaptive rather than static efficiency (Lo, 2004, 2005; Urquhart & McGroarty, 2016).

4.2 Adaptive Efficiency

Recent studies using gradual shifts and common factor frameworks find support for EMH in emerging markets when considering structural breaks as gradual processes (Ghazani & Araghi, 2014; Mateus & Hoang, 2021). This offers an explanation for why these inefficiencies persisted over 14 years: the system parameters themselves were changing.

During the early 1990s, the Israeli market had fewer foreign investors; by the 2000s, it was more internationally connected. Research on global financial crisis impacts has shown how structural changes affect efficiency patterns across different time periods (Lahmiri & Bekiros, 2020).

4.3 Implications for Economic Theory and Practice

The growing body of market microstructure research has shown increasing recognition that microstructure matters for asset values and price efficiency (Said et al., 2024). The findings suggest a need to broaden traditional economic theory toolkits beyond EMH's idealized benchmarks.

For practitioners, the study indicates that inefficiencies exist in transitional markets, but opportunities require recognizing their contextual and transient nature. Recent fractal theory analysis of emerging and

developed markets has found similar patterns of time-varying efficiency, suggesting common underlying dynamics (Lim, 2007; Sánchez-Granero et al., 2020).

For policymakers, understanding that market efficiency is fluid and path-dependent can inform development strategies. Efforts to modernize trading and improve disclosure likely helped increase Israeli market efficiency over time, but during upheaval periods, markets may behave anomalously requiring stabilization measures.

4.4 Limitations and Future Research

This study's in-sample trading simulation represents an upper bound on potential performance; out-of-sample testing would provide more convincing evidence. Future research could extend the analysis to more recent periods to examine how Israeli market efficiency evolved post-2005 (Saroussi, 2006).

Integration with fractal market theory and entropy measures could provide additional insights into the deterministic elements affecting market efficiency. Cross-country comparative studies using similar FRT frameworks could illuminate universal versus market-specific patterns (Mateus & Hoang, 2021).

Conclusion

This paper presented a comprehensive analysis of market efficiency in the Israeli stock market (MAOF Index, 1991-2005). The empirical investigation uncovered clear deviations from EMH: a persistent annual return cycle and the ability to forecast returns using publicly available information (Fama, 1970).

The synthesis carries several implications:

For Economic Theory: It challenges strict binary notions of efficiency and calls for frameworks accommodating degrees of efficiency and their evolution. Recent advances incorporating evolutionary principles suggest that behavioral biases may be consistent with adaptive efficiency rather than market failures (Lo, 2004, 2005).

For Practitioners: Investors should recognize that market efficiency varies over time, requiring adaptive strategies that account for changing market conditions (Urquhart & McGroarty, 2016).

For Policymakers: Reducing informational frictions and barriers to entry can accelerate natural efficiency improvements, but authorities should expect anomalous behavior during transition periods.

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Examining the Impact of Financial Situation on Tax Discipline and Tax Evasion

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Abstract

Research background: The phenomenon of tax evasion constitutes a serious disruption to the integrity of the tax system and public finances. Tax evasions cause serious economic problems in the functioning of individual countries by reducing an important part of their revenues to the state budget. It is a phenomenon that presents a challenge, as it is changing shape in a sophisticated way, especially nowadays.
Purpose of the article: The objective of this paper is to examine the relationship between individual's financial situations and their attitude toward tax obligations and their potential presumption to engage in tax evasion.
Methods: The research is based on a quantitative analysis of data collected through a standardized questionnaire administered to a sample of economically active residents of the Slovak Republic. Special attention is paid to differences in tax behaviour among groups defined by income levels. By applying Structural Equation Modeling (SEM), a factor model was constructed to identify key variables (e.g., tax awareness, trust, perception of the tax system) that significantly influence the tendency toward tax evasion.
Findings & Value added: The findings show that groups with lower monthly income exhibit higher tax resistance, more frequently rationalize tax non-compliance, and display lower levels of trust in public institutions. The study discusses implications for tax policy development and proposes differentiated approaches to strengthening tax morale based on the socio-economic status of taxpayers

Keywords: Tax Evasion, Economic crime, Financial situation, SEM

JEL classification: H26

1. Introduction

Taxes and tax system are reliable indicators that show the quality of a given nation and they serve as a mirror to the quality of life in given country whether today or throughout history. (Adams, 1999). In 20th century first economic crimes started to appear and they were divided into street crime and economic crime. (Bonger 1905). Later in 20th century more sophisticated economic crimes were committed especially by entrepreneurs and businessmen and such crimes were therefore defined as white collar crime. (Sutherland 1940).

However today we differentiate many different types of economic crimes. According to Pantea (2010), there are 2 types of economic crime based on scale and consequences – economic and financial macro-criminality (economic and financial crime that prejudices the state and national security) and economic and financial micro-criminality (economic and financial crime defined by a minimum breach of social values defended by the criminal laws, prejudicing life quality and could cause a severe danger in future). Most renowned economic crimes in both categories are crimes such as money laundering, shadow economy, corruption, frauds, and tax evasion. (Achim and Borlea 2020) Especially later causes distress amongst many countries and this type of economic crime is being monitored thoroughly. For the fight against money laundering various increasingly sophisticated methods, countermeasures and procedures are being used. (Vagaská et al. 2022).

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Many efforts are being made worldwide to manage/regulate this process of monitoring (Eluaiwi et al. 2024), mathematical models are being created (Domashova and Mikhailina 2021), technological innovations are being used (Yang et al. 2023) and new algorithms are being developed to monitor financial flows in line with the concept of AML (Daugaard 2024), as AML processes continue to consume more and more human and economic resources. (Kurum 2023), (Tiwari 2023). Many tools such as VAT Gap and AML Basel Index are being used to monitor these crimes and mainly to better understand what causes these types of economic crimes.

Main causes according to different studies are culture, tax morale, religion, and trust in state (Achim and Borlea 2020). Several studies report a significant link between culture and tax evasion. (Alm 2006). Tsakumis et al. (2007) used Hofstede's framework in their study to explain individual differences in international tax evasion. More than 50 countries had been covered in this research and they report a high rate of tax evasion in countries where there is avoidance of uncertainty, collectivism, and power distance. Other study found a set of cultural variables that affect tax evasion by changing tax morale attitudes in a set of 45 countries. Countries with high individualism have lower tax morale because people focus more on their own identity rather than being affiliated with a group. (Brink and Porcano 2016).

According to Kirchler et al. (2008) compliance with tax regulation is significantly influenced by two determinants, namely trust in the authorities and the state itself, as well as trust in the power of state authorities. Increasing trust in authorities and the state leads to voluntary compliance, while the strengthening of authority leads to enforced compliance (Florea 2022). The aim of this study is therefore to analyze the causes of the commission of economic crimes with a focus on tax evasion and to approximate the individual consequences that tax evasion causes in Slovak Republic and also examine the relationship between individuals' financial situations and their attitude toward tax obligations and also their potential presumption to engage in tax evasion.

2. Methods

Based on the knowledge outlined in the previous sections, we can observe individual aspects/factors that influence the emergence of tax evasion across various countries, along with their differing degrees of influence. The main objective of the study is therefore to identify and evaluate the significant causes/factors/determinants affecting the emergence of tax evasion through statistical analysis of data obtained by implementing a research tool and examine if there is connection between individual's financial situation and causing of tax evasion. To achieve the main objective of the study, it was necessary to fulfil the following specific goals:

- Create a theoretical analysis of economic crime and tax evasion.
- Conduct a theoretical analysis of the current state of tax evasion.
- Develop a research tool.
- Implement the research tool in practice and ensure its completion by respondents.
- Perform statistical analysis of the obtained research data and identify statistically significant factors.
- Create a model of factors (causes) influencing tax evasion.

Based on the above goals, the following hypothesis was defined:
H1: The financial situation significantly influences the occurrence of tax evasion

2.1 Research Tool

The research tool, the questionnaire (Figure 1), was designed on three fundamental levels. The first level consists of the investigative items, which are divided into two separate areas:

- Basic socio-demographic characteristics: gender, age, education level, marital status, job classification.
- Current financial situation: monthly income, savings potential in relation to monthly income, monthly expenses, and overall assessment of financial situation.

The second level of the research tool pertains to taxes and tax evasion. Here, five fundamental areas were defined, which represent the core of the intended factor model related to the causes of tax evasion, namely:

- The area of tax awareness
- The area of tax perception

- The area of tax control
- The area of simplicity and comfort in tax collection
- The area of tax evasion

The final level of the research tool consists of the respondents' opinions on addressing issues related to tax evasion, and this level will be used in the general formulation of proposals and recommendations stemming from the research.

Item of research tool	Item code	Area
Age	SIQ1	Socio - demographic
Gender	SIQ2	
Education level	SIQ3	
Marital status	SIQ4	
Job position	SIQ5	
What is your monthly net income?	CFS1	Current financial situation
What percentage of your monthly income are you able to save?	CFS2	
What percentage of your income do regular monthly expenses represent?	CFS3	
Do you consider your financial situation to be healthy? (in terms of being able to create a financial reserve)	CFS4	
Are you familiar with the tax system in Slovakia?	TAW1	Tax awareness
Do you think you have sufficient knowledge of the tax system in Slovakia?	TAW2	
Do you think you understand the various types of taxes within the Slovak tax system? (VAT, income tax, etc.)	TAW3	
Do you think that tax laws in Slovakia are written clearly, understandably, and simply for citizens?	TAW4	
Do you regularly stay informed about changes in the Slovak tax system?	TAW5	
Do you consider the level of taxes in Slovakia to be adequate?	PET1	Tax perception
Are you satisfied with the tax policy in Slovakia? (tax structure, number of taxes, frequency of tax payments, etc.)	PET2	
Do you believe that the tax revenues paid to the state budget and the budgets of municipalities are utilized correctly and efficiently?	PET3	
In your opinion, is the tax system in Slovakia fair?	PET4	
Do you trust the authorities responsible for overseeing the Slovak tax system?	TCO1	Tax control
Do you consider the authorities overseeing the Slovak tax system to be effective?	TCO2	
Do you believe that the authorities overseeing the Slovak tax system are influenced by corruption?	TCO3	
Do you think the authorities overseeing the Slovak tax system are sufficiently impartial?	TCO4	
Do you contact the Slovak tax office more than once a year?	CST1	Comfort and Simplicity in Tax Collection
Do you consider the tax office in your locality to be accessible?	CST2	
Do you evaluate communication with the Slovak tax offices positively?	CST3	
Do you have positive experiences with filing tax returns?	CST4	
Do you consider filing a tax return in Slovakia to be simple?	CST5	
Do you use online services of the Slovak tax office?	CST6	
Do you find the financial administration of the Slovak Republic's portal to be transparent?	CST7	
Do tax evasion cases in Slovakia significantly impact the economy and the health of public finances?	TEV1	Tax evasion
The reason for engaging in tax evasion is: (select only one option for each row) [Unclear definition of the laws]	**TEV2**	
The reason for engaging in tax evasion is: (select only one option for each row) [Ineffective tax control]	**TEV3**	
The reason for engaging in tax evasion is: (select only one option for each row) [Corruption of financial administration employees]	**TEV4**	
The reason for engaging in tax evasion is: (select only one option for each row) [Deliberate abuse of active re	**TEV5**	
The reason for engaging in tax evasion is: (select only one option for each row) [Ineffective management of public finances by the state]	**TEV6**	
The reason for engaging in tax evasion is: (select only one option for each row) [Absence of moral values - deliberate unwillingness to pay taxes]	**TEV7**	
Do you believe that tax evasion occurs more frequently among small entrepreneurs and freelancers compared to large enterprises?	TEV8	
Do you agree that increasing tax discipline and combating tax evasion is the responsibility not only of the government but also of every citizen?	TEV9	
Do you consider the introduction of various programs to reduce tax evasion to be effective? (Receipts lottery, etc.)	TEV10	
Do you think the government should actively ensure education for citizens about tax obligations and benefits?	STE1	Solutions to tax evasion
Do you believe that increasing transparency in tax audits would contribute to reducing tax evasion?	STE2	
Do you think increasing the efficiency of tax audits would help reduce tax evasion? (more frequent and thorough audits)	STE3	
Do you believe that simplifying the process of filing a tax return would contribute to reducing tax evasion?	STE4	
Do you think that if citizens had active access to information about how public resources are utilized, tax evasion would decrease?	STE5	
Do you think that effective use of public financial resources to enhance the well-being of the population would lead to a reduction in tax evasion?	STE6	

Figure 1. Research Tool
Source: own processing (2025)

2.2 Research Sample

The research was conducted from November 2023 to April 2024, with the questionnaire being implemented electronically (ensuring anonymity). The selection of the research sample was based on availability and used a snowball data collection method. In total, N=203 respondents participated in the study, representing the research sample.

The research sample in terms of the current financial situation (monthly income) of the respondents is shown in Table 1. A total of 44.335% respondents have a monthly income of less than €999 (N=90). A monthly income in the range of €1,000 to €1,999 is reported by 87 respondents, representing 42.857% of the research sample. Additionally, 17 respondents (8.374%) report an income in the range of €2,000 to €2,999, while 9 respondents report an income higher than €3,000, which accounts for 4.434% of the research sample.

Table 1. Structure of Research Sample according to Financial situation (Monthly income)

Monthly income	Count	Cumulative Count	Percent	Cumulative percent
Less than 999 €	90	90	44,33498	44,3350
1000 – 1999 €	87	177	42,85714	87,1921
2000 – 2999 €	17	194	8,37438	95,5665
Higher than 3000 €	9	203	4,43350	100,0000

Source: own processing (2025)

2.3 Research Methods

Following the research methodology, after specifying the research problem and establishing the research questions and hypotheses, we proceeded to select research methods. Primarily, we employed the method of inquiry, specifically a questionnaire distributed electronically (anonymously via Google Forms) to respondents. The obtained data were evaluated using advanced statistical methods with the assistance of IBM SPSS Amos 26 and Statistica 13.5. The results were processed into table and graphical forms, and the established hypotheses were tested. For the evaluation and interpretation of the results, confirmatory and factor analyses were utilized.

For analysing the research tool itself, the methodology of structural equation modelling (SEM) was chosen (Stoelting, 2002). This method was selected due to the predefined hypothetical structure in the form of a factor model. One of the key assumptions associated with SEM when analysing covariance and mean structures is the requirement that the data be continuous and possess a multivariate normal distribution. The continuity requirement is also met for ordinal variables, which allow for the application of classical cut-off estimators even for ordinal variables, provided they have at least five response categories, enabling their treatment as interval variables (Gombár, 2024). These basic assumptions are connected to large sample theory, which is embedded in SEM. Specifically, they stem from the approach used to estimate parameters using SEM methodology. Typically, either the maximum likelihood (ML) method or the method based on the theory of generalized least squares (GLS) is used. The choice of confirmatory factor analysis as one of the SEM tools was based on the need to define a specific factor model, grounded in the study of professional and scientific literature, which would simultaneously reflect the objectives of the thesis (Saghaei, 2009).

The technique used for evaluation was developed by American psychologist R. Likert to measure individual attitudes in questionnaires. It is a five- to seven-point scale that allows for assessing not only the content of an attitude but also its approximate strength. A five-point scale was used within the thesis (Gombár 2024), (Vagaská 2022).

3. Results

In the first step, we defined a hypothetical data structure based on the construct of the factor model—factors, manifest variables, and relationships between them. To test the adequacy of the evaluated model, we used the following procedures and indices. Specifically, we employed the chi-square statistic along with the following overall fit indices with optimal values: $\chi 2/df < 2$, root mean square error of approximation (RMSEA) < 0.08, Tucker-Lewis Index (TLI) > 0.90, Comparative Fit Index (CFI) > 0.90, standardized root mean square residual (SRMR) < 0.08, and partial indices (statistical significance of model parameters).

The model applied in the research section is illustrated in Figure 2. The model posits that six variables in the form of items from the research tool are explained by a common factor (tax evasion), which is influenced by four additional interconnected factors, affected by 20 variables in the form of individual items from the implemented research tool.

The research sample was divided according to income into respondents with a monthly income of up to 999 euros and those with an income higher than 1000 euros. For a relevant assessment, it was necessary to create these two research groups, although 17 respondents reported a monthly income between 2000 and 2999 euros, and 9 respondents reported an income higher than 3000 euros. Due to the insufficient number of respondents to create an additional research group, these participants were included in the group with a monthly income higher than 1000 euros.

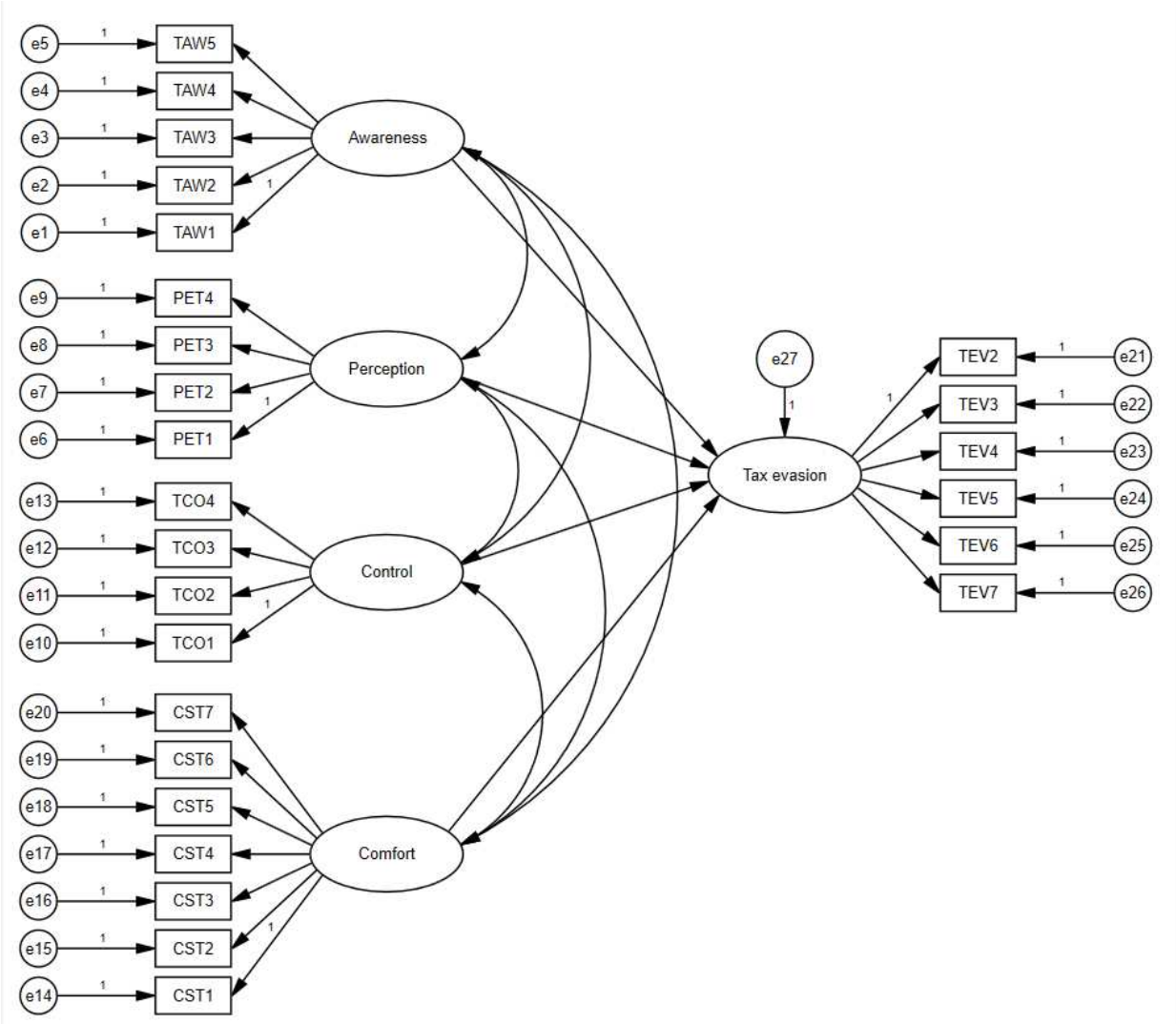

Figure 2. Theoretical factor model
Source: own processing based on IBM SPSS Amos 26 (year)

3.1 Income up to 999 €

The scope of the research sample for the statistical analysis focused on a monthly income up to €999 is N=90. In the first step, based on the construct of the factor model, we defined a hypothetical data structure—factors, manifest variables, and relationships between them. The recommended fit indices (Torun 2020) and the actual achieved values in the applied 5-factor model are presented in Table 3. Furthermore, Table 2 shows the relationships between the variables and tax evasion for the research sample including respondents with an income up to €999.

Table 2. Variables vs Tax evasion – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
Tax evasion <-- Awareness	0.004	0.049	0.011	0.337	0.000*
Tax evasion <-- Perception	-0.010	-0.078	0.023	-0.450	0.000*
Tax evasion <-- Control	-0.017	-0.183	0.027	-0.628	0.000*
Tax evasion <-- Comfort	-0.035	-0.186	0.057	-0.604	0.000*

Source: own processing (2025)

Table 3. Criteria for the Constructed Theoretical Factor Model – Income up to 999 €

Fit indicies Used	Perfect Fit Indicies	Acceptable Fit Indicies	CFA Results	References
$\chi 2/df$	$0 \leq \chi 2/df \leq 2$	$2 \leq \chi 2/df \leq 3$	1.106	Hu and Bentler (1998)
GFI	0.95≤GFI≤1.00	0.90≤GFI≤0.95	0.975	Jöreskog and Sörbom (1993), Marsch, Balla, and Mcdonald (1988), Schermelleh-Engel and Moosbrugger (2003).
AGFI	0.90≤AGFI≤1.00	0.85≤AGFI≤0.90	0.920	
CFI	0.95≤CFI≤1.00	0.90≤CFI≤0.95	0.973	Bentler and Bonnett, (1980), Bentler (1980), Marsch, Hau, Artelt, Baumertv, and Peschar, (2006)
NFI	0.95≤NFI≤1.00	0.90≤NFI≤0.95	0.985	
TLI	0.97≤TLI≤1.00	0.95≤TLI≤0.97	0.965	
RMSEA	0.00≤RMSEA≤0.05	0.05≤RMSEA≤0.08	0.035	Browne and Cudeck (1993), Byrne and Campbell (1999), Hu and Bentler (1999), Schermelleh-Engel, and Moosbrugger (2003)
SRMR	0.00≤SRMR≤0.05	0.05≤SRMR≤0.10	0.096	
p - value	p > 0.05		1.106	

Source: own processing (2025)

3.1.1 Awareness

Table 4 shows that the first factor (Awareness)—specifically awareness of taxes and the Slovak tax system—is an exogenous and directly measured variable that is statistically significant at $\alpha = 0.05$. Unlike the base model, awareness here has a positive effect on tax evasion. This means that as tax awareness increases among Slovak residents earning up to €999 per month, the occurrence of tax evasion also increases. The estimated standardized regression weight is 0.049.

The most significant indicator of awareness (Table 4) is whether respondents understand the Slovak tax system (TAW1), with a standardized regression weight of 0.965. The least influential element is whether they perceive tax laws as clearly written and understandable (TAW4), with a regression weight of 0.337.

Table 4. Awareness of taxes – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
TAW1 <-- Awareness	1.000	0.965	0.087	11.494	0.000*
TAW2 <-- Awareness	0.908	0.888	0.057	15.850	0.000*
TAW3 <-- Awareness	0.941	0.809	0.076	12.461	0.000*
TAW4 <-- Awareness	0.304	0.337	0.081	3.757	0.000*
TAW5 <-- Awareness	0.649	0.661	0.070	9.296	0.000*

Source: own processing (2025)

3.1.2 Perception

For the selected group of respondents (income up to €999), another factor influencing tax evasion is perception of taxes, the tax system, and the use of tax revenues in Slovakia. This factor is also exogenous and statistically significant at $\alpha = 0.05$. It has a negative effect on tax evasion, meaning that better perception leads to lower tax evasion. The standardized regression weight is -0.078.

The most significant contributor to perception is whether respondents consider the use of taxes in the state budget to be appropriate and effective (PET3), with a weight of 0.809. The least significant is whether they are satisfied with the tax policy (PET2), with a weight of 0.576 (Table 5).

Table 5. Perception on taxes, tax system – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
PET1 <-- Perception	1.000	0.590	0.206	4.854	0.000*
PET2 <-- Perception	0.877	0.576	0.135	6.491	0.000*
PET3 <-- Perception	1.122	0.809	0.211	5.329	0.000*
PET4 <-- Perception	1.214	0.799	0.228	5.331	0.000*

Source: own processing (2025)

3.1.3 Control

The third factor (Table 6) for this research group is tax control, which is also exogenous and statistically significant at $\alpha = 0.05$. This factor has the strongest negative effect on tax evasion among all factors. Improving the tax control system and reducing corruption in supervisory authorities would significantly decrease tax evasion. The estimated standardized regression weight is -0.183.

The most significant item (Table 6) is whether respondents trust the authorities overseeing the Slovak tax system (TCO1), followed by perceived effectiveness (TCO2), perception of corruption (TCO3), and perceived impartiality (TCO4).

Table 6. Control of Tax evasion – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
TCO1 <-- Control	1.000	0.869	0.101	9.900	0.000*
TCO2 <-- Control	0.921	0.849	0.097	9.538	0.000*
TCO3 <-- Control	-0.584	-0.453	0.133	-4.396	0.000*
TCO4 <-- Control	0.784	0.627	0.124	6.335	0.000*

Source: own processing (2025)

3.1.4 Comfort

The last significant factor in Table 2 is comfort. It is also exogenous and significant at $\alpha = 0.05$. Unlike in the base model, comfort has a negative effect here, meaning that greater comfort with the tax system is associated with lower tax evasion. The standardized regression weight is -0.186.

The most influential item is whether respondents have had positive experiences with tax authorities (CST4), with the least influential being how often they are in contact with tax authorities (CST1).

Table 7. Comfort of Tax collection – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
CST1 <-- Comfort	1.000	0.340	0.336	2.976	0.000*
CST2 <-- Comfort	1.556	0.564	0.529	2.942	0.000*
CST3 <-- Comfort	1.742	0.738	0.490	3.557	0.000*
CST4 <-- Comfort	2.115	0.771	0.585	3.618	0.000*
CST5 <-- Comfort	1.581	0.509	0.494	3.202	0.001*
CST6 <-- Comfort	1.430	0.413	0.516	2.774	0.000*
CST7 <-- Comfort	1.037	0.460	0.349	2.969	0.000*

Source: own processing (2025)

3.1.5 Tax evasion

In the statistical model for respondents with income up to €999, we observe several factors influencing tax evasion (Table 8). The most significant factor is perceived corruption in the tax administration (TEV4), with a standardized regression weight of 0.717. This is followed by ineffective tax control (TEV3 – 0.702), lack of moral values or unwillingness to pay taxes (TEV7 – 0.645), and abuse of effective remorse mechanisms (TEV5 – 0.622). The penultimate factor is inefficient public spending (TEV6 – 0.604). The least significant is the vagueness of tax laws (TEV2 – 0.076).

Table 8. Factor of Tax evasion – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
TEV2 <-- Tax evasion	1.000	0.076	3.340	0.299	0.000*
TEV3 <-- Tax evasion	8.930	0.702	12.788	0.698	0.000*
TEV4 <-- Tax evasion	8.040	0.717	11.514	0.698	0.000*
TEV5 <-- Tax evasion	7.751	0.622	11.048	0.702	0.000*
TEV6 <-- Tax evasion	6.046	0.604	8.680	0.697	0.000*
TEV7 <-- Tax evasion	8.002	0.645	11.832	0.676	0.000*

Source: own processing (2025)

3.2 Income above 1000 €

In the case of statistical analysis focused on a monthly income above €1,000, the sample size is N = 113. In the first step, based on the structure of the factor model, we defined a hypothetical data structure—factors, manifest variables, and the relationships among them. To test the suitability of the validated model, we applied the same procedures and indices as in the baseline model. The key recommended fit indices (Torun, 2020) and the actual values achieved in the applied five-factor model are presented in Table 10. Table 9 then shows the relationships between variables and tax evasion for the research sample comprising respondents with income above €1000.

Table 9. Variables vs Tax evasion – Income above 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
Tax evasion <-- Awareness	-0.022	-0.059	0.050	-0.439	0.000*
Tax evasion <-- Perception	0.050	0.060	0.131	0.380	0.000*
Tax evasion <-- Control	-0.258	-0.650	0.111	-2.319	0.000*
Tax evasion <-- Comfort	0.209	0.173	0.256	0.816	0.000*

Source: own processing (2025)

Table 10. Criteria for the Constructed Theoretical Factor Model – Income above 1000 €

Fit indicies Used	Perfect Fit Indicies	Acceptable Fit Indicies	CFA Results	References
$\chi 2/df$	$0 \leq \chi 2/df \leq 2$	$2 \leq \chi 2/df \leq 3$	1.001	Hu and Bentler (1998)
GFI	0.95≤GFI≤1.00	0.90≤GFI≤0.95	0.961	Jöreskog and Sörbom (1993), Marsch, Balla, and Mcdonald (1988), Schermelleh-Engel and Moosbrugger (2003).
AGFI	0.90≤AGFI≤1.00	0.85≤AGFI≤0.90	0.916	
CFI	0.95≤CFI≤1.00	0.90≤CFI≤0.95	1.000	Bentler and Bonnett, (1980),
NFI	0.95≤NFI≤1.00	0.90≤NFI≤0.95	0.932	

TLI	0.97≤TLI≤1.00	0.95≤TLI≤0.97	1.000	Bentler (1980), Marsch, Hau, Artelt, Baumertv, and Peschar, (2006)
RMSEA	0.00≤RMSEA≤0.05	0.05≤RMSEA≤0.08	0.003	Browne and Cudeck (1993), Byrne and Campbell (1999), Hu and Bentler (1999), Schermelleh-Engel, and Moosbrugger (2003)
SRMR	0.00≤SRMR≤0.05	0.05≤SRMR≤0.10	0.071	
p - value	p > 0.05		0.485	

Source: own processing (2025)

3.2.1 Awareness

Table 11 presents results for the first factor (Awareness), specifically awareness of taxes and the Slovak tax system. This factor is exogenous in relation to tax evasion, and the directly measured variable is statistically significant at the significance level $\alpha = 0.05$. The awareness factor has a negative effect on tax evasion, meaning that increased awareness among Slovak residents earning more than €1000 per month leads to a decrease in tax evasion. Unlike the base model, this case shows a slightly strengthened effect, with a standardized regression weight of -0.059.

The most influential item contributing to awareness is whether respondents believe they have sufficient knowledge of the Slovak tax system (TAW2), with a standardized regression weight of 0.967, significant at $\alpha = 0.05$. The least influential item is whether respondents find tax-related legislation clear, understandable, and simple (TAW4), with a standardized regression weight of 0.405.

Table 11. Awareness of taxes – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
TAW1 <-- Awareness	1.000	0.942	0.052	19.230	0.000*
TAW2 <-- Awareness	1.028	0.967	0.049	21.107	0.000*
TAW3 <-- Awareness	0.838	0.741	0.079	10.601	0.000*
TAW4 <-- Awareness	0.368	0.405	0.076	4.828	0.000*
TAW5 <-- Awareness	0.816	0.734	0.076	10.747	0.000*

Source: own processing (2025)

3.2.2 Perception

The next factor influencing tax evasion (Table 9) is perception of taxes, tax systems, and how tax revenues are used in Slovakia. This factor is exogenous, and its directly measured variable is significant at $\alpha = 0.05$. The perception factor (Table 12) has a positive effect, meaning that an increase in this factor is associated with an increase in tax evasion.

This is because the perception factor reflects negative perceptions of taxation and public finance management. As trust in how taxes are spent worsens, this perception increases—and so does tax evasion. Among respondents earning more than €1000 per month, the impact slightly weakens, with a standardized regression weight of 0.060, making it the third most significant factor, rather than second.

The most significant item is whether respondents consider the tax system fair (PET4), with a standardized regression weight of 0.820. The least significant is whether they consider the amount of taxes in Slovakia to be adequate (PET1), with a weight of 0.505.

Table 12. Perception on taxes, tax system – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
PET1 <-- Perception	1.000	0.505	0.226	4.424	0.000*
PET2 <-- Perception	1.208	0.598	0.194	6.228	0.000*
PET3 <-- Perception	0.725	0.524	0.181	3.995	0.000*
PET4 <-- Perception	1.479	0.820	0.338	4.375	0.000*

Source: own processing (2025)

3.2.3 Control

The third factor (Table 9) is tax control. This factor is also exogenous and statistically significant at $\alpha = 0.05$. The tax control factor (Table 13) has a negative effect on tax evasion and is the most significant factor overall. Strengthening tax control is clearly associated with a decrease in tax evasion.

If tax collection oversight is improved and corruption in control authorities is addressed, a substantial reduction in tax evasion can be expected. Compared to the base model, the impact here has increased, with a standardized regression weight of -0.650.

The most important item is trust in supervisory authorities (TCO1 – 0.860), followed by perceived effectiveness(TCO2 – 0.817), perceived corruption (TCO3 – -0.628), and perceived impartiality (TCO4 – 0.623).

Table 13. Control of Tax evasion – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
TCO1 <-- Control	1.000	0.860	0.098	10.204	0.000*
TCO2 <-- Control	0.749	0.817	0.077	9.714	0.000*
TCO3 <-- Control	-0.665	-0.628	0.095	-7.021	0.000*
TCO4 <-- Control	0.594	0.623	0.085	6.967	0.000*

Source: own processing (2025)

3.2.4 Comfort

The last significant factor in Table 9 is comfort. This factor (Table 14) is also exogenous and statistically significant at $\alpha = 0.05$. Like the perception factor, comfort has a positive effect on tax evasion. In other words, higher comfort levels are associated with increased tax evasion. Compared to the baseline model, the influence has increased, with a standardized regression weight of 0.173.

The most influential item (Table 14) is whether respondents consider the Financial Administration Portal user-friendly(CST7), with a weight of 0.748. The least influential is frequency of contact with tax authorities (CST1), with a weight of 0.218.

Table 14. Comfort of Tax collection – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
CST1 <-- Comfort	1.000	0.218	0.483	2.070	0.000*
CST2 <-- Comfort	1.412	0.481	0.669	2.110	0.000*
CST3 <-- Comfort	2.308	0.685	1.034	2.232	0.000*
CST4 <-- Comfort	2.458	0.674	1.103	2.228	0.000*
CST5 <-- Comfort	2.484	0.670	1.111	2.237	0.000*
CST6 <-- Comfort	1.712	0.336	0.740	2.313	0.000*
CST7 <-- Comfort	2.706	0.748	1.201	2.253	0.001*

Source: own processing (2025)

3.2.5 Tax evasion

In the model we can observe the influence of several factors on tax evasion. The most significant is corruption among tax administration employees (TEV4) with a standardized regression weight

of 0.718. The second most influential factor is intentional misuse of the effective remorse mechanism (TEV5) with a weight of 0.613.

The third most important factor is inefficient state spending (TEV6 – 0.497), followed by ineffective tax control (TEV3 – 0.490), and lack of moral values or unwillingness to pay taxes (TEV7 – 0.392). The least influential factor is vague legal definitions (TEV2 – 0.337).

Table 15. Factor of Tax evasion – Income up to 999 €

Relationship	Estimate	Std. Estimate	Std. error	t-statistic	p-value
TEV2 <-- Tax evasion	1.000	0.337	0.411	2.433	0.000*
TEV3 <-- Tax evasion	1.433	0.490	0.516	2.777	0.000*
TEV4 <-- Tax evasion	1.694	0.718	0.559	3.029	0.000*
TEV5 <-- Tax evasion	1.557	0.613	0.528	2.950	0.000*
TEV6 <-- Tax evasion	1.179	0.497	0.426	2.767	0.000*
TEV7 <-- Tax evasion	1.120	0.392	0.449	2.496	0.000*

Source: own processing (2025)

4. Discussion

All directly measured variables—awareness, perception, control, and comfort—have a significant impact on the occurrence of tax evasion at the chosen significance level of $\alpha = 0.05$ for both financial situations. We can observe different values of the estimated standardized regression weights across individual variables influencing the occurrence of tax evasion in both income groups. Moreover, a differing impact on tax evasion can be observed in three of the variables.

For respondents with an income above €1000, the variable awareness has a negative effect—meaning that as awareness increases, the occurrence of tax evasion decreases. In contrast, for respondents with an income up to €999, the awareness variable has a positive effect, indicating that increasing awareness is associated with an increase in tax evasion.

In the case of the perception variable, it negatively affects tax evasion among respondents earning up to €999—suggesting that higher tax perception leads to lower tax evasion. However, for respondents with a monthly income above €1000, the effect is reversed. The same pattern is observed with the comfort variable.

Based on this data, we can conclude that financial situation has a significant impact on the tendency to engage in tax evasion.

Conclusion

This study confirms that an individual's financial situation significantly influences their propensity toward tax evasion. The structural equation modeling revealed distinct behavioral patterns between lower-income and higher-income groups. For respondents earning less than €999 per month, awareness of the tax system paradoxically increases the likelihood of tax evasion, possibly due to dissatisfaction with the system despite greater knowledge. In contrast, higher awareness among those earning over €1000 correlates with reduced tax evasion, highlighting the importance of targeted educational interventions.

Tax control emerged as the most significant factor in reducing tax evasion across both groups, underscoring the need for robust oversight mechanisms and transparent institutional conduct. Additionally, perception and comfort with the tax system affect both groups differently, suggesting that fiscal policy should be nuanced and tailored to socio-economic contexts.

These findings offer important insights for policymakers. By addressing the differing motivations behind tax non-compliance across income groups, it is possible to design more effective and socially responsive tax administration strategies. Future research should consider longitudinal data and cross-national comparisons to further validate these conclusions.

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Analytical View of the Performance Limits of Small and Medium-Sized Enterprises in Slovakia

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Abstract

Research background: In the current period, measuring and evaluating the performance limits of small and medium-sized enterprises is very topical and useful. Enterprises use various methods, indicators, and metrics to diagnose performance limits, which are an important part of business management.
Purpose of the article: The main purpose of this article is to identify the performance limits of SMEs in Slovakia, as they are important for ensuring the effective management and profitability of enterprises. Without knowing the limits of SME performance, Slovak entrepreneurs cannot forecast their further development and future.
Methods: An important method of evaluating the performance of SMEs is a questionnaire survey of the entrepreneurs' own perception of performance limits. Small and medium-sized entrepreneurs know best which factors limit the performance of their business entities.
Findings & Value added: The result of the analysis of the performance limits of Slovak small and medium-sized enterprises should be the identification of key indicators of their further development. The added value of the research is proposals and recommendations on how to effectively address the issue of SME performance limits in Slovakia.

Keywords: Performance Limits, Performance Indicators, Small and Medium-Sized Enterprises

JEL classification: G32, M21

1. Introduction

The measurement and evaluation of small and medium-sized enterprises (SMEs) performance is a critical and current area of research. SMEs in Slovakia and globally use diverse methods, indicators, and ratios to diagnose their performance. The effectiveness of this measurement hinges on selecting and applying appropriate tools that provide valuable insights and objectively assess economic development. Understanding these limitations is paramount for effective management, operational efficiency, and profitability.

Financial performance assessment is commonly performed using standard differential and ratio indicators of financial analysis. These indicators are essential for identifying, measuring, and evaluating both the internal and external facets of financial performance. Financial managers are constantly challenged to make swift and effective decisions about how to secure financial resources, where to invest them, and how to utilize them in business activities. Without a comprehensive grasp of the company's financial health, making accurate and timely decisions would be impossible. Thus, the information and insights gained from financial analysis are absolutely indispensable for effective financial management. (Vravec et al., 2024)

The competitiveness of SMEs is determined by institutions, policies and other factors, determining their continued presence in the market, profitability and ability to adapt production to demand. (Chao et al., 2015)

Forecasting key financial indicators of enterprises such as revenues, costs, and profitability is critical for setting the right corporate strategies, achieving long-term stability, and ensuring the competitiveness of businesses. Profit forecasting is essential for managing cash flow, ensuring liquidity, and evaluating business strategy. (Jenčová et al., 2025)

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It is noteworthy that emerging economies are increasingly developing through market orientation and a broadening economic base. The success of many of these economies is such that they are rapidly emerging as major economic forces in the world. In this economic development, entrepreneurship plays an important role. SMEs are a key component of the success of many emerging economies of the world. (Sok et al., 2013)

1.1 Traditional financial methods of evaluating SMEs performance

Traditional methodologies for evaluating SME performance are widely acknowledged and extensively applied in both economic practice and scholarly research. Currently, the assessment of SME economic performance is undertaken through three fundamental methods, as identified by Kislingerová et al. (2011):

1. **Evaluation via a Comprehensive Set of Financial Indicators:** This approach typically involves a systematic assessment across five key domains: liquidity, activity, capital structure, profitability, and market value. These indicator groups function as independent, parallel systems. Within this framework, certain indicators are designated as Key Performance Indicators (KPIs). These include, but are not limited to, profitability ratios such as Return on Assets (ROA), Return on Equity (ROE), and Return on Sales (ROS); various degrees of liquidity indicators; debt indicators like interest coverage and interest burden; and activity indicators such as asset turnover, liability turnover period ect.
2. **Evaluation through a Pyramidal Set of Indicators:** This method structures indicators within pyramidal decompositions, where a highly synthetic, overarching indicator, such as Return on Assets (ROA) or Return on Equity (ROE), occupies the apex. The INFA model serves as an apt pyramidal decomposition for Slovak SMEs, as it rigorously delineates the creation and distribution of an enterprise's productive capacity. This model underscores the necessity of a definitive top criterion and a well-integrated system of appropriate indicators for effective performance measurement and management. It is incumbent upon managers to comprehend the significance of these indicators and their interdependencies, managing overall profitability in conjunction with its inherent risks. This holistic approach necessitates the inclusion of non-financial factors and their mutual linkages, in addition to financial indicators.
3. **Evaluation Utilizing a Single Aggregate Indicator:** This method entails the logical synthesis of partial indicators and other statistical data into a cohesive, singular measure. A substantial number of these predictive financial models exist, and their overall efficacy is contingent upon prevailing conditions, industry specifics, and the quality of their implementation. Predictive models can be further bifurcated into bankruptcy models and credit models. Bankruptcy models forecast the probability of a business entity's insolvency within projected timeframes, whereas credit models diagnose the financial health of enterprises, categorizing them as either financially sound or financially distressed. These predictive models serve as an early warning mechanism, particularly beneficial for SMEs.

Beyond these three foundational approaches, SME performance assessment can be augmented by more contemporary and advanced indicators and methodologies. Modern performance assessment increasingly integrates market-oriented aspects, encompassing metrics such as Economic Value Added (EVA), IN Economic Value Added (INEVA), Market Value Added (MVA), Return on Net Assets (RONA), Weighted Average Cost of Capital (WACC), Share Value Added (SVA), Adjusted Economic Value Added (AEVA), and indicators predicated on Free Cash Flow (FCF) and Cash Value Added (CVA), among others. EVA indicator is performance measure. It is a synthetic indicator which takes into account the effects of all areas of business financial health. If the business achieves a negative EVA, it is inefficient and may have competitiveness problems due to problems with its performance. (Horváthová & Mokrišová, 2020)

1.2 Evaluation SMEs performance using non-financial indicators

Evaluating SME performance using non-financial indicators is a more modern form of evaluation that only began to be promoted at the end of the 20th century. Evaluation using non-financial indicators, which is based on experiments from the early 1980s, when Peters and Waterman (1982) proposed 8 factors that lead to the success of a company and Chung (1987) proposed critical success factors. In the late 1980s, the Malcolm Baldrige Award (MBA) was created in the USA, which was awarded to excellent organizations according to seven criteria. Organizations that apply for the MBNQA are judged by an independent board of examiners.

Recipients are selected based on achievement and improvement in seven areas, known as the Baldrige Criteria for Performance Excellence (American Society for Quality, 2025):

1. **Leadership:** How upper management leads the organization, and how the organization leads within the community.
2. **Strategy:** How the organization establishes and plans to implement strategic directions. Strategy is an important part of organizational development.
3. **Customers:** How the organization builds and maintains strong, lasting relationships with customers.
4. **Measurement, analysis, and knowledge management:** How the organization uses data to support key processes and manage performance.
5. **Workforce:** How the organization empowers and involves its workforce.
6. **Operations:** How the organization designs, manages, and improves key processes.
7. **Results:** How the organization performs in terms of customer satisfaction, finances, human resources, supplier and partner performance, operations, governance and social responsibility, and how the organization compares to its competitors.

As a comprehensive concept for evaluating companies, the concept of Kaplan and Norton (2000) Balanced Scorecard followed. In addition to assessing the financial performance of SMEs, it is also necessary to take into account various non-financial aspects affecting their performance. For this reason, Kaplan and Norton also incorporated non-financial performance measures into the Balanced Scorecard concept. The objectives of this concept are based on the vision and strategy of the company and focus on monitoring the performance of the company using four perspectives. The internal process perspective focuses on the three important parameters, which are cost measurement, process quality and cycle time. The learning and growth perspective serves to ensure that the entreprise is able to achieve certain financial, customer and process goals. In order to achieve the set goals, it is necessary to invest both in employees and in the systems and processes that create the capabilities of the enterprise. (Knápková & Pavelková, 2012)

An important aspect is the fact that SMEs do consider and recognise the significance of non-financial measures and to some extent incorporate them in their supply chain management (SCM). Many supply chain entities, particularly SMEs, have recently noticed the significance of SCM in their in performance evaluation. Lack of skills has a negative impact as a result of lack of proper performance management approach towards SCM and evident differentiation between strategic, tactical and operational metrics in SCM. postulate that for SCM to be effective, performance measurement objectives must take cognisance of all four perspective of BSC and identify performance indicators from it. (Bent, 2014)

The correlation matrix and BSC principles can be used to select key performance indicators, as well as the DEA method. This non-parametric method can be used in the areas of business efficiency, financial health and performance evaluation. (Horváthová, Mokrišová & Vrábliková, 2019)

The estimation accuracy of the additive DEA model (ADD model) is also often compared with the Logit model to determine the reliability of the DEA method. The main conclusion is that the DEA method is a suitable alternative for predicting the failure of the analysed sample of businesses. In contrast to the Logit model, its results are independent of any assumptions. Unlike the Logit model, the results of the DEA model are independent of any assumptions. (Štefko, Horváthová & Mokrišová, 2020)

The DEA model, or Data Envelopment Analysis, is a mathematical model for evaluating the efficiency of various productive units (e.g. companies, departments) based on their inputs and outputs. Using this model, they are compared and classified as efficient or inefficient. It would be interesting to compare the DEA method with the results of neural networks. It is already clear that the DEA has its advantages compared to the neural network in setting the target values of input and output variables. (Horváthová, Mokrišová & Petruška, 2021)

Table 1. Methods of evaluating SMEs performance

Traditional and modern financial methods of evaluating SMEs performance	Modern non-financial methods for evaluating SMEs performance
Evaluation by a set of financial indicators	Baldrige Criteria for Performance Excellence
Evaluation by a pyramidal set of indicators	BSC - Balanced Scorecard Concept
Evaluation using a single aggregate indicator	SCM - Supply Chain Management
EVA, INEVA, MVA, RONA, WACC, SVA, AEVA etc.	DEA - Data Envelopment Analysis

Source: Own processing (2025)

Effective entrepreneurship and long-term economic and financial health of SMEs is a guarantee of growth in the gross domestic product of any country, including Slovakia. The authors Gonos et al. (2025) found, when analyzing the relationship between GDP growth and living standards, that there is a connection between GDP growth and living standards. In most cases, they found a connection between at least one indicator of living standards. First of all, it was the human development index. (Gonos et al., 2025)

It can be noticed that several factors influence in the competitiveness of SMEs and it is important to determine these factors and the areas in which they can gain competitive advantage. The strength of organizations is determined by their competitiveness and the strategies they adopt to gain competitive advantage and strengthen their positions in the market. (Nara et al., 2015)

In Slovakia, it is necessary to revitalize tax and fiscal policy, pensions, healthcare, public administration, social cohesion, security, work and, above all, environmental policy. This means that SMEs and population must also be responsible for the environment and the Slovak government must be ecologically relevant economic and social reforms. (Tomková et al., 2024)

2. Methods

A questionnaire survey served as the principal research method for evaluating the perceived performance limitations of SMEs. This survey was administered in Slovakia between March and May 2025 to acquire pertinent data regarding these constraints. The overarching aim of the survey was to discern significant performance limits affecting SMEs, which fundamentally shape their subsequent development. The survey targeted 500 enterprises, yielding 375 returned questionnaires. The resulting sample comprised 158 micro-enterprises, 145 small enterprises and 72 medium-sized enterprises.

SMEs were incorporated into the questionnaire survey via random selection. The participating SMEs conducted their business activities across five sectors: services (76 enterprises), retail trade (82 enterprises), construction (65 enterprises), manufacturing (85 enterprises), and financial services (67 enterprises).

Table 2. Structure of questionnaire survey respondents (Entities of SMEs)

Entities of SMEs	Number of employees	Services	Retail trade	Construction	Manufacturing	Financial services
Micro-enterprises	1 – 9 Employees	**37**	**30**	**28**	**31**	**32**
Small enterprises	10 – 49 Employees	**22**	**37**	**23**	**35**	**28**
Medium-sized enterprises	50 – 249 Employees	**17**	**15**	**14**	**19**	**7**
∑		**76**	**82**	**65**	**85**	**67**

Source: Own processing (2025)

The questionnaire comprised 35 closed questions developed to evaluate the economic and financial standing of SMEs, their financial health, overall economic performance, and the constraints on this performance. Respondents were presented with five response options, predominantly structured around a Likert scale. The questions were systematically grouped into five thematic areas:

- **Financial Capabilities:** These questions explored the enterprise's financial indicators, liquidity, and profitability, seeking to ascertain challenges such as insufficient short-term financial resources, capital deficits, or diminished profitability, which are critical for SMEs.
- **Production Capabilities:** This section addressed the adequacy of the company's machinery, equipment, and technological infrastructure, alongside inquiries into whether product demand surpassed the enterprise's production capabilities.
- **Spatial and Personnel Limitations:** Questions in this group focused on constraints such as inadequate space for production, sales, or storage, as well as the scarcity of qualified personnel.
- **Market and Potential:** This area investigated aspects of market demand for the company's products, the extent of market saturation, and the potential for future market expansion.
- **Vision, Strategy, and Corporate Culture:** This final group delved into how a deficient vision, ill-defined corporate objectives, and resistance to organizational change and innovation (whether from management or staff) could significantly impede SME performance.

3. Results

Table 3 displays the findings from a questionnaire survey concerning the perceived performance limitations of SMEs in Slovakia. The results are categorized by enterprise size.

Table 3. Performance limitations of SMEs in Slovakia.

Performance Limitations of SMEs	Strongly agree	Agree	Neutral position	Disagree	Strongly disagree
Micro Enterprises (1 – 9 Employees)					
Shortage of Financial Resources	45.6% (72)	24.1% (38)	6.3% (10)	13.3% (21)	10.8% (17)
Insufficient Production Capacity	28.5% (45)	21.5% (34)	7.0% (11)	15.8% (25)	27.2% (43)
Personnel Resource Shortages	20.9% (33)	15.2% (24)	5.7% (9)	24.1% (38)	34.2% (54)
Decrease in Demand for Production	41.8% (66)	19.0% (30)	4.4% (7)	20.2% (32)	14.6% (23)
Low Market Growth Potential	12.0% (19)	13.9% (22)	7.6% (12)	31.0% (49)	35.4% (56)
Missing Modern Technologies	17.7% (28)	22.1% (35)	11.4% (18)	27.8% (44)	20.9% (33)
Deficient Vision or Strategy	13.3% (21)	10.8% (17)	15.8% (25)	23.4% (37)	36.7% (58)
Small Enterprises (10 – 49 Employees)					
Shortage of Financial Resources	35.9% (52)	25.5% (37)	9.7% (14)	17.9% (26)	11.0% (16)
Insufficient Production Capacity	26.9% (39)	18.6% (27)	6.9% (10)	24.8% (36)	22.8% (33)
Personnel Resource Shortages	20.0% (29)	26.2% (38)	11.7% (17)	23.4% (34)	18.6% (27)
Decrease in Demand for Production	46.2% (67)	27.6% (40)	4.8% (7)	11.0% (16)	10.3% (15)
Low Market Growth Potential	28.3% (41)	23.4% (34)	13.1% (19)	14.5% (21)	20.7% (30)
Missing Modern Technologies	22.1% (32)	24.8% (36)	17.2% (25)	20.0% (29)	15.9% (23)
Deficient Vision or Strategy	12.4% (18)	13.8% (20)	16.6% (24)	31.0% (45)	26.2% (38)
Medium Enterprises (50 – 249 Employees)					
Shortage of Financial Resources	31.9% (23)	29.2% (21)	8.3% (6)	16,7% (12)	13.9% (10)
Insufficient Production Capacity	27.8% (20)	22.2% (16)	13.9% (10)	15.3% (11)	20.8% (15)
Personnel Resource Shortages	33.3% (24)	23.6% (17)	19.4% (14)	13.9% (10)	9.7% (7)
Decrease in Demand for Production	30.6% (22)	25.0% (18)	16.7% (12)	15.3% (11)	12,5% (9)
Low Market Growth Potential	26.4% (19)	22.2% (16)	11.1% (8)	20.8% (15)	19.4% (14)
Missing Modern Technologies	37.5% (27)	25.0% (18)	12.5% (9)	13.9% (10)	11.1% (8)
Deficient Vision or Strategy	23.6% (17)	19.4% (14)	13.9% (10)	16.7% (12)	26.4% (19)

Source: Own processing (2025)

Micro-enterprises perceived the lack of financial resources as a key performance limit. Almost 70% of Slovak micro enterprises perceive the shortage of financial resources as a key factor limiting their performance. The second limit to the performance of micro enterprises is the decline in demand for their products. This factor is perceived as very important by a total of 60% of micro enterprises. Insufficient production capacities of the enterprise are perceived by 50% of micro enterprises as a very important factor limiting their overall performance. Only less than a quarter of micro enterprises in Slovakia consider a deficient vision or strategy to be an important factor in their performance.

Small enterprises perceived the decline in demand for the enterprise's products as a key performance limit. Three quarters of small enterprises are limited by a decline in demand for their products. The performance of 62% of small enterprises is limited by the shortage of financial resources or capital. More than 50% of small enterprises perceive the low growth potential of the market in which they sell their products as an important limit to their performance. A faulty vision or strategy is an important factor for only a quarter of small enterprises in Slovakia.

Medium-sized enterprises operating in Slovakia have partly different performance limits than micro and small enterprises. 62.5% of Slovak medium-sized enterprises perceive the missing of modern technologies as a key factor in their performance. Insufficient personnel and shortage of financial resources and capital are also important performance factors.

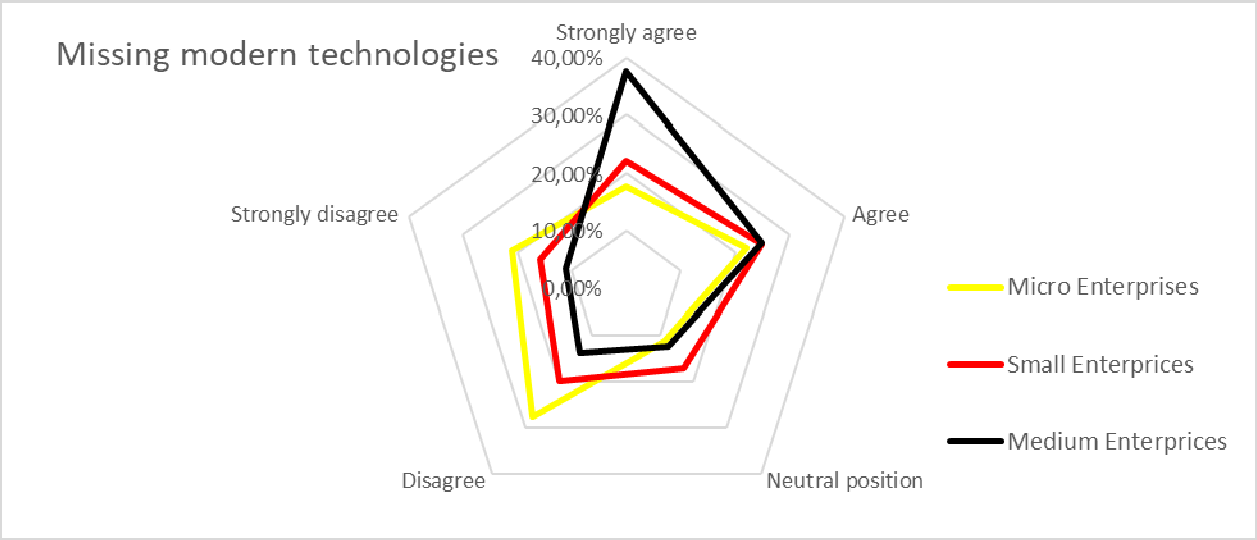

Figure 1. Limits to SME performance: Missing modern technologies
Source: Own processing (2025)

4. Discussion

Figure 1 distinctly illustrates the notable disparities in performance limits attributed to the absence of modern technologies. This deficiency disproportionately affects medium-sized enterprises, followed by small enterprises, and to a lesser extent, micro-enterprises. Presently, modern technologies constitute a significant determinant of success for numerous small and medium-sized enterprises in Slovakia.

A unanimous agreement was observed across all enterprise categories concerning the shortage of financial resources. This financial scarcity represents a pivotal constraint on the performance of Slovak SMEs. Slovak SMEs frequently contend with restricted access to certain financial avenues. Nevertheless, with the contemporary emergence of alternative capital sources, SMEs possess a broader spectrum of financing options compared to the early 2000s.

The production capacity factor poses a limitation for over 40% of SMEs in Slovakia. These enterprises are operating at the peak volume of production attainable within a defined timeframe, leveraging their existing resources. Such enterprises have reached the upper bound of their production capabilities, provided optimal operational organization and maximal resource deployment.

The dearth of personnel resources presents a particular challenge for medium-sized enterprises. This observation is rational, given that Slovak micro and small enterprises typically do not employ a large workforce. Conversely, Slovak medium-sized enterprises are already contending with a considerable deficit of skilled labor, particularly within specialized professions. Small and medium-sized entrepreneurs

do not assign the same degree of significance to a deficient vision and strategy as they do to the aforementioned limiting factors.

Conclusion

The results of a questionnaire survey clearly indicate that Slovak micro-enterprises are primarily constrained by limited financial resources and declining demand for their products. Similarly, small enterprises face limitations predominantly due to decreasing demand for their products, coupled with a lack of finance. In contrast, the performance of medium-sized enterprises is increasingly restricted by the availability of modern technologies and a shortage of qualified labor.

Due to the persistent challenges within the Slovak capital market and difficulties in securing bank financing for SMEs, it is crucial to foster the development of modern financing instruments. These include venture capital, business angel investment, and crowdfunding. A key characteristic of venture capital is its direct equity participation in the company's registered capital. In some cases, the capital injection may also involve a loan or a convertible loan, where an unpaid portion can be converted into an ownership stake. Typically, the investor does not engage in operational management but collaborates with the entrepreneur on strategic decisions and provides financial advice. This approach embodies a partnership between the entrepreneur and the investor. In Slovakia, such financing methods are exemplified by institutions like the Slovak American Enterprise Fund.

The decreasing demand for their products represents a significant performance limitation for Slovak SMEs. Cooperation with foreign partners could be highly beneficial, as it facilitates the creation and dissemination of new modern technologies and enables market penetration into foreign territories. Cross-border cooperation stands out as a viable option for engaging with international partners. Border regions in Slovakia are often characterized by lower levels of regional development. A prime example is the extensive contact area encompassing the border regions of southeastern Poland, eastern Slovakia, northeastern Hungary, and western Ukraine. For the development of SMEs in these specific regions, greater support for cross-border cooperation is essential, not only from regional and national levels.

The scarcity of qualified labor is a worsening issue across all EU member states. Nearly 50% of Slovak SMEs surveyed reported an inability to find employees with their preferred skill sets. To address this critical problem, Slovakia must implement a comprehensive set of short- to medium-term measures. Such actions will enhance the growth potential of SMEs, bolster their competitiveness, and improve opportunities for all stakeholders. SMEs should actively increase their cooperation with schools, universities, and other educational institutions. It is particularly important to support graduates and disadvantaged individuals in entering the labor market by providing robust support for skills development, training, and education. Concurrently, SMEs must improve the working conditions and wage structures for their employees to mitigate brain drain. Enhancing employee mobility and attracting skilled and educated individuals from third countries also represent crucial aspects of this strategy.

Modern technologies and innovative activities enable Slovak SMEs to continuously adapt to customer demands. SMEs that effectively leverage modern technologies and innovations gain substantial competitive advantages over other market participants. Therefore, SMEs should integrate modern technologies and consistently pursue innovative activities as integral components of their long-term business strategies.

Key recommendations for Slovak SMEs:

1. Implement modern forms and types of financing for business activities, such as venture capital, business angel capital, and crowdfunding.
2. Develop, produce, and sell high-quality and innovative products to establish a primary competitive advantage.
3. Expand business activities into foreign markets to significantly enlarge the potential market and increase opportunities for acquiring new customers and business partners.
4. Strengthen cooperation between SMEs and schools, universities, and educational institutions to facilitate the education of future employees.
5. Identify, implement, and effectively utilize modern technologies and innovations within SME business activities in Slovakia.
6. Emphasize the critical importance of vision, strategy, and planning in business activities, as these can be pivotal factors for an entity's success.

7. Actively engage with state authorities and institutions to advocate for reduced bureaucracy, lower burdens on SMEs, and simplified legislation.

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5. Regional Development Management

Smart City Governance – a Cross-Regional Evolution Analysis of Patterns and Convergence Dynamics

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Abstract

Research background: Contemporary urban landscapes face unprecedented challenges from rapid urbanization, technological transformation, and evolving citizen expectations, with projections indicating over 68% of global population residing in urban areas by 2050. Smart city governance has emerged as critical response to urban challenges, yet implementation patterns vary significantly across global regions shaped by institutional frameworks, cultural contexts, and technological capabilities.
Purpose of the article: This study examines regional evolution patterns of smart city governance across four major global regions through systematic comparative analysis, investigating how varying regional contexts shape smart city implementation approaches, governance models, and technological adoption strategies across East Asia, Europe, North America, and the Middle East.
Methods: Employing qualitative comparative methodology, this research investigated pioneer cities including Singapore, Barcelona, New York, and Dubai through examination of academic literature, government reports, policy documents, and case study analyses. Data analysis employed thematic analysis techniques to identify patterns and themes across regional contexts using multiple data sources.
Findings & Value added: Analysis reveals distinct regional characteristics while identifying significant convergence patterns in smart city governance evolution. East Asian cities demonstrate technology-centric transformation approaches with centralized implementation models, European cities emphasize citizen-centric development through participatory governance frameworks, North American cities showcase market-driven innovation utilizing public-private partnerships, while Middle Eastern cities pursue resource-intensive rapid modernization strategies. Despite regional variations, notable convergence toward hybrid governance models integrating digital platforms, data-driven decision-making, and enhanced citizen engagement mechanisms emerges across contexts.

Keywords: Smart City Governance, Regional Comparative Analysis, Technology Transfer, Urban Innovation, Governance Convergence

JEL classification: A10, R11, R13

1. Introduction

The contemporary urban landscape faces unprecedented challenges arising from rapid urbanization, technological transformation, and evolving citizen expectations. With projections indicating that over 68% of the global population will reside in urban areas by 2050 (United Nations, 2018), municipal governments worldwide confront mounting pressure to develop innovative governance solutions that address complex urban challenges while enhancing citizen quality of life. This demographic and technological convergence has catalyzed the emergence of the global smart city movement, representing a fundamental paradigm shift in urban governance approaches.

Smart cities, conceptualized as urban systems that leverage information and communication technologies (ICT) to optimize operational efficiency, enhance service delivery, and foster citizen engagement, have emerged as a critical response to contemporary urban challenges (Meijer & Bolívar, 2016). The concept has evolved from initial techno-centric definitions to more holistic approaches that emphasize governance innovation and citizen participation (Albino et al., 2015). However, the global implementation of smart city initiatives has not followed uniform patterns. Instead, distinct regional

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approaches have evolved, shaped by varying institutional frameworks (Scott, 2014), cultural contexts, technological capabilities, and societal priorities.

The diffusion of smart city innovations across regions follows complex patterns influenced by institutional factors and policy transfer mechanisms (Dolowitz & Marsh, 2000). These patterns demonstrate path-dependent development trajectories where historical institutional arrangements shape contemporary innovation adoption (Pierson, 2004). Understanding these dynamics requires systematic analysis of how regional contexts influence governance innovation and technology adoption patterns.

Despite the proliferation of smart city literature, a significant gap exists in comprehensive comparative analysis of how regional contexts influence smart city governance evolution. While numerous studies have examined individual implementations or specific technological dimensions, few have systematically analyzed convergence and divergence patterns across major global regions (Castelnovo et al., 2016). This analytical gap limits understanding of how contextual factors shape governance innovation and technological adoption patterns in urban environments.

The significance of this research extends beyond academic inquiry to provide practical insights for urban policymakers, technology vendors, and international development organizations. As global smart city investment continues to expand—with market projections exceeding $2.5 trillion by 2025 (Frost & Sullivan, 2021)—understanding regional patterns and universal principles becomes crucial for optimizing resource allocation, avoiding implementation pitfalls, and accelerating successful deployment. Furthermore, the COVID-19 pandemic has accelerated digital transformation in urban governance, making comparative analysis of governance models increasingly relevant for post-pandemic urban recovery strategies (OECD, 2020).

This study addresses the identified research gap through comprehensive comparative analysis of smart city governance evolution across four major global regions. The research employs institutional theory and technology transfer frameworks to analyze smart city governance evolution, recognizing that governance innovations emerge from complex interactions between technological capabilities, institutional arrangements, and societal demands (Nam & Pardo, 2011). The analysis builds on policy transfer literature (Evans & Davies, 1999) to understand how governance innovations diffuse across different institutional contexts while adapting to local conditions.

2. Methods

2.1 Research Design

This study employed qualitative comparative methodology (Lijphart, 1971) to analyze smart city governance evolution across four major global regions: East Asia, Europe, North America, and the Middle East. The comparative approach enabled systematic examination of similarities and differences across regional contexts while identifying patterns of convergence and divergence, following established comparative analysis frameworks (Meijer & Bolívar, 2016).

The research design recognized that complex organizational phenomena require theoretical frameworks that can bridge gaps between abstract conceptual understanding and practical implementation realities (Scott, 2014). The methodological approach emphasized systematic integration of multiple knowledge sources while maintaining analytical rigor through comprehensive examination of diverse cases across different regional contexts. This approach aligns with institutional theory perspectives that emphasize the importance of contextual factors in shaping organizational innovation and governance transformation (Pierson, 2004).

2.2 Case Selection

Pioneer cities were selected from each region based on criteria including implementation maturity, governance innovation, and international recognition. Selected cities included Singapore, Seoul, and Tokyo (East Asia); Amsterdam, Barcelona, and Helsinki (Europe); New York, Toronto, and San Francisco (North America); and Dubai, Abu Dhabi, and Doha (Middle East).

The case selection strategy prioritized theoretical relevance rather than statistical representativeness, identifying cities that had undergone comprehensive smart city transformations under conditions that illuminate key theoretical relationships of interest (Yin, 2018). This approach enabled examination of how different institutional contexts, cultural values, and technological capabilities influence governance innovation patterns. The selection criteria ensured representation of different governance traditions,

technological capabilities, and implementation approaches while maintaining focus on cities with sufficient implementation experience to provide meaningful insights.

2.3 Data Sources and Analysis

The analysis drew on multiple data sources including academic literature, government reports, policy documents, and case study analyses. Data collection emphasized peer-reviewed sources from established databases including Web of Science, ensuring quality and credibility of source materials while maintaining comprehensive coverage of relevant literature. Additional sources included official government publications, international organization reports, and industry analyses to capture diverse perspectives on smart city governance evolution.

Data analysis employed thematic analysis techniques to identify patterns and themes across regional contexts, following established procedures for qualitative comparative research (Dameri & Benevolo, 2016). The analytical approach involved systematic comparison across different regional contexts to identify underlying principles operating consistently in various settings while highlighting areas where different approaches offered complementary rather than competing perspectives.

Multiple sources of evidence were utilized to ensure comprehensive understanding of governance transformation processes and outcomes while maintaining analytical rigor through systematic data triangulation. This approach enabled identification of robust patterns supporting theoretical development while acknowledging contextual variations requiring localized adaptation. The analysis followed Rogers' (2003) diffusion of innovations framework to understand how smart city technologies and governance practices spread across different regional contexts.

3. Results - Regional Smart City Governance Models

3.1 East Asian Region: Technology-Driven Transformation

East Asian smart city governance exhibits distinctive characteristics centered on technology-driven transformation approaches. These cities have adopted centralized implementation models characterized by strong top-down governance structures and advanced infrastructure development priorities (Nam & Pardo, 2011). The regional approach emphasizes technological sophistication and operational efficiency, reflecting broader cultural values prioritizing collective benefit and hierarchical decision-making structures (Angelidou, 2014).

Singapore's Virtual Singapore project exemplifies the regional approach through comprehensive digital twin implementation across the entire city-state. This initiative demonstrates extensive integration of real-time data collection, predictive modeling, and citizen service delivery through unified digital platforms. The project represents a significant investment in technological infrastructure that enables comprehensive urban monitoring and predictive governance capabilities (Frost & Sullivan, 2021).

Seoul's Smart Seoul 2015 initiative showcases sophisticated data-driven urban planning approaches, integrating transportation, energy, and service delivery systems through advanced analytics and citizen feedback mechanisms. The initiative demonstrates how technological sophistication can be combined with centralized governance frameworks while maintaining citizen engagement through digital platforms rather than traditional participatory mechanisms (Angelidou, 2014).

The regional model demonstrates how technological sophistication can be combined with centralized governance frameworks while maintaining citizen engagement through digital platforms rather than traditional participatory mechanisms. This approach reflects institutional contexts emphasizing efficiency and technological advancement as primary governance objectives, shaped by cultural values that prioritize collective outcomes over individual participation (Scott, 2014).

3.2 European Region: Citizen-Centric Participatory Governance

European smart city governance emphasizes citizen-centric development through participatory governance frameworks prioritizing sustainability and social inclusion (Castelnovo et al., 2016). This approach reflects broader European values emphasizing democratic participation, environmental sustainability, and social cohesion. The regional model demonstrates how technological innovation can be integrated with participatory governance mechanisms, creating hybrid approaches that balance efficiency gains with democratic accountability (Albino et al., 2015).

Barcelona's extensive sensor network for comprehensive urban monitoring exemplifies how technological sophistication can be combined with transparent data governance and citizen

participation. The initiative demonstrates integration of environmental monitoring, traffic management, and citizen services through participatory governance frameworks that maintain democratic oversight of technological implementation. The city's emphasis on technological sovereignty and citizen data rights reflects European values prioritizing democratic control over technological development (OECD, 2020).

Helsinki's AI governance experiments represent innovative approaches to testing artificial intelligence applications in municipal services while maintaining democratic oversight and citizen engagement. These experiments demonstrate how emerging technologies can be integrated responsibly within existing governance frameworks without compromising democratic participation or citizen rights (Angelidou, 2014).

Amsterdam's circular economy initiatives demonstrate integration of sustainability principles with smart city technologies, showcasing how environmental priorities can be combined with technological innovation through participatory governance frameworks. The initiatives reflect European emphasis on sustainable development and citizen participation in environmental governance (Albino et al., 2015).

3.3 North American Region: Market-Driven Innovation

North American smart city governance demonstrates innovation and efficiency-driven approaches through strong public-private partnership models and market-driven strategies (Dameri & Benevolo, 2016). This approach reflects broader cultural values emphasizing entrepreneurship, innovation, and market-based solutions to public challenges. The regional model demonstrates how market mechanisms can drive technological innovation while addressing public needs through partnership frameworks.

New York's LinkNYC digital infrastructure project represents comprehensive public-private partnership approaches to digital infrastructure development. The initiative demonstrates how market-driven innovation can address public connectivity needs while generating revenue through innovative business models that balance public service requirements with private sector capabilities (Frost & Sullivan, 2021).

Toronto's Quayside smart city initiative demonstrated ambitious approaches to comprehensive smart city development through private sector leadership and public sector oversight. Despite implementation challenges, the initiative provided valuable insights into partnership governance models and the complexities of balancing private innovation with public accountability (OECD, 2020).

San Francisco's smart city initiatives emphasize innovation-driven approaches leveraging the region's technological capabilities and entrepreneurial culture. The city's approach demonstrates how existing technological ecosystems can be leveraged for urban innovation while maintaining public sector oversight and citizen engagement (Yin, 2018).

3.4 Middle Eastern Region: Resource-Intensive Rapid Modernization

Middle Eastern smart city governance pursues rapid modernization approaches through resource-intensive development models focused on comprehensive urban transformation. This approach reflects regional priorities for economic diversification, international competitiveness, and technological leadership. The regional model demonstrates how substantial resource investment can accelerate smart city development while addressing unique contextual challenges.

Dubai's Smart Dubai initiative represents comprehensive smart city transformation through substantial resource investment and centralized coordination. The initiative demonstrates integration of transportation, energy, governance, and economic development through unified technological platforms supported by significant financial resources and centralized implementation authority (Angelidou, 2014).

Abu Dhabi's Masdar City project integrates sustainability principles with smart city technologies, demonstrating how environmental priorities can be combined with technological innovation in comprehensive urban development projects. The initiative showcases resource-intensive approaches to creating model smart cities from ground-up development (Albino et al., 2015).

Doha's smart city initiatives demonstrate rapid implementation approaches leveraging substantial financial resources and international expertise. The approach reflects regional strategies for technological leapfrogging and international competitiveness through comprehensive urban modernization (Frost & Sullivan, 2021).

3.5 Cross-Regional Patterns and Convergence

Analysis reveals distinct patterns in technology adoption across regions while identifying significant convergence trends. East Asian cities demonstrate early adoption of advanced technologies with emphasis on comprehensive integration and operational efficiency (Rogers, 2003). European cities pursue balanced technology-society approaches that prioritize democratic participation and sustainability considerations. North American cities emphasize innovation-driven adoption strategies leveraging market mechanisms and private sector capabilities.

Despite these regional variations, observable convergence toward hybrid governance models combines elements from different regional approaches while maintaining contextual adaptations (Meijer & Bolívar, 2016). This convergence manifests through digital platform integration across all regions, increasing emphasis on data-driven decision-making, enhanced citizen engagement mechanisms adapted to local participation traditions, and growing focus on environmental sustainability and resilience.

Cross-regional analysis reveals critical insights for successful smart city governance implementation. Contextual adaptation emerges as imperative for successful implementation, requiring adaptation to local institutional contexts rather than direct replication of successful models from other regions (Evans & Davies, 1999). Technology-society balance proves essential for effective smart city governance, requiring balanced approaches that leverage technological capabilities while maintaining social cohesion and democratic accountability (OECD, 2020).

The convergence patterns suggest emergence of global best practices that transcend regional boundaries while requiring contextual adaptation for successful implementation. This evolution reflects learning processes facilitated by international knowledge networks and policy transfer mechanisms (Dolowitz & Marsh, 2000).

4. Discussion

4.1 Evolution Trajectory and Transformation Dynamics

The analysis reveals complex evolution patterns in smart city governance that transcend simple technological determinism. Rather than linear progression from traditional to smart governance, the evidence suggests path-dependent evolution influenced by institutional contexts, cultural values, and stakeholder configurations (Castelnovo et al., 2016). This evolution pattern aligns with institutional theory perspectives emphasizing the importance of historical legacies in shaping contemporary governance innovation (Pierson, 2004).

Convergence patterns suggest the emergence of a global smart city governance paradigm, though this convergence occurs through adaptation rather than standardization. Regional variations persist while universal principles emerge, creating frameworks that combine global best practices with local contextual adaptation (Rogers, 2003). This pattern reflects complex diffusion processes where governance innovations spread across different institutional contexts while adapting to local conditions.

The transformation dynamics demonstrate how technological capabilities interact with institutional arrangements to create distinct governance models. These models reflect regional values and priorities while incorporating global technological trends and best practices (Scott, 2014). The evolution trajectory suggests increasing sophistication in balancing technological capabilities with governance requirements and citizen expectations.

4.2 Critical Success Factors

Strong political leadership emerges as a universal success factor across all regional contexts, though leadership requirements vary according to governance traditions. East Asian contexts require sustained technocratic leadership capable of coordinating complex technological implementation (Angelidou, 2014). European contexts require democratic leadership capable of building consensus among diverse stakeholders. North American contexts require entrepreneurial leadership capable of managing public-private partnerships.

Robust technical infrastructure provides the foundation for smart city governance, but infrastructure requirements vary according to implementation approaches and governance priorities. Technical capabilities must extend beyond physical infrastructure to encompass human resources, organizational competencies, and governance frameworks for technology management (Nam & Pardo, 2011). The COVID-19 pandemic has highlighted the importance of digital infrastructure resilience and adaptability (OECD, 2020).

Effective stakeholder engagement emerges as a critical differentiator between successful and struggling implementations across all regional contexts. However, engagement mechanisms must be adapted to local participation traditions and institutional frameworks. Successful engagement requires systematic approaches that go beyond consultation to encompass co-creation and collaborative governance.

Financial sustainability and resource mobilization represent critical success factors that vary according to regional economic contexts and governance models. Different regions demonstrate varying approaches to financing smart city development, from public investment to public-private partnerships to private sector leadership (Dameri & Benevolo, 2016).

4.3 Persistent Challenges

Digital divide issues persist across all regional contexts, though manifestations vary according to socioeconomic contexts and policy frameworks. The challenge extends beyond access to encompass digital literacy, cultural relevance, and meaningful participation in digital governance processes (Dameri & Benevolo, 2016). The pandemic has exacerbated digital divides while highlighting their importance for equitable governance (OECD, 2020).

Data governance emerges as a critical challenge requiring balance between data utilization for improved services and protection of citizen privacy and democratic rights. Privacy concerns extend beyond technical security to encompass citizen control over personal data and transparency in data usage (Albino et al., 2015). Different regional approaches to data governance reflect varying cultural values and regulatory frameworks.

Financial sustainability poses persistent challenges, particularly for smaller cities and developing regions. Financial sustainability requires business model innovation that balances public service requirements with revenue generation capabilities while maintaining long-term viability (Frost & Sullivan, 2021). The economic impacts of the pandemic have intensified financial pressures while increasing demands for digital governance capabilities.

Technological lock-in and vendor dependency represent emerging challenges as cities become increasingly dependent on specific technological platforms and providers. These challenges require careful attention to interoperability, open standards, and long-term technology governance strategies (Yin, 2018).

Conclusions

This research contributes to smart city governance literature through systematic comparative analysis of regional evolution patterns and convergence dynamics. The study demonstrates that while distinct regional characteristics persist, significant convergence toward hybrid governance models is occurring across global contexts, suggesting emergence of global best practices that can be adapted to local contexts.

The research reveals that regional differentiation maintains distinctive characteristics reflecting institutional contexts and cultural values, while convergence toward hybrid governance models suggests universal principles that transcend regional boundaries. Critical success factors prove universal in importance but require contextual adaptation in implementation, including political leadership, technical infrastructure, stakeholder engagement, governance frameworks, and innovation-stability balance.

Key implementation challenges transcend regional boundaries, suggesting systemic issues requiring coordinated responses and knowledge sharing across different contexts. Successful knowledge transfer requires active adaptation rather than passive replication, highlighting the importance of institutional entrepreneurship and creative adaptation of successful practices to local contexts.

The research findings suggest several policy implications for cities, national governments, and international organizations. Cities should develop contextually adapted implementation strategies that leverage global best practices while respecting local institutional contexts and citizen preferences, investing in institutional capacity building alongside technological infrastructure development. National governments should create enabling policy frameworks that support local innovation while ensuring coordination across jurisdictional boundaries.

Future research should examine the long-term sustainability of different governance models and their adaptability to emerging challenges such as climate change, demographic transitions, and technological

disruption. Additional research is needed on the role of citizen participation in different governance models and the effectiveness of various engagement mechanisms across different cultural contexts.

Smart city governance represents an ongoing experiment in institutional innovation that combines technological capabilities with governance traditions in pursuit of improved urban outcomes. Success requires careful balance between global learning and local adaptation, between technological sophistication and democratic accountability, between efficiency gains and social inclusion.

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Pre-pandemic Challenges and Socio-economic Disparities in the Prešov Region

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Abstract

Research background: The aim of this study is to assess the pre-pandemic socio-economic development of the Prešov region over a fifteen-year period.
Purpose of the article: The analysis is based on four main areas: demography, labor market, economic performance, and environmental factors.
Methods: Official statistical data were used, on the basis of which three research hypotheses were tested. The research focuses on the relationship between regional GDP and three variables - tourism (number of guests), unemployment rate, and number of employees in industry and construction.
Findings and Value added: Correlation analysis confirmed statistically significant relationships between variables and GDP. The findings point to the need to support investments, tourism development, and environmental sustainability as key factors for regional development and reducing disparities. The results serve as a basis for creating effective regional policy.

Keywords: Pre-pandemic socio-economic condition, Regional development, Regional disparities, Labor market, Tourism, Capital inflow, Sustainable environment, Prešov Region

JEL classification: O18, P25, R10

1. Introduction

The persistent uneven development of regions has long prompted the formation of dedicated regional policies aimed at mitigating territorial disparities and promoting more balanced and inclusive economic and regional development. The design of such policies is contingent on robust, methodologically sound analyses of socio-economic indicators, which support evidence-based decision-making by policy makers. A multitude of comparative and evaluative techniques are employed in regional studies; however, the reliability of such analyses depends critically on the selection of appropriate indicators, methodological rigor, and contextual interpretation. The accuracy of conclusions is highly sensitive to the applied analytical frameworks and the proper integration of quantitative and qualitative dimensions.

Regional analysis primarily focuses on identifying, explaining, and evaluating disparities across territorial units. Comprehensive regional studies are considered instrumental for improving the quality of life, particularly in light of increasing intra-national disparities (Allardt, 1993). As emphasized by Medvedeva et al. (2021), a region functions as a key subsystem within the broader socio-economic structure of a state, encompassing interactive relationships between the economic, governmental, and civil spheres.

The development trajectory of regions is shaped by a multitude of interrelated factors including innovation capacity, entrepreneurial activity, labor market efficiency, human capital endowment, governance quality, and institutional infrastructure (Bagdasarian et al., 2015). Scholars increasingly recognize the need for meso-level analyses—a level between the national and local scale—which allow for the detection of interregional disparities and development asymmetries (Antipin et al., 2020).

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Recent international studies reflect a growing interest in the regional differentiation trend. For instance, research from Russia (Tabachnikova et al., 2017; Nezhnivenko et al., 2021) illustrates the strong dependence of national development on the performance of its regions. However, limited fiscal autonomy and central budget constraints, combined with regressive tax policies, often exacerbate inequalities and undermine local development efforts (Makarenko et al., 2020). Similarly, studies from the Czech Republic (Sojková, 2016) and Poland (Barska et al., 2022) have identified multiple factors influencing regional development, including economic structure, infrastructure, employment, housing, and demographic shifts. Vardanyan and Lewandowski (2018) emphasized the value of cross-national comparisons (e.g., Poland vs. Armenia), highlighting the role of historical and socio-political context in shaping regional socio-economic outcomes.

In the context of the Slovak Republic, several authors (e.g., Melo & Richter, 2015; Marchevská et al., 2022) have documented significant regional disparities, particularly in eastern regions such as the Prešov and Košice self-governing regions. These disparities are most evident in labor market performance, income levels, RGDP, and foreign direct investment (Angelovič & Benč, 2015). Although recent findings suggest some convergence (Marchevská et al., 2022), structural and territorial inequalities persist.

A nuanced understanding of regional development requires not only macro-level indicators but also disaggregated micro-economic data such as employment rates, industrial participation, and sectoral productivity (Gevorgyan & Margaryan, 1994). Therefore, the present study aims to evaluate the pre-pandemic socio-economic condition of the Prešov Region by analyzing a selected set of indicators across four key dimensions: demographic structure, labor market, economy, and environment. The analysis spans a period of 15–20 years and seeks to identify structural limitations as well as development opportunities with the potential to improve the living standards of the region's population.

2. Methodology

The primary objective of this research is to analyze the pre-pandemic socio-economic condition of the Prešov Region over a time span of 15 to 20 years. This main goal is operationalized through four sub-objectives:

(1) to characterize and evaluate the development of the region in terms of its demographic structure, economic performance, labor market, and environmental context;
(2) to conduct a statistical analysis of selected indicators;
(3) to identify key strengths and weaknesses of the region;
(4) to formulate potential policy challenges and recommendations for regional improvement.

The research is grounded in quantitative methods and utilizes secondary data obtained from the Statistical Office of the Slovak Republic, specifically from the publicly accessible DATAcube database. These datasets are collected and published on a quarterly or annual basis. Additionally, selected indicators were supplemented with data from the EU-SILC (European Union Statistics on Income and Living Conditions), which are also publicly available via the national statistical portal.

The socio-economic analysis is structured into four thematic dimensions:

- Demographic structure: total population, population density, average age, natural population change, and internal structure of the population;
- Labor market and tourism: number of employees by sector, unemployment rate, average gross wage, number of registered registered job seekers, number of accommodation facilities, and number of guests;
- Economic performance: gross domestic product (GDP), regional gross domestic product (RGDP), number of industrial enterprises, industrial revenues, and tourism-related revenues;
- Environmental indicators: land use structure, percentage of population connected to sewage and water supply systems, and baseline emissions.

To address the research objectives, a set of three hypotheses was formulated to test the statistical relationships between selected variables. The dependent variable is regional gross domestic product (RGDP), while the independent variables include:

(a) number of guests in the region (tourism activity),
(b) unemployment rate, and
(c) number of employees in the industrial and construction sectors.

Data analysis was conducted using descriptive statistics (e.g., minimum, maximum, mean, median, standard deviation) and Shapiro–Wilk normality tests to assess data distribution. Based on the distributional characteristics, correlation analysis was applied using Pearson or Spearman correlation coefficients as appropriate. All statistical procedures were performed in the Jamovi software environment, which provides an accessible and robust platform for applied socio-economic research.

Characteristics of the research object

The main region studied, which was the subject of the analysis, is the Prešov Region. European Union qualifies the region for the NUTS III group. The Prešov Region is located in the northeast of the Slovak Republic. Region was established in 24 July 1996 based on the Act of the National Council of the Slovak Republic No. 221/1996 Coll. on the Territorial and Administrative Organization of the Slovak Republic. The area of the region is 8,974 km2, which represents 18.3% of the area of the state and is the second largest region of the Slovak Republic. The northern border of the region is the state border with the Republic of Poland. The eastern border is the state border with Ukraine. The region borders the Košice Region to the south and the Žilina Region to the west.

The region includes 13 districts, namely: Bardejov, Humenné, Kežmarok, Levoča, Medzilaborce, Poprad, Prešov, Sabinov, Snina, Stará Ľubovňa, Stropkov, Svidník and Vranov nad Topľou. The largest district by area is Poprad (1,105 km2) and the smallest is Stropkov (389 km2).

Figure 1. Self-governing Prešov Region
Source: Phrsr-psk-2021-2030 (2023)

The Prešov Region has a variety of natural conditions associated with the geological conditions of the territory, soil conditions and the structure of land use. In individual parts of the region, the occurrence of natural phenomena, preserved and valuable ecosystems is recorded, which are currently declared protected in various degrees of protection. The main streams flowing through the Prešov Region are Hornád, Torysa, Topľa, Ondava and Laborec. The territory of the region is rich in sources of natural healing waters. The most famous include Bardejov Spa, Cigeľka, Vyšné Ružbachy, and natural sources of mineral table waters Lipovce - Salvator. The region is poor in mineral raw materials, but in the localities Solivar - Prešov there are significant deposits of rock salt.

The territory of the Prešov Region is a relatively sparsely populated territory of the Slovak Republic. The average population density is 91.3 inhabitants per km2. The Prešov Region has also significant differences between individual districts. Within the region, we find districts that are the largest in terms of population within the Slovak Republic, e.g. Prešov, and then districts that are among the smallest, e.g. Medzilaborce. This difference is also observed in the population density. The regional capital Prešov is the dominant city of the region, and with more than 90 thousand inhabitants, it is the third largest city in the Slovak Republic. As a city, Prešov has international and national importance in terms of population, population concentration and economic activities (PSK, 2023).

3. Analysis of social-economic situation in the analyzed country

Demographic structure

Table 1 gives basic development of demographic structure at the beginning of the analyzed period, compared with the 2020 situation.

Table 1. Selected indicators of demographic structure for Prešov Region inhabitants

	Year	
	2020	2002
Number of inhabitants	827 028	807 011
Rate of inhabitants in preproductive age (%)	18,02	22
Rate of inhabitants in productive age (%)	67,17	67,78
Rate of inhabitants in postproductive age (%)	14,81	10,22
Average age of inhabitants	39,05	34,17
Density of inhabitants per km2	92,13	88,4
Natural population growth	2022	2991

Source: own processing according to ŠÚSR

The settlement structure in the Prešov Region is influenced by natural conditions, population density and terrain. During the monitored period, the number of inhabitants of the region grew and as of 31.12.2020 reached 827,028, which is 20,017 more than in 2009. The region is the most populous in Slovakia, but at the same time has a below-average population density (92.13 inhabitants/km²) and is the second largest in terms of area after the Banská Bystrica Region.

Differences are clear between the southwest (population growth) and the northeast (decline). The demographic structure shows an aging population - the share of children is decreasing and the share of seniors is increasing, although the region still has the highest share of the pre-productive population and the lowest share of the post-productive. The average age in 2020 was 39.05 years and has been increasing in the long term. Despite the declining trend in natural increase, in 2020 it was the highest in the Prešov Region.

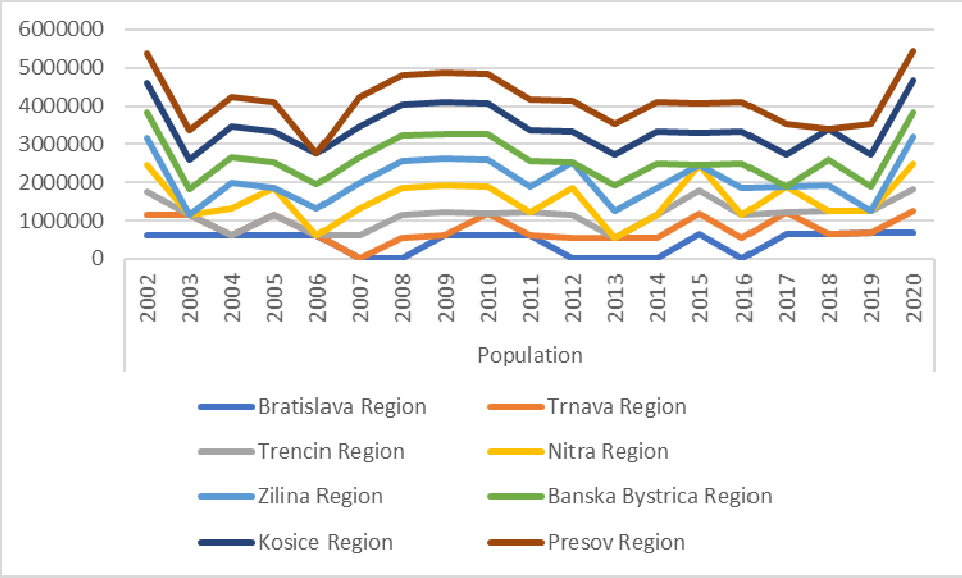

Figure 2. Development of population number in Prešov Region
Source: own processing

Between 2002 and 2020, the Prešov Region maintained the highest population of all Slovak regions, although in 2006 it experienced a short-term decline, during which its population approached that of the Košice Region. Overall, demographic development was fluctuating, but since 2019 there has been a slight increase again.

Despite the overall population growth, the northeast of the region shows an unfavorable development due to high mortality. At the same time, the population is aging - the share of young people is decreasing and the share of older age groups is increasing. This leads to a deteriorating age structure, lower reproductive capacity and a higher economic burden.

Job market

In the labor market, labor itself acts as a production factor, for which there is demand from firms and supply from households and workers. When deciding on the supply of labor, they consider the reward for this work and the consumption that the reward will enable them to make. That is why much attention is paid to the analysis of the labor market, in economic, social and political contexts (see analysis results in Table 2).

Table 2. Selected indicators for job market in Prešov Region

	Year	
	2020	2009
Total number of employees	186 895	138 578
Number of employees in industry and construction	52 645	38 559
Measure of unemployment (%)	11,39	18,29
Number of employment applicants	49 912	78 081
Average gross wage (EUR)	1086,00	636,43
Number of accommodation facilities	824	605

Source: own processing

Table 2 shows that the number of employees in the Prešov Region is growing, but in 2020 it was one of the regions with the lowest employment, which is related to the departure of residents for work. 52,645 people worked in the construction industry, which ranked the region second from the bottom in employment in industry and construction. The Trenčín Region has the most companies in these sectors.

In 2020, the Prešov Region had 344 industrial enterprises (4th place in Slovakia) and 13 industrial parks, mostly "green", with good transport accessibility. Their focus is mainly on mechanical engineering, electrical engineering, industrial and textile production.

The key problem remains high unemployment - in 2020 it reached 11.39%, the highest among all regions. Although unemployment gradually decreased after the 2009 crisis, it rose again in 2020 due to the COVID-19 pandemic. This development highlights the region's vulnerability to external economic shocks and the need for targeted employment policies.

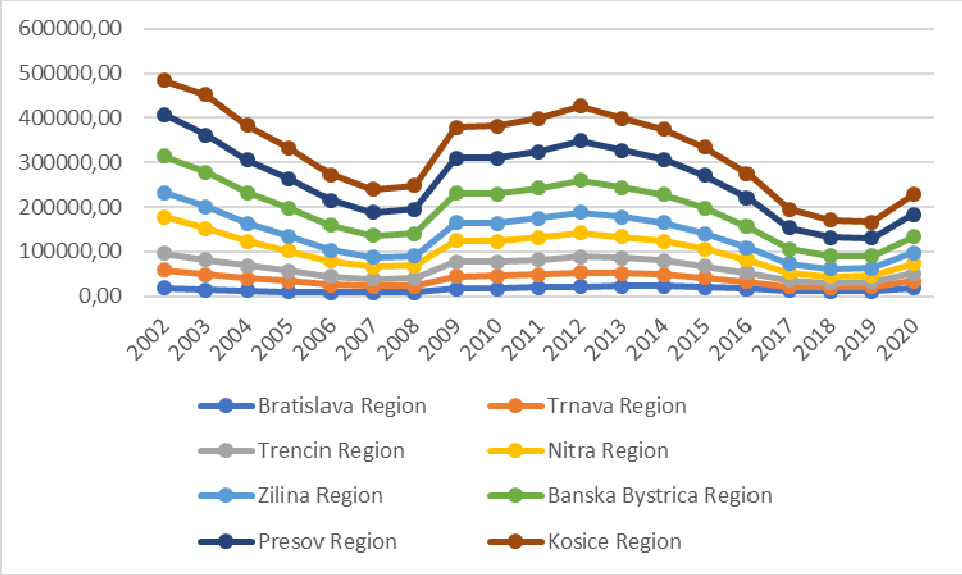

Figure 3. Number of registered job seekers
Source: own processing

In 2020, the average gross wage in the Prešov Region reached €1,086, which was the lowest of all regions. The national average was €1,265.88, with the highest in the Bratislava Region (€1,688). Despite the low wage level, the region has recorded an increase of €449.57 since 2009, indicating a gradual leveling of differences.

The Prešov Region also had the highest number of registered job seekers – 49,912 people. Although the number of unemployed people has been decreasing in the long term, it increased again in 2019 and 2020, mainly due to the increase in the long-term unemployed. These people often face low qualifications and poor work habits.

Solving this problem requires targeted measures – retraining, vocational training and motivational tools for employers – to reduce regional differences and increase employment.

Economy

According to the data of the Statistical Office of the Slovak Republic, the Prešov Region achieves low GDP per capita values. As a result, the region is ranked among the least performing regions of the Slovak Republic. In the monitored period, it is possible to see a slight increase in GDP per capita (see Table 3). From 2002 to 2008, the development of GDP in the Prešov Region had an increasing tendency. Since 2008, we have been recording a decrease. However, since 2009, GDP has been growing again. We also observe a minimal decrease in 2013. From 2014 to 2019, the development of GDP in the Prešov Region has an increasing character. A decrease occurs again in 2020, but these changes in 2021, when we again recorded an increase in GDP.

Table 3. Selected indicators in area Economy in Prešov Region

	Year	
	2020	2009
GDP per inhabitant (EUR)	10 414,72	6 820,48
RGDP (mil.EUR)	8 613,02	5 492,83
Number of industrial organizations	3 730	1 649
Sale of industry (EUR)	5 004 685,00	2 276 585,00
Number of beds in accommodations facilities	36 792,00	32 764,00
Sales of tourism	5 454 100,00	
Number of visitors	1 108 313,00	586 447,00

Source: own processing

Regional GDP per capita also has a growing trend during this period (Figure 4). The EU classification classifies the Prešov Region as a less developed region, as the region's GDP is less than 75% of the EU average.

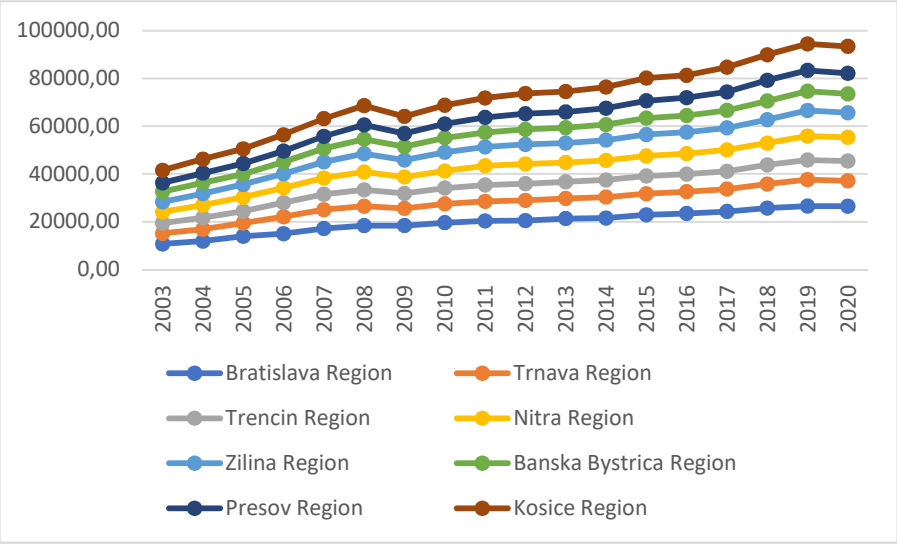

Figure 4. Development of RGDP in all Regions (mil. EUR)
Source: own processing

Real GDP takes inflation into account, so it is lower than nominal GDP in the event of positive inflation. The highest real GDP was recorded in the Košice region, followed by the Prešov region. Overall, Slovakia has a positive GDP growth trend, with a slight decrease in 2020 due to the pandemic.

Industrial production is key to the economy. In terms of the number of industrial enterprises, the Prešov region was in 4th place in 2020 (344 enterprises), but industrial revenues were among the lowest – only the Banská Bystrica region was worse.

The Prešov region is one of the least performing regions in Slovakia, with a GDP per capita below 75% of the EU average. The population is aging and demographic growth is low. It therefore needs restructuring and attracting foreign investment.

Living environment

A significant part of the territory of the Prešov Region lies in foothills and mountainous areas, which presents difficult production conditions for agricultural production. Part of the territory occupies the territory of protected natural areas, which means that the production process is limited by environmental protection measures. Agricultural land cannot be used very intensively for these reasons. Since 2002, land use has tended to decrease and increase. Agricultural land is being converted to industrial zones, warehouses or areas for residential and mixed construction. A trend that cannot be stopped, but can be reasonably and purposefully regulated. The construction of residential and industrial areas in the region caused the area of agricultural land to reach 41.55% in 2020.

Table 4. Selected indicators of Living environment in Prešov Region

	Year	
	2009	2020
Use of soil	8 973 889 511	8 972 756 706
Number of inhabitants, connected to the water supply and sewage system (%)	78	82,1
Basic (solid) emission (tons)	385,7	7 041,70

Source: own processing

In the field of environment, the Prešov Region is among the regions with a high proportion of inhabitants connected to water supply and sewage. The proportion of inhabitants supplied with water from the tap in the region is 82.1%. The average within the Slovak Republic is close to 100%, with a value of 90.15%. The positive level of the indicators is related to the number of people living in cities.

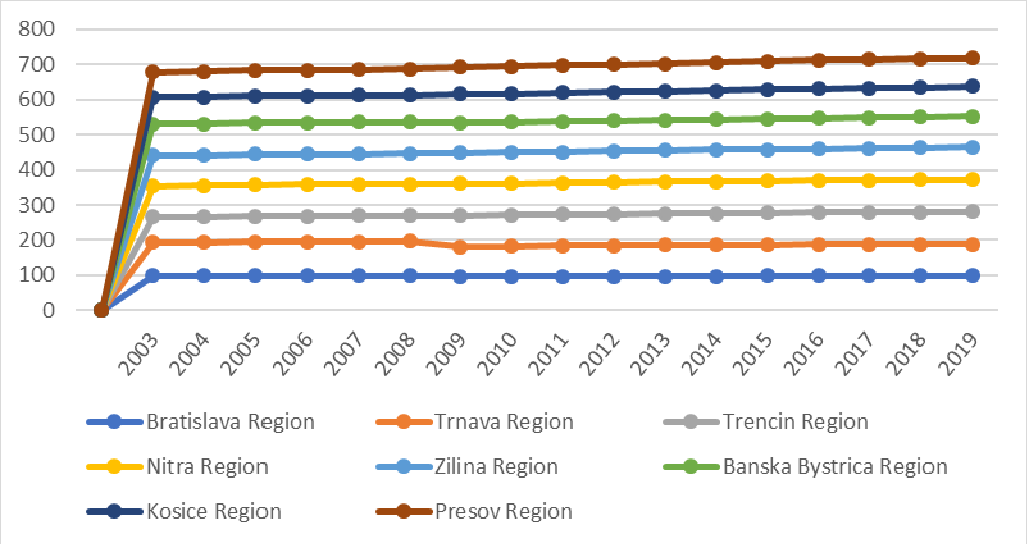

Figure 5. Development of inhabitants' rate connected to water supply and sewage system
Source: own processing

The share of the population connected to water supply and sewage is highest in the Prešov region. The population density and the number of inhabitants of all regions in Slovakia of course influence this. The course of the graph in Figure 5 is increasing throughout the entire monitored period. The value in 2020 is therefore the highest of all years, in all regions.

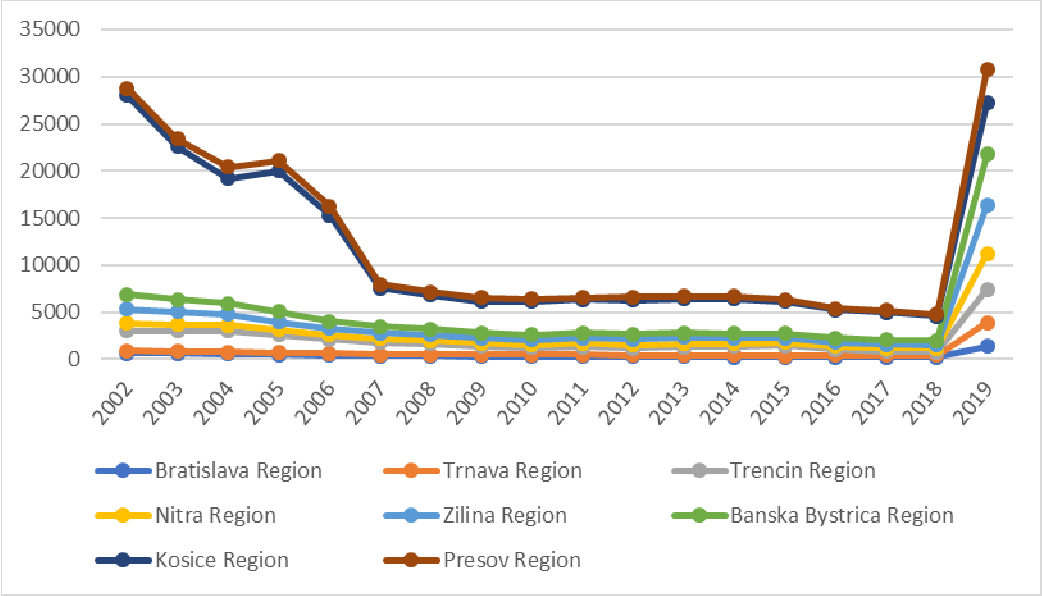

Figure 6. Development of basic emissions
Source: own processing

Figure 6 shows the bases, i.e. solid emissions for individual regions in tons. As we can see in the graph, the Prešov Region, together with the Košice Region, achieved significantly higher values in 2002 than the other regions of Slovakia. They managed to correct this fact and reduce the emission values over the years. They came closest to the other regions of Slovakia in 2007, but the emission value in these regions was still slightly higher than in the other regions. From 2007 to 2018, all regions of Slovakia, including the Košice and Prešov Regions, maintained constant values. However, in 2018, emissions increased in all regions. In the Prešov and Košice Regions, this increase was steeper than in the other regions of Slovakia.

Overall, the Prešov Region has long been ranked among the regions with good air quality, which is given by the type of industrial production and the nature of settlement. Tab. No. 4 shows a significant increase in solid emissions since 2009. In 2020, the average number of solid emissions was 3849.01 tons. Since the 1990s, the region has experienced a significant improvement in the state of the environment due to the use of more environmentally friendly technologies and significant investments in ecological measures.

4. Research hypothesis

H1: We assume that there is a dependence between the development of the RGDP of the Prešov Region and the development of the number of guests in the region.

H2: We assume that there is a dependence between the development of unemployment and the development of the RGDP in the Prešov Region.

H3: We assume that there is a dependence between the development of the number of employees in industry and construction and the development of the RGDP in the Prešov Region.

Correlation analysis was used to determine statistically significant correlation. If the p-value was less than 0.05, it can be concluded that there is a statistically significant relationship between the variables. If the correlation coefficient is positive. It presents a positive correlation, if the correlation coefficient is negative, it is a negative correlation. Statistics were performed using the free and open-source statistical data analysis software Jamovi, which provides a user-friendly interface with a wide range of statistical tools and techniques for data analysis, including descriptive statistics, hypothesis testing, regression analysis, and others.

Table 5. Illustration of indicators in Jamovi software

Descriptives

	RHDP	number of guests	unemployment	number of employees	RHDP
N	18	18	18	12	12
Mean	6310	722683	15.1	49040	7168
Median	6433	676142	15.6	46293	7067
Sum	113575	13008287	271	588484	86018
Standard deviation	1591	138770	3.94	6562	1099
Minimum	3654	586447	8.19	38559	5493
Maximum	8734	1108313	20.7	57882	8734
Shapiro-Wilk W	0.959	0.818	0.939	0.899	0.939
Shapiro-Wilk p	0.579	0.003	0.279	0.155	0.484

Source: own processing in Jamovi

The dependent variable RGDP was analyzed in terms of descriptive statistics for the period from 2003 to 2020/a period of 18 years, but also for the period from 2009 to 2020/a period of 12 years.

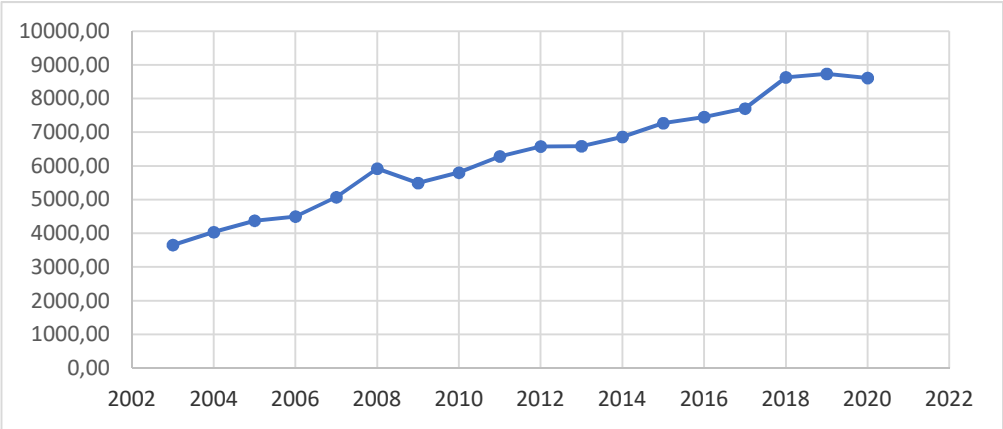

Figure 7. RGDP in Prešov Region during 18-year period
Source: own processing in Jamovi

The average RGDP for a period of 18 years in PSK is 6,310, while for a period of 12 years it is 7,168. From this, it can be concluded that the value of RGDP of PSK is growing significantly and has an upward trend.

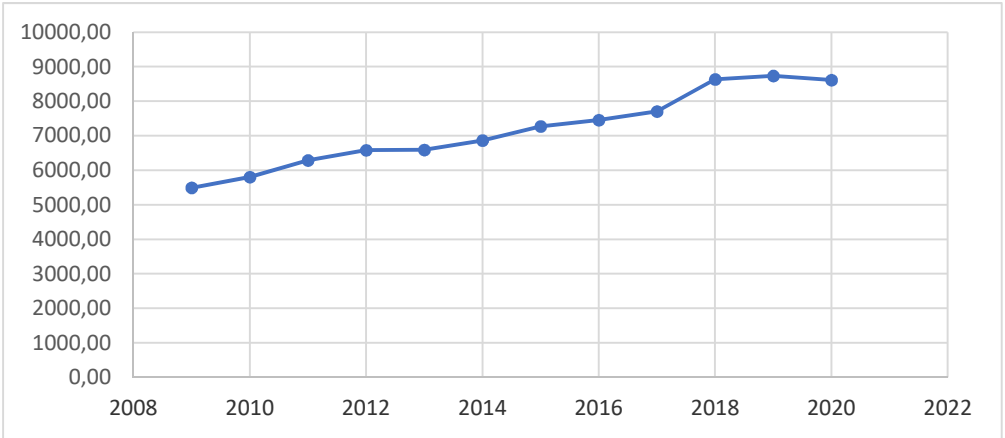

Figure 8. RGDP in Prešov Region during 12-year period
Source: own processing in Jamovi

The number of guests at PSK over a period of 18 years was on average 722,683, the lowest in 2009 /586,447, the highest in 2019 /1,108,313. The number of guests at PSK also had an increasing trend over a period of 18 years (see Figure 9).

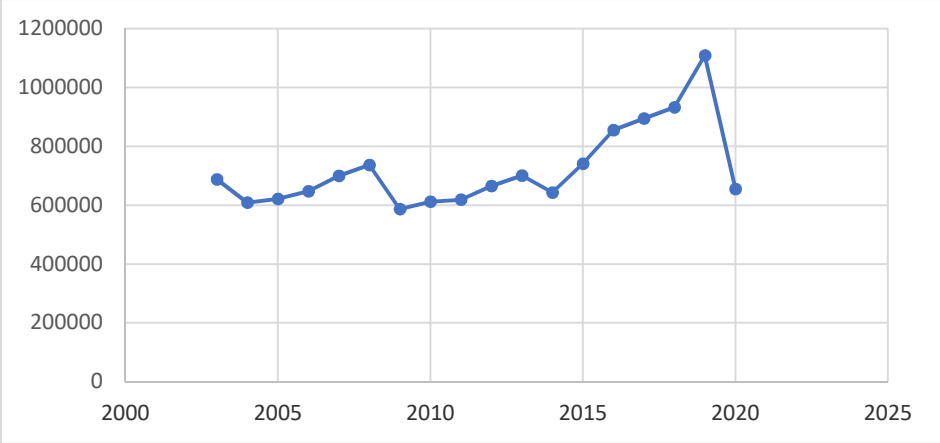

Figure 9. Development of visitors in Prešov Region
Source: own processing in Jamovi

Based on the results of the Shapiro-Wilk test (Figure 10), it can be stated that the RGDP value for the 18-year period is 0.579, which means that the data have a normal distribution. The value for the number of guests in PSK for the 18-year period is 0.003, the data do not have a normal distribution, and therefore, to test the dependence between the variables, it is necessary to use the Spearman correlation coefficient.

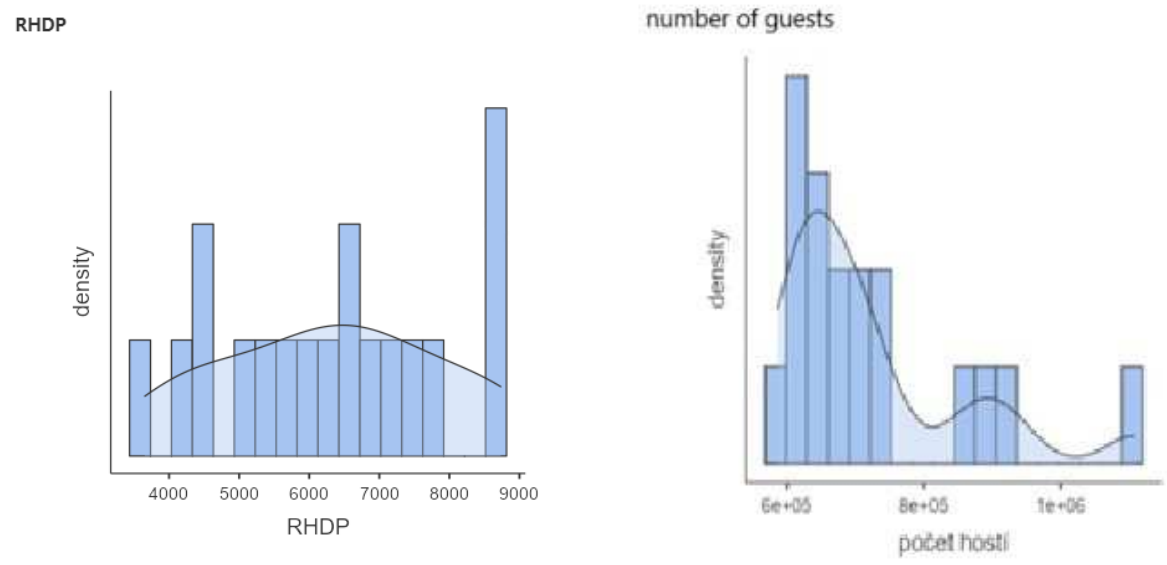

Figure 10. Histograms Shapiro-Wilk test – RGDP and number of visitors
Source: own processing in Jamovi

The average unemployment rate in the PSK for the period of 18 years has been at the level of 15.1%. The lowest was in 2019 (8.19%), the highest in 2012 (20.66%). The unemployment curve has an increasing - decreasing tendency (see Figure 11).

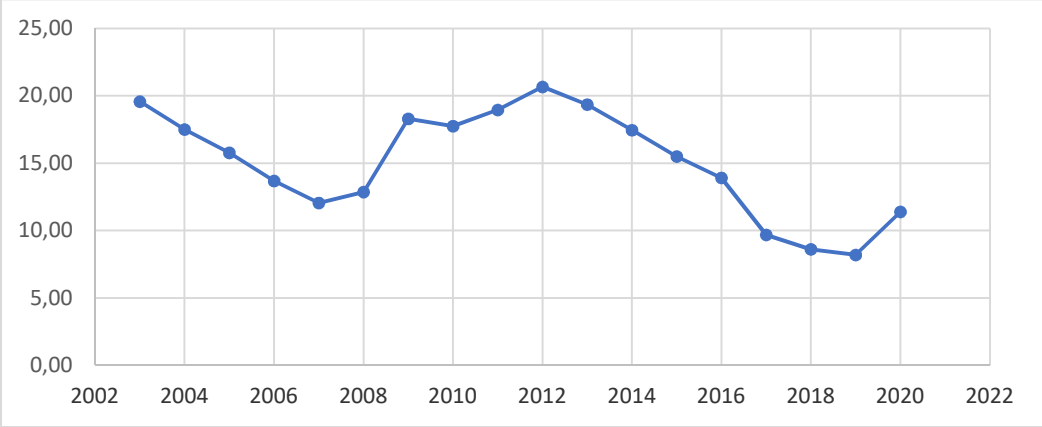

Figure 11. Measure of unemployment in Prešov Region
Source: own processing in Jamovi

Based on the results of the Shapiro-Wilk test, it can be stated that the p-value for unemployment over the 18-year period is 0.279, which means that the data have a normal distribution. Pearson's correlation coefficient was used to test the relationship between RGDP (over 18 years) and unemployment in PSK.

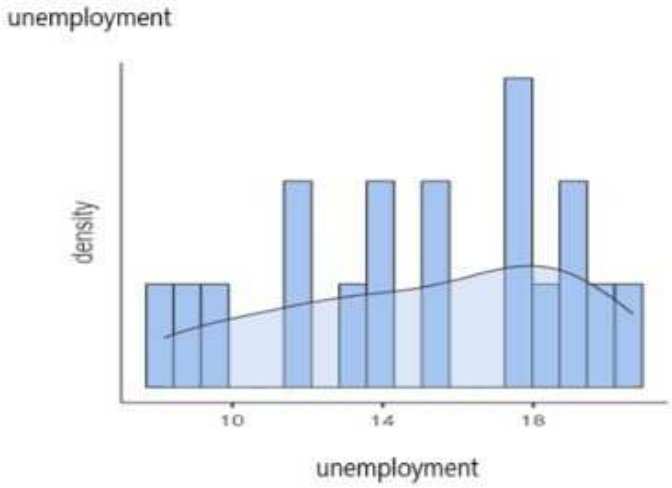

Figure 12. Histogram Shapiro-Wilk test for unemployment
Source: own processing in Jamovi

The number of employees in construction and industry in PSK has been on average at 49,040 over a period of 12 years. The lowest number of employees was in 2009/38,559, the highest in 2017/57,882. The number of employees over a period of 12 years has a slightly increasing trend.

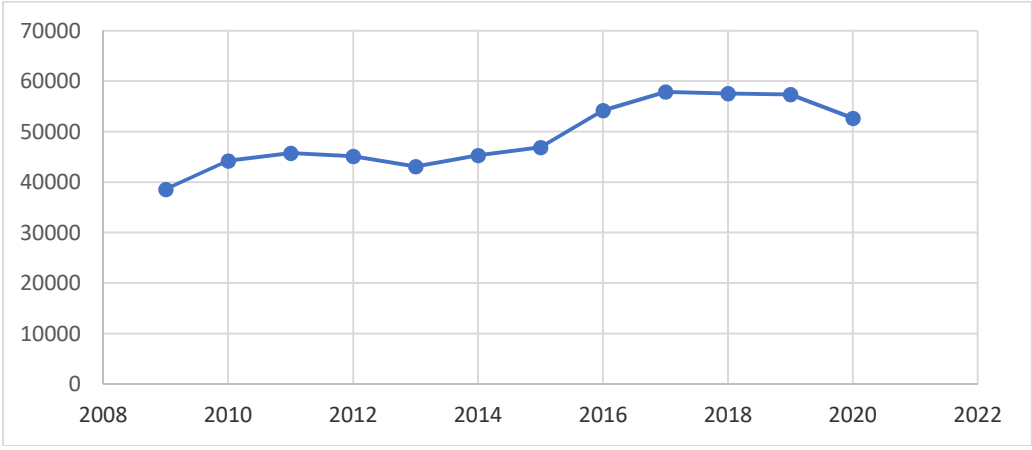

Figure 13. Number of employees in industry and construction in Prešov Region
Source: own processing in Jamovi

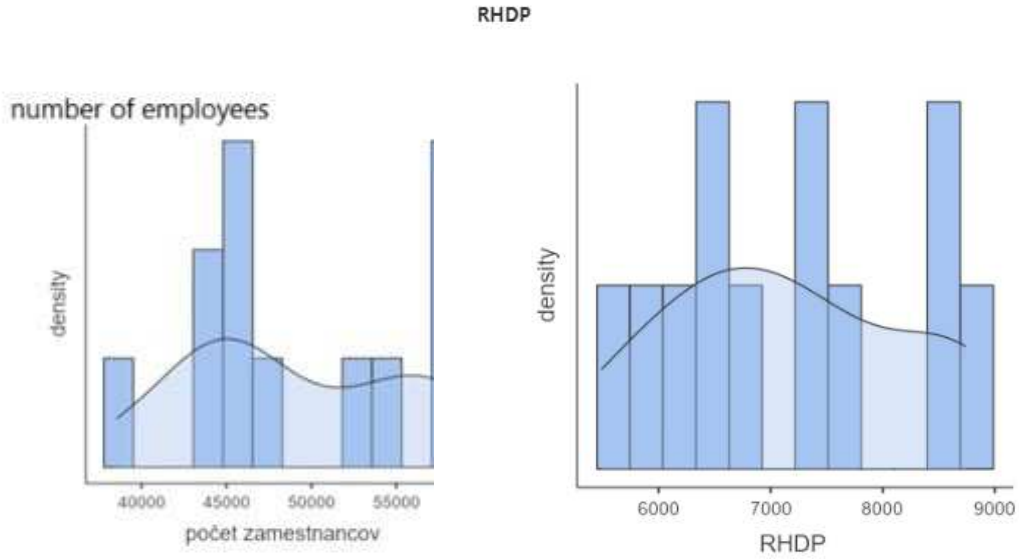

Figure 14. Histograms Shapiro-Wilk test – number of employees and RGDP
Source: own processing in Jamovi

Based on the results of the Shapiro-Wilk test, it can be stated that the p-value for the number of employees is 0.155 for the 12-year period; the p-value for RGDP in PSK for the 12-year period is 0.484, which means that the data have a normal distribution. The Pearson correlation coefficient was used for testing.

H1: We assume that there is a relationship between the development of the RGDP of the Prešov Region and the development of the number of guests in the region.

Correlation Matrix

	RHDP	Number of Guests
RHDP	Spearman's rho — p-value —	—
Number of Guests	Spearman's rho 0.664** p-value 0.003	—

Note: *p* < .05, **p** < .01, ***p*** < .001

Figure 15. Correlation of RGDP and number of Guests
Source: own processing in Jamovi

Based on the results of the correlation analysis, using Spearman's correlation coefficient, the relationship between the variables is positive (0.664), p value =0.003, which is less than 0.05 and represents a statistically significant correlation. This means that H1 can be confirmed.

H2: We assume that there is a dependence between the development of unemployment and the development of RGDP in the Prešov Region.

Correlation Matrix

	RHDP	Unemployment
RHDP	Pearson's r — p-value —	—
Unemployment	Pearson's r -0.567* p-value 0.014	—

Note: *p* < .05, **p** < .01, ***p*** < .001

Figure 16. Correlation of RGDP and Unemployment
Source: own processing in Jamovi

Based on the results of the correlation analysis, using Pearson's correlation coefficient, the relationship between the variables is negative (-0.567), the p value =0.014, which is less than 0.05 and represents a statistically significant correlation. This means that H2 can be confirmed.

H3: We assume that there is a relationship between the development of the number of employees in industry and construction and the development of RGDP in the Prešov Region.

Correlation Matrix

	RHDP	Number of Employees
RHDP	Pearson's r — p-value —	—
Number of Employees	Pearson's r 0.891*** p-value < 0.001	—

Note: *p* < .05, **p** < .01, ***p*** < .001

Figure 17. Correlation of RGDP and number of employees in industry and construction
Source: own processing in Jamovi

Correlation analysis using Spearman's coefficient showed a strong positive relationship between real GDP (RGDP) and the number of employees in industry and construction ($r = 0.891$; $p < 0.001$), thus confirming hypothesis H3.

All three variables—number of tourists, unemployment rate, and number of employees in productive sectors—had a statistically significant relationship with RGDP. The number of employees had the strongest positive impact, followed by a moderate correlation with the number of tourists. Unemployment had a negative correlation, indicating that the growth of unemployment reduces the economic performance of the region.

The results confirm the importance of an efficient labor market and tourism development for the economic resilience of the region.

5. Discussion and Conclusions

The analysis of the Prešov Region's pre-pandemic socio-economic conditions confirms its status as Slovakia's most populous and second-largest region. While the population continues to grow, it is also aging due to a declining number of individuals in the pre-productive age group and a rise in those in productive and post-productive stages. This trend may strain the labor market and social systems in the future.

Economically, the region has a balanced sectoral structure, dominated by manufacturing and SMEs. However, limited foreign investment hampers innovation and growth, and the region consistently ranks lowest in GDP share among Slovak regions, highlighting national economic disparities.

Tourism offers untapped potential due to cultural heritage and natural attractions, but poor infrastructure and services limit its development. The labor market faces significant challenges, particularly in long-term unemployment among low-skilled and vulnerable groups.

To address these issues, the region needs strategic efforts in boosting investment, modernizing tourism, and improving environmental sustainability. These actions could support inclusive growth and better living standards.

In conclusion, the study's aim to assess the region's socio-economic profile and identify development challenges was achieved. The findings offer a solid basis for strategic planning, with the potential for sustainable and balanced regional development.

Acknowledgements

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The Role of the Solidarity Economy in Rural Areas

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Abstract

Research background: A better understanding of the spatial structure of the rural areas and small villages shows that people living in disadvantaged settlements have limited labour market opportunities. In recent years, an increasing number of social cooperatives have been set up in Hungary as an alternative to public employment. These can also be identified as building blocks of the solidarity economy. Therefore, Social cooperatives also play an important role in local and rural development.
Purpose of the article: This paper aims to analyse social cooperatives in small villages in Hungary from a rural development perspective. In the Hungarian spatial structure, small villages are typically located on the periphery, with mostly disadvantaged inhabitants with low educational attainment.
Methods: The research methodology is based on a case study design. The author visited the municipality of Páty and studied the public employment and the social cooperative. The results were recorded in a case study that can be used in education.
Findings & Value added: In these settlements, local communities can better understand what hinders and what helps their economy to grow and improve living standards by assessing their economic base. With this new knowledge, local communities can achieve results through strategically designed programmes and projects that social cooperatives can join and help achieve.

Keywords: Solidarity economy, Social cooperatives, Rural areas, Hungary

JEL classification: R23

1. Introduction

Reducing unemployment cannot be expected to be significantly or sustainably solved by the actors of the economy. The employment opportunities in the profit-oriented sector are not limitless, and their concentration is noticeable in large cities. People living in disadvantaged rural areas, often with low levels of education, have very limited opportunities. The author does not see the solution to Hungary's unemployment problems in public employment, but rather in the solidarity economy (also known as the social economy). The core value of the solidarity economy is that its activities are carried out not for the individual but for the benefit of the community, aiming to support the formation of communities organised along territorial lines or shared interests. Individuals involved in the solidarity economy cooperate for mutual benefit.

Public employment, a frequently used active labour market policy tool, may be a suitable option in settlements where job opportunities are limited or completely lacking (Ördögh, 2002; Váradi, 2015; Cseres-Gergely & Molnár, 2014; Koltai, 2014; Mélypataki, 2017). However, the focus should be on identifying possible ways to move beyond public employment. One such direction is towards the solidarity economy. In disadvantaged and underdeveloped regions with a lack of enterprises, public employment alone is not a sufficient solution.

In recent years, the Hungarian government has seen the establishment of social cooperatives as a transitional solution for exiting public employment, making municipal membership mandatory. The legal framework to support this is already in place. It is also important to support the employment initiatives of nonprofit organisations, social enterprises, and social cooperatives, as these are the main building blocks of the solidarity economy, creating jobs outside the mainstream labour market (Neamtan, 2002).

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The COVID-19 pandemic created a new situation in the domestic labour market, reshaping it on regional and local levels (Karácsony et al., 2021). A significant portion of businesses became non-operational, and many sectors lost a large part of their workforce. Given the current economic conditions, it is necessary to review the structure of the labour market and its regional inequalities. The currently functioning public employment program only partially addresses labour market problems, and in peripheral (small village) areas, it is often the only available job opportunity. There is a demand for additional alternative solutions, such as strengthening the solidarity economy (through social enterprises and cooperatives) (Gadócziné Fekete et al., 2018) or expanding atypical employment opportunities. Some of these solutions, as good practices in local employment development, fall under the concept of social innovations (Benedek et al., 2020). These social innovations are often informal and remain hidden, which makes it difficult to assess the societal significance of the solidarity economy sector in Hungary (Birkhölzer, 2000; Gadócziné Fekete & Lipták, 2014).

Today, the most widespread economic model includes three economic sectors operating alongside each other. The first sector, referred to as economically active, is the competitive sector, which consists of business enterprises and economic associations whose primary goal is profit generation. The second sector, considered economically inactive due to the absence of business activity, comprises budgetary and public institutions whose main function is to operate public administration and welfare subsystems.

The organisations in the third sector show a highly diverse picture. This sector includes the solidarity economy, which encompasses social enterprises and economically active nonprofit organisations—the community economy, which consists of organisations operating on a charitable basis, and the informal economy, which includes family and self-sufficiency activities and is often referred to as the shadow economy.

The core value of the solidarity economy is that its activities serve the interests of the community rather than the individual. It aims to support the development of communities organised on a territorial basis or around shared interests (Birkhölzer, 2000). Individuals involved in the solidarity economy cooperate for mutual benefit. The key players in the solidarity economy are social enterprises and cooperatives. Social enterprises serve the community and do not aim to maximise profit; their target group typically consists of the long-term unemployed. In Hungary, the social land program can be regarded as a form of social enterprise (Gadócziné Fekete & Solymári, 2004).

2. Methods

The methodology of case study preparation is a qualitative research approach aimed at the in-depth and detailed examination of a specific phenomenon, process, organisation, or community. In case studies, it is essential to define the objective and formulate the research question. This is followed by the selection of the specific settlement, data collection, a visit to the location, conducting interviews, and evaluating their results.

In the present study, the author chose the settlement of Páty, which is located about 40 kilometres from the capital, yet still retains a rural character, with residents facing various labour market challenges. The author visited the settlement in April 2025. The main aim of the study is to present a local best practice that provides solutions to the problems of the local community in a rural area. The set of applied indicators was introduced through the analysis of available statistical data in order to describe the economic and social situation of the settlement. The following research question was formulated: What role does one of Hungary's best-known civil organisations, the Hungarian Charity Service of the Order of Malta (Magyar Máltai Szeretetszolgálat), play in Páty, and how can it contribute to improving the local labour market situation?

3. Results

3.1 Introduction of the municipality of Páty

Páty is a dynamically developing village in Pest County, located in the Zsámbék Basin, approximately 40 kilometres west of Budapest. Due to its excellent location and good transport connections, it is a popular place to live for those who appreciate both the proximity to the capital and a peaceful, natural environment. The area of the settlement is 39.3 km², and its population reached 8,739 in 2025. The number of inhabitants is continuously increasing; Figure 1 shows the number of live births and deaths.

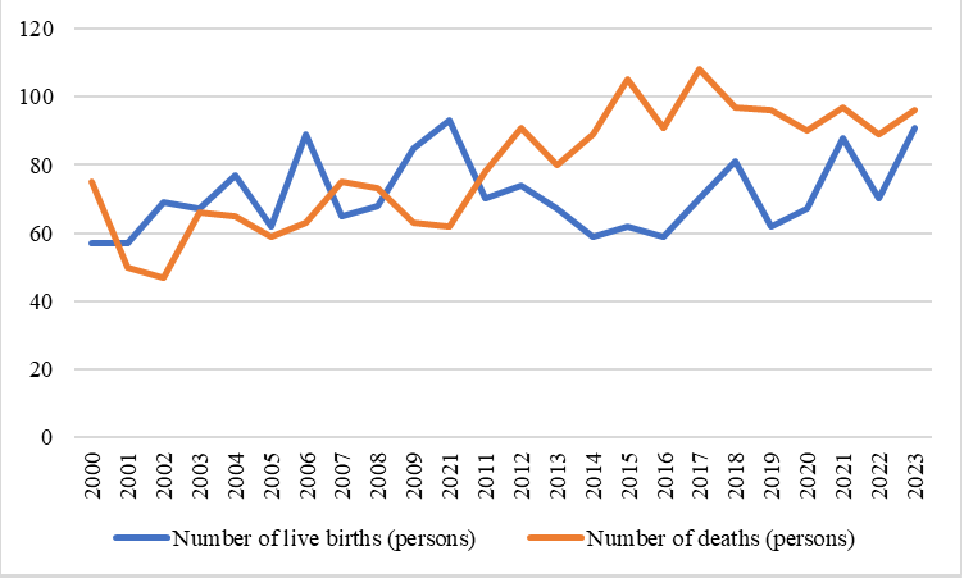

Figure 1. Demographic trends in Páty (2000-2023)
Source: own processing (2025)

Migration trends in Páty between 2002 and 2023 overall show a predominance of immigration, indicating continuous population growth in the settlement (Figure 2). From 2014 onwards, a significant increase in immigration began, peaking in 2022 with 721 people. This trend suggests that Páty has become an attractive destination, likely due to improved transport options, favourable real estate conditions, and an enhanced quality of life. Emigration remained at a lower level but gradually increased over the years. In 2002, 138 people left the village, while in 2022, this number rose to 285. Although the growth is not as steep as that of immigration, it may indicate that some residents eventually move on or that local living conditions are changing. In 2023, both figures declined, which may signal a shift in the settlement's dynamics. Possible reasons include economic factors, labour market developments, or a slowdown in real estate prices and the improvement of local infrastructure.

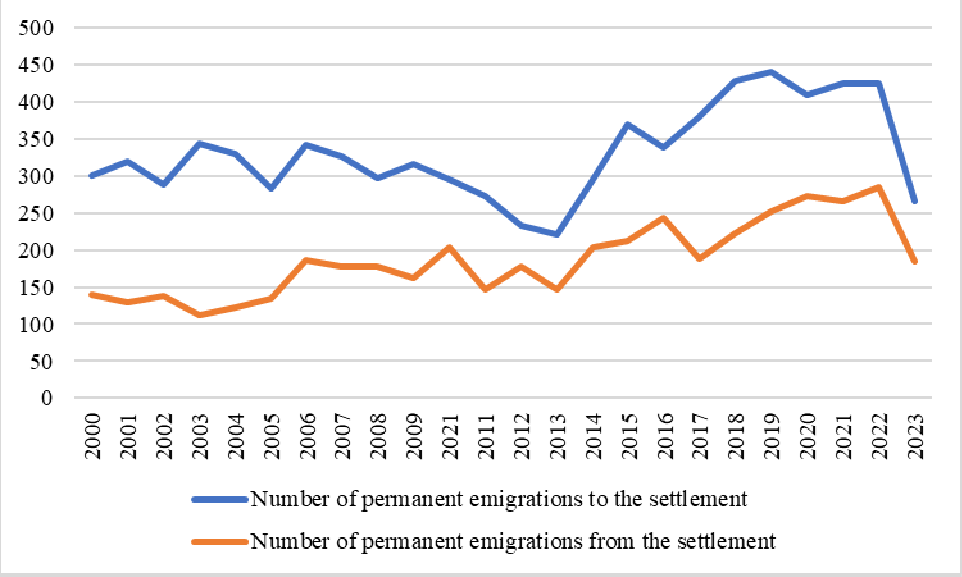

Figure 2. Migration trends in Páty (2000-2023)
Source: own processing (2025)

The number of registered job seekers in the municipality increased dramatically during the economic crisis of 2008, but since the end of the crisis, the municipality has experienced a reasonable level of unemployment. There are a limited number of jobs available, but they do exist (Figure 3).

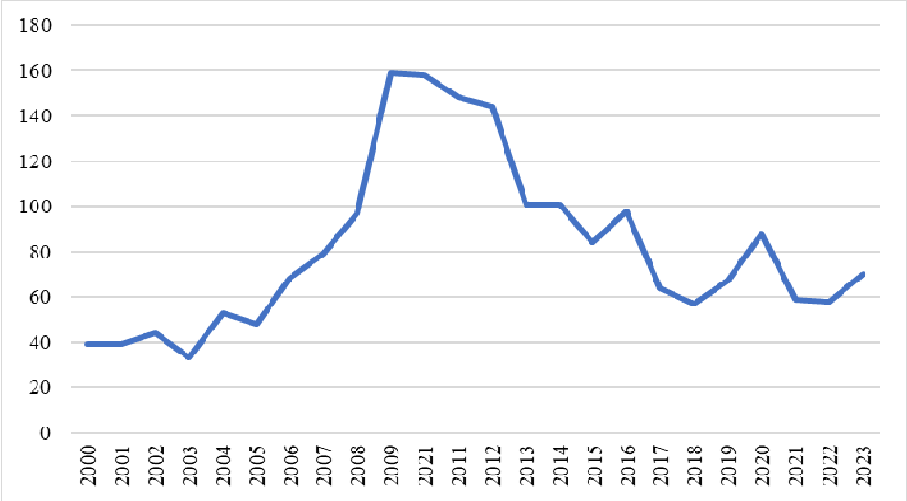

Figure 3. Total number of registered job seekers in Páty (2000-2023)
Source: own processing (2025)

In recent decades, Páty has undergone significant development; in addition to industrial and commercial investments, new residential areas have also been established, making the village attractive to both families and businesses. The cultural and community life of the village is also vibrant. The famous wine cellar row of Páty, which is unique in Hungary, is located on a hillside in the forest, with three streets of cellars built one above the other. The settlement is increasingly recognising the unique value of this location, and regularly organises cellar days and other cultural events there. A special community initiative began in Páty several years ago: five houses were established, initially providing homes for foster parents and the children in their care. Over time, a retirement home was added to the area, creating a space for intergenerational encounters and promoting mutual support and cohabitation. Later, the foster families moved out, and the buildings were given new roles. Two of them were converted into residential homes for young people with disabilities, which are still operating today. Another building now houses an office, while one of the houses was transformed into a handicraft workshop specialising in ceramics. The fifth building is currently uninhabited, but its cellar hosts a tea business that offers opportunities for the local community.

3.2 Introduction of the Hungarian Charity Service of the Order of Malta

The Hungarian Charity Service of the Order of Malta (Magyar Máltai Szeretetszolgálat Egyesület) was officially registered in early 1989, making it one of the first organisations to be recognised as an independent civil society organisation. Its motto – "Defending the faith and serving the poor" – also defines its mission. The organisation collects and distributes donations to support people in need, as well as the healthcare, social, and child welfare institutions that serve them.

The Hungarian Charity Service provides employment opportunities for thousands of people across the country, including many with reduced work capacity – people living with disabilities or health impairments. The organisation also functions as an accredited employer and provides protected work environments for approximately 100 employees at several locations. Accredited employment is carried out through three nonprofit economic entities, one of which – Máltai Gondoskodás Nonprofit Kft. – specialises specifically in rehabilitation-focused employment.

Currently, the association employs between 100 and 110 people with disabilities, health conditions, or multiple disadvantages in integrated work environments across various towns and cities in Hungary. Many of them are physically disabled and could work from home, but they choose to be present in person due to the sense of workplace community. For them, an accessible working environment is provided. They are expected to perform at the same level as their colleagues, and their employment is not intended to obtain subsidies, but to carry out necessary work.

The Hungarian Charity Service of the Order of Malta is the third-largest public employment provider in the country, employing around 300 public workers in its institutions nationwide. Unlike many other public employers that form separate groups for public employment, here the workers are fully integrated into the operations of the organisation. Its long-term goal is to transition these individuals into the open

labour market. Many of them are people with health conditions who lack the documentation required for supported employment programs, yet they struggle with serious health issues, including individuals who are homeless or living on the brink of homelessness.

3.3 Employment situation in Páty

At the Páty complex, various forms of employment operate, including developmental employment and public employment. Developmental employment is run by the Hungarian Charity Service of the Order of Malta. There are three craft workshops on site (Tea Packaging Workshop, Ceramics Workshop, and Creative Workshop), where people with disabilities living in residential homes, as well as individuals with reduced work capacity and health impairments from nearby settlements, are employed.

Figure 4. Decorations made in the Creative Workshop
Source: Photo of Creative Workshop, Facebook (2025)

The establishment of the craft workshops marked a turning point in employment in Páty, as it made it possible to involve people with disabilities and health conditions from the surrounding area. Several workshops in Páty employ only people with disabilities. The tea packaging plant began operation in 2015, focusing on packaging hibiscus tea. The raw material arrives from Africa in sacks, and workers use a sorting machine to classify it into three size categories. After sorting, the contents are manually checked to ensure the packages contain only hibiscus flowers.

The Ceramics Workshop was founded in 1988 by Father József Hagyó, the only male member in Hungary of the Little Brothers of Jesus religious order. His mission was to live among and support marginalised people. He found a community of parents whose recently graduated children with disabilities needed meaningful and regular activities. This led to the creation of the workshop, which experimented with various activities before ceramics became its main focus.

The newest workshop is a sewing room, established with grant funding, where work will soon begin. In addition, the launch of a carpentry and maintenance workshop is underway. The operations of the workshops are designed to complement each other's activities. Each workshop was created one after another, always adapting to current needs. Grant funds are typically used for their establishment, usually covering the cost of basic equipment. Later, additional funding helps expand the equipment base, leading to a broader product range and improved quality.

A significant portion of job opportunities, training, and sales arise from personal connections. Whether it's friends, former colleagues, or religious communities, these relationships play an important role in business development and customer acquisition. For example, a screen-printing workshop initially only produced branded items such as T-shirts and bags for internal use. However, growing demand brought in external orders, and now demand is so high that the business doesn't need online advertising. When a new challenge arises and there is no prior experience, professional connections are just as useful as online research. For instance, a woodworking shop needed to acquire equipment: after defining the workspace and specific needs, the right experts helped with decision-making.

A strong network of relationships is also essential for businesses dealing with handcrafted products. In developing sales channels, long-standing contacts are very helpful. The ceramics workshop, for example, expanded its market with support from a church community. The founders reached out to churches in nearby settlements, where they organised markets after Sunday Mass. For a long time, this remained one of their main sales methods.

Each workshop employs multiple techniques within a given professional field, allowing for tasks with varying levels of difficulty. This not only accommodates workers' different abilities but also offers flexible economic solutions, as the most appropriate technology can be applied to any given situation. There is always something to do in the workshops, and when a large order comes in, it's often necessary to reassign workers to meet deadlines. However, when there are no urgent tasks, tea sorting is always an available alternative. Since tea demand peaks in winter, the workshops work ahead so they can focus on other orders during the holiday season. The workshops work closely together, so task reassignment doesn't cause disruption. The work is varied not only in quantity but also in nature: learning new tasks and adapting to changes are both challenging and engaging, making everyday work more interesting.

4. Discussion

The goal of the workshops is not to produce goods unnecessarily, but to focus specifically on orders that are truly needed. Ideally, new demands arrive continuously, and capacities are allocated accordingly. This requires the conscious management of time, energy, and financial resources. In a dynamically operating enterprise, there is always something to do, and it often happens that resources must be coordinated to complete a larger project. When there are no urgent tasks, it is worthwhile to work ahead and focus on activities that will make future work easier. This way, work becomes not only continuous but also varied, helping employees learn new methods while making everyday tasks more engaging.

Achieving excellent results requires the use of proper tools and machinery. In a bakery, for example, the kneading machine, oven, and other equipment must be of high quality, as this ensures consistent product standards. To maintain competitiveness, it's always best to use top-quality ingredients and precise technologies.

In the various workshops, mixed groups work together, including people with disabilities and reduced work capacity. Coordinated work between individuals with different abilities is especially important, as it ensures both quality and efficiency.

Many people take on volunteer work, whether for school community service or personal development. Numerous students and young people work here for shorter or longer periods to gain experience in working environments and community activities. Foreign volunteers also participate, eager to learn more about the social sector before seeking long-term employment in the field. Volunteering not only shapes attitudes toward work but also offers a meaningful community experience. Collaboration with local communities and other organisations is key to smooth operations. Residents from nearby settlements often contribute as well, gladly participating in individual projects.

In Hungary, many rural settlements host good practices in public employment or operate social cooperatives. The Maltese Charity Service is actively involved in several of these locations, providing professional support in a helping capacity and maintaining a network. Employing people with disabilities or reduced work capacity is crucial in addressing labour market challenges. For these social groups, the social value of employment is often even more important than the economic benefit — it allows them to once again feel like full members of society, contributing to the creation of shared value through their work.

Conclusion

Employment is under continuous development, as each new idea that is implemented is quickly followed by the next step. Currently, efforts are underway to acquire a new printing technology. Experience shows that managers and employees strive to organise tasks as flexibly as possible to ensure smooth workflow. At the same time, they place great importance on everyone actively participating in the work and do not consider it acceptable for someone to opt out of tasks simply because they are not in the mood to work. In such situations, it can be observed that team members motivate each other to complete the tasks, while the workshop leader monitors from the background and intervenes if necessary.

The public employment program of Páty village is a good example of how initiatives based on local conditions and needs can contribute to increasing employment and fostering community development.

For participants, the program not only provides financial security but also offers training and development opportunities that support their reintegration into the open labour market. Results show that targeted public employment is not merely a temporary solution but a sustainable long-term tool for promoting social and economic integration.

Acknowledgements

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Regional Impact of Public Support with a Special Regard to Investment Incentives in the Czech Republic

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Abstract

Research background: Investment incentives have long been a key component of regional development policy in the Czech Republic. Introduced in 1998, tthey were primarily designed to attract investment and stimulate job creation, particularly in structurally disadvantaged regions. Despite their widespread application and legislative evolution, there is still a lack of systematic evaluation of their spatial impact.
Purpose of the article: The article aims to assess the spatial distribution and regional impact of investment incentives in the Czech Republic. It seeks to determine the extent to which public support contributes to balanced territorial development and whether the current allocation mechanisms reflect strategic regional policy objectives.
Methods: The regional distribution and effectiveness of public investment support in the Czech Republic are analysed using data from CzechInvest (2001–2024). Cluster-and-outlier analysis based on Anselin Local Moran's I was employed to identify spatial concentrations of subsidies at the level of municipalities with extended powers (AD MEP). The analysis was supplemented with descriptive statistics and robustness checks to account for non-normal data distributions.
Findings & Value added: The findings reveal significant spatial disparities in the allocation of investment incentives. High–High clusters (regions with above-average subsidy concentrations) were primarily located in industrially developed areas with strategic investment projects. Conversely, Low–Low clusters highlighted under-supported regions. The presence of outliers—municipalities with unexpected subsidy levels—further points to inconsistencies in the system's regional targeting.

Keywords: Investment incentive, Cluster analysis, Regional development, Czech Republic, Subsidy

JEL classification: R58, H25, O18

1. Introduction

Public investment support schemes, particularly investment incentives, represent one of the key instrument of regional development policy in the Czech Republic. These incentives aim to stimulate economic growth, attract both domestic and foreign capital, and foster job creation, particularly in structurally disadvantaged regions. Since the investment incentive framework was established in 1998 and revised in 2000, this policy tool has played a central role in the country's strategy to maintain its competitiveness within Central Europe and also globally. Despite its long-standing application and various legislative updates, a comprehensive and territorially detailed evaluation of the system's effectiveness, particularly with regard to its regional impact, remains insufficient.

This contribution forms part of a broader research agenda addressing the efficiency and territorial impacts of public financial interventions, with a particular focus on investment incentives. Our research explores how these incentives influence both regional and local development, including their implications for municipal budgets. This paper is an initial step in this long-term investigation. As a necessary starting point, it aims to analyse the spatial concentration of investment incentives; further detailed quantitative and qualitative assessments of their allocation and use will follow. The findings from this phase will lay

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the groundwork for deeper evaluations of their long-term effectiveness and strategic alignment with regional development goals.

In addition to a theoretical overview and an analysis of the current investment support system in the Czech Republic, this paper primarily assesses the regional distribution and effectiveness of public investment support in the Czech Republic. Particular emphasis is placed on the spatial patterns and concentration of incentives, culminating in a cluster analysis of investment incentives across Czech regions at the level of municipalities with extended powers (AD MEP).

1.1 Theoretical background

Investment incentives are often presented as an effective means of promoting economic development, particularly at a regional level. They are considered a catalyst for regional growth, as they attract new investors to areas that are structurally weaker or less developed. Through real investments, they can potentially contribute to job creation, increase demand for local suppliers and services, and support the development of infrastructure and vocational education in the region. The most frequently cited advantages include increased regional attractiveness for investors, accelerated industrial development and modernization, reducted regional disparities, support for underdeveloped areas and multiplied economic effects. However, the overall impact of investment incentives on regional output is ambiguous and difficult to quantify, with different studies showing different results (Blaschke, 2022). The direct impact on regional unemployment is also unclear (Falisová and Glova, 2025).

Investment incentives have both direct and indirect effects on regional development, making precise measurement challenging. Directly, they stimulate job creation by attracting new businesses or enabling existing ones to expand. This benefits not only the companies but also the local construction sector and other related services. These incentives often bring significant capital inflows, which are sometimes accompanied by public investments in infrastructure, thereby improving the overall business environment. Fiscal incentives are probably the most popular and frequently used type of investment incentive. While some tax breaks may initially reduce government revenues, the resulting economic growth can expand the local tax base over time (Gaspareniene, Kliestik, Sivickiene, Remeikiene & Endrijaitis, 2022), as well as having other indirect effects that can result in a change of company strategy (Yu Qi, Jianshun Zhang, Jianwei Chen, 2023). Additionally, incentivised companies often introduce new technologies and skills, leading to workforce upskilling.

These investments indirectly help to develop local supply chains by creating demand for regional suppliers and services, thereby fostering a more diverse and resilient economy (Johnson, Kopel, Lankisch and Pfeiffer, 2021).

The resulting increase in employment and wages generates a multiplier effect, boosting household spending and supporting other sectors. Successful projects can enhance the region's reputation, attracting further investment and encouraging social stability by reducing outmigration. However, achieving these positive outcomes depends heavily on the targeted and effective management of incentives. Poorly designed incentives may fail to deliver sustainable benefits or create dependency. Therefore, investment incentives should be integrated into broader regional strategies that promote long-term innovation and inclusive growth (Vas, Z., Szakálné Kanó, I., & Vida, G., 2024).

On the other hand, investment incentive systems also present certain risks and disadvantages. They are often criticised for being inefficient and unsustainable.They may also create an uneven playing field among businesses. When some companies receive government support, such as tax breaks, cash grants, or infrastructure assistance, while others operating in the same sector or region do not, it can lead to market distortions and unfair competition (Partridge et al., 2019, Gençer, 2024 or Jemberu and Knápková, 2024).

Investment incentives also incur significant financial costs for the government. Providing tax breaks, cash subsidies, or infrastructure support requires allocation of public funds, which can place a substantial burden on national or regional budgets (McDonald III, Bruce, Decker and Johnson, 2021).

While investment incentives are often justified on economic grounds, they are frequently shaped by political considerations, which can significantly influence how and where they are allocated. In many cases, decisions about providing incentives are not based solely on objective economic analyses or long-term regional development strategies, but rather on short-term political goals, such as attracting visible investments before elections or responding to pressure from influential interest groups.

This political influence can lead to asymmetric and inefficient outcomes. For instance, incentives may be granted to projects in politically significant regions, regardless of whether those areas genuinely

require external support or possess the capacity to sustain the investment in the long term. Conversely, regions or firms with the potential to generate higher added value or innovation might be overlooked simply because they lack political visibility or lobbying power.

Moreover, when political motives dominate, investment incentives may favour large multinational corporations that promise immediate job creation, while smaller domestic companies or startups, which might offer more sustainable and inclusive growth, receive little or no support (Vas, Z., Szakálné Kanó, I., & Vida, G., 2024). This can distort competition, reduce market fairness, and undermine the effectiveness of public spending.

Information asymmetry also plays an important role in investment incentives, as investors often possess more detailed knowledge about their plans and needs than public authorities, which can lead to inefficient or one-sided decisions. This imbalance may result in public funds being misallocated, unfair competition, and incentives being granted to projects that do not deliver the promised economic or social benefits (Katitas and Pandya, 2024).

1.2 Development of the Investment Incentives System in the Czech Republic: Institutional Framework and Regulatory Transformation

The investment incentives system is a key economic policy tool in the Czech Republic, aimed at promoting economic growth by stimulating capital investments and related employment. Introduced in 1998, it was developed to enhance national competitiveness during the post-transformation restructuring period, with a particular focus on attracting foreign direct investment (FDI), particularly in the manufacturing sector.

The first phase, referred to as the pre-legislative regime, was based on government resolutions and offered incentives through memoranda negotiated individually between investors and state authorities. The minimum investment threshold was initially set at USD 25 million, but was later reduced to USD 10 million, thereby expanding eligibility to domestic enterprises. Incentives included tax relief, interest-free loans and workforce retraining support.

A major institutional change occured with the adoption of Act No. 72/2000 Coll., on Investment Incentives, which came into effect on 1 May 2000 (Czechinvest, 2022). This legislation codified the investment support system and introduced the “decision on the promise of investment incentive” as a legally binding entitlement. Since then, the legal framework has undergone several amendments in response to the evolving needs of the Czech economy, growing experience with the incentive scheme and EU law harmonization requirements.

Following the Czech Republic’s accession to the EU in 2004, the system became subject to the EU’s state aid rules, requiring national schemes to comply with regional aid guidelines. Investment incentives are regularly reviewed by the European Commission to assess their compatibility with the internal market, paying particular attention to their impact on competition and trade among member states. However, the absence of comprehensive national-level evaluations of the system’s effectiveness indicates a gap in institutional feedback mechanisms (MPO, 2006).

Subsequent amendments, particularly in 2007, 2012 and 2015, sought to modernise the system and improve its competitiveness in the global investment environment (MPO, 2025). The range of eligible activities was expanded to include strategic service centers and R&D centers), and a “strategic investment project” status was introduced alongside regional differentiation of support. However, with each amendment, the system became increasingly complex and less transparent, which may diminish its attractiveness to investors.

By 2024, a total of 1,336 investment projects had received support through this system, with a cumulative investment value of CZK 998,417 billion, resulting in approximately 204,816 new jobs (CzechInvest, 2025). While these figures confirm a significant quantitative impact, questions remain about the qualitative outcomes, particularly with regard to cost-effectiveness and the long-term structural benefits to the Czech economy.

1.3 Regional Dimension of the Investment Incentives System

One of the key objectives of the Czech investment incentives system is to promote regional development and reduce territorial disparities. Currently, the system favours investment in structurally affected areas, and the eligibility criteria continue to reflect the EU’s regional state aid framework.

The primary tool used to deliver regional support is the "regional aid map," which determines the maximum permissible levels of public aid for each region. The map applies to all forms of regional investment aid, including the Czech investment incentives scheme, and must be approved by the European Commission (Evropská komise, 2021).

A new version of the regional aid map for the Czech Republic (Figure 1) came into force on 1 January 2022, introducing significant structural changes. Unlike the previous period, during which aid intensity (excluding Prague) was relatively uniform, the updated map introduces considerable regional differentiation. For the first time, certain types of investments are now excluded from support in specific parts of the country, making the system more selective and targeted in its regional application.

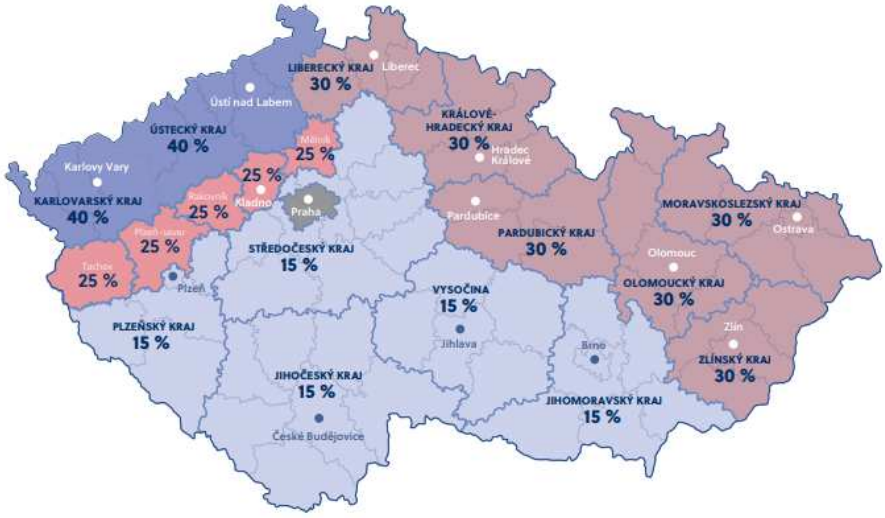

Figure 1. Regional Aid Map
Source: CzechInvest (2025)

When determining the conditions for granting investment incentives, the Regional Development Strategy of the Czech Republic is also considered. This strategy identifies areas that are economically and socially disadvantaged. However, the geographical distribution of these areas does not fully correspond to either the regional division defined by the regional aid map, or the distribution of regions with high unemployment rates, which is another commonly used indicator to define preferential areas. This results in a certain misalignment between strategic documents and the instruments applied in the provision of public support.

Historically, decisions on granting investment incentives did not systematically consider whether the investment was located in a region that was strategically important for the state's development . However, targeted regional support can effectively encourage investors to locate projects in less developed areas, thus contributing to reduction of regional disparities, both in terms of economic performance and unemployment levels.

Although investment incentives are not usually the main factor in investors' location decisions, they can play a significant role in the final stage of choosing a location, particularly when the expected return on investment is marginal or when investors are choosing between several similarly attractive locations.

2. Methods

For our analysis, we used data obtained from CzechInvest (2025). CzechInvest is a government-run investment and development agency overseen by the Ministry of Industry and Trade. It attracts investors, supports the development of production and other facilities in the Czech Republic and, crucially for this study, it is a place where application for the investment incentive are submitted. These subsidies are provided either as direct grants or as tax relief. The latter is employed far more frequently, roughly tenfold.

The dataset records the volume of subsidies granted and shows when and where they were awarded. Individual awards range from CZK 1,000,000 (approximately €40,000) to CZK 3,000,000,000 (approximately €120,000,000).

Out of 1,483 applications from private companies, 899 received support. We were able to match 767 of these awards, covering the period from 2001 to 2024 – ample observations for the subsequent analyses.

Descriptive statistics for the total subsidy (direct grants + tax relief) and for its natural logarithm (to be used in later regressions) are presented below.

Table 1. Descriptive statistics

	Subsidy total (Thousand CZK)	*Log subsidy total (Thousand CZK)*
Mean	136204.68	4.95
Standard Error	6799.61	0.01
Median	79213.00	4.90
Mode	43703.00	4.64
Standard Deviation	188313.65	0.39
Sample Variance	35462032052.05	0.15
Kurtosis	85.94	2.37
Skewness	7.13	-0.13
Range	3062507.10	3.49
Minimum	1000.00	3.00
Maximum	3063507.10	6.49
Count	767.00	767.00

Source: Own processing

Figure 2 shows the geographical distribution of subsidies.

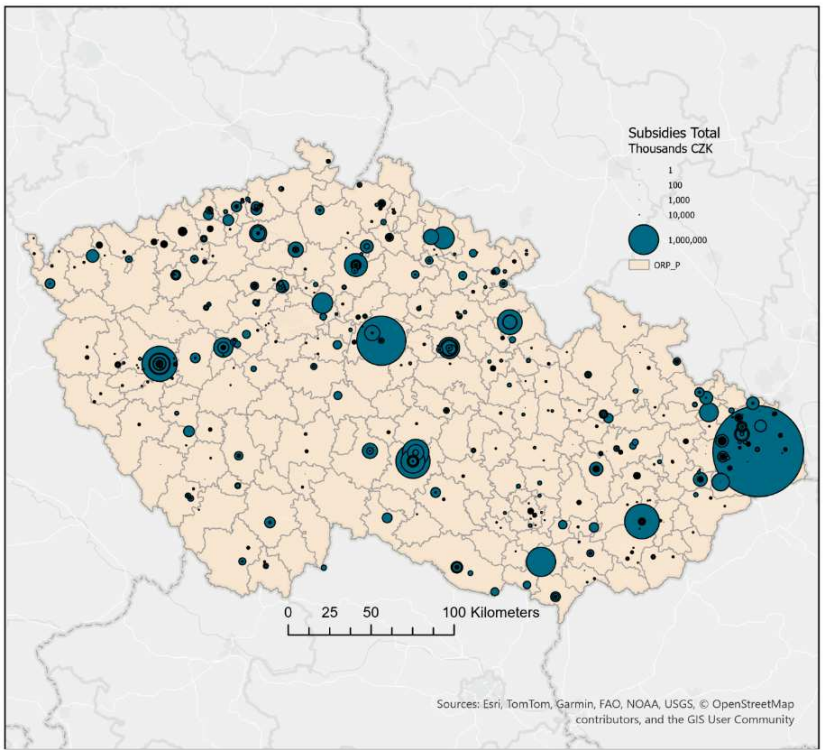

Figure 2. Overview of geographical distribution of subsidies awarded by CzechInvest
Source: The authors' original map; data from CzechInvest (n.d.).

Several large-scale projects qualify as statistical outliers, most notably the Hyundai Motor Company plant in Nošovice (Moravskoslezský kraj), the Toyota Peugeot Citroën Automobile plant in Kolín and the Daikin Europe plant in Plzeň. Because these investments are decisive for local employment and development, they remain in the dataset despite diverging from the mean.

Another issue is limited normality, which is evident in the frequency distribution of the log-transformed subsidy total (Figure 3). To avoid biased inference, robust standard errors are used in all regressions.

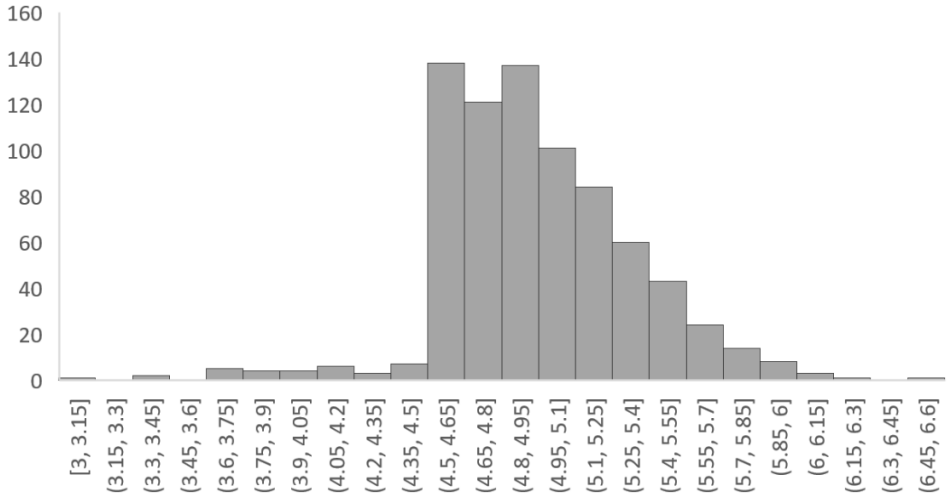

Figure 3. Frequency distribution of Log Subsidy Total
Source: The authors' original creation, data from CzechInvest (n.d.)

Small subsidies (on the left side of the distribution) are not awarded very often, probably because CzechInvest financing is difficult to obtain and only certain types of company apply. For the purposes of our analysis, this is not a major problem, but robust standard errors must be used in all regressions to ensure that the statistical significance is not affected by the insufficient normality of our data.

3. Results

To examine the spatial dimension of CzechInvest subsidies and their regional impact, we first aggregated the data according to the administrative districts of municipalities with extended powers (AD MEPs). With 205 AD MEPs, the Czech Republic has a sufficient number of administrative districts for spatial statistics, yet they are large enough to capture regional effects. The aggregated results are shown in Figure 4.

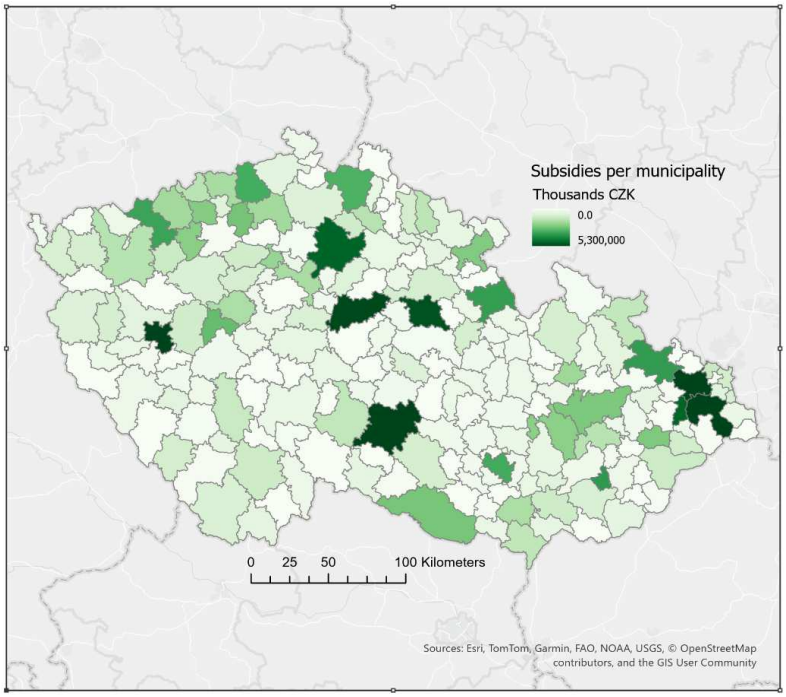

Figure 4. Subsidies per administrative district of municipalities with extended powers (AD MEP)
Source: Authors' original map; data from CzechInvest (n.d.).

To further assess the spatial dimension of the subsidies and to identify areas where they cluster, we performed at subsidies have been received; and Low–Low clusters, which are municipalities with very few subsidies. The analysis also identified Low–High outliers – individual municipalities that received unexpectedly low scluster-and-outlier analysis. This method identifies natural groupings (clusters) in the data. In this case, the clusters represent municipalities that received either many (positive clusters) or few (negative clusters) subsidies (Esri, n.d.). It employs Anselin Local Moran's I to determine whether values in neighbouring municipalities are statistically significantly correlated (a 95 % significance level was used). In other words, it tests whether municipalities with high subsidy values are more likely to be located near other municipalities with high values (i.e. positive correlation). The analysis used an inverse Euclidean distance of the eight closest neighbours.

The following clusters were produced by this analysis : High–High clusters (bright green), which are areas where many investmenubsidies given the levels in surrounding areas – and High–Low outliers, which received unexpectedly high levels of investment.

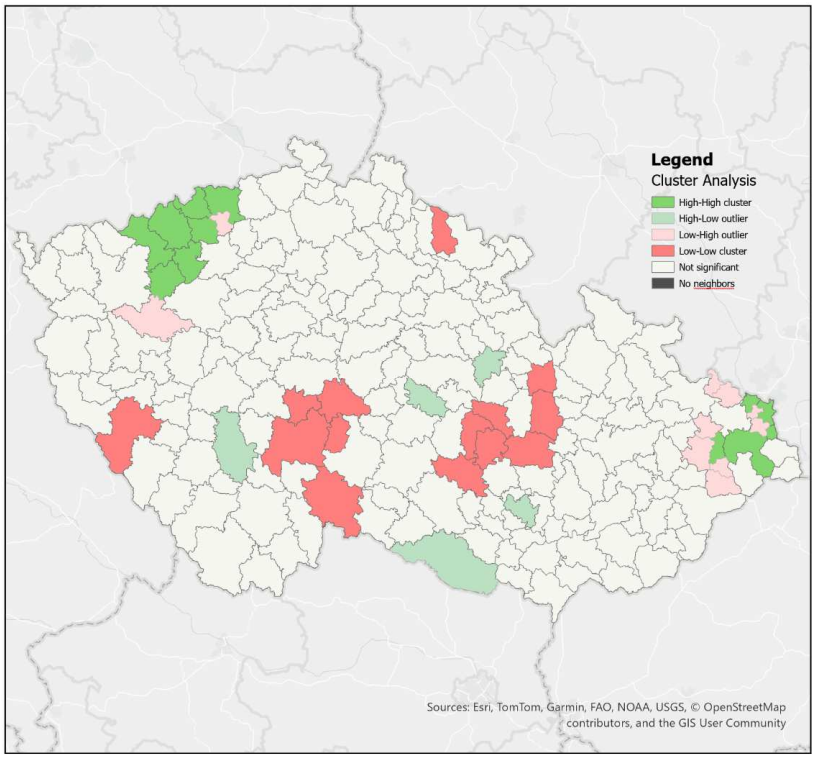

Figure 5. Results of the Cluster and Outlier Analysis
Source: The authors' original map; data from CzechInvest (n.d.).

The inner workings of the cluster analysis are visible on the spatial-regression scatterplot shown in the following figure 6.

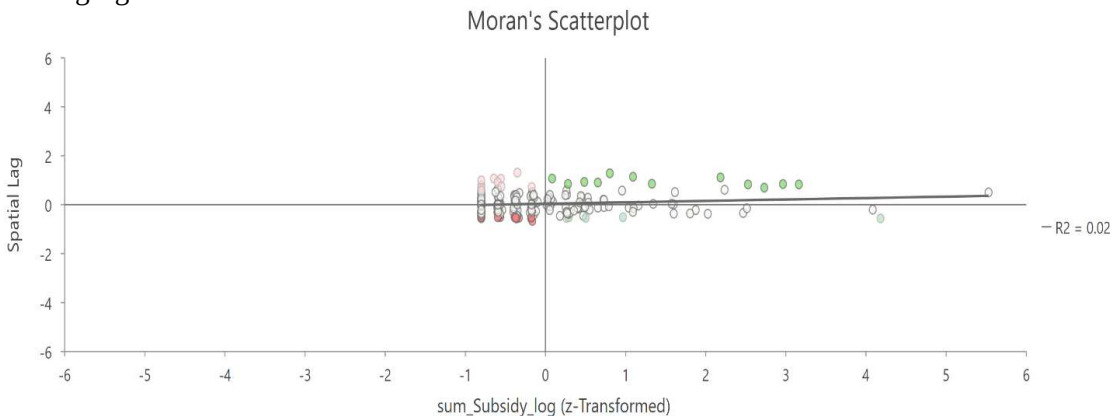

Figure 6. Cluster and Outlier Analysis spatial regression scatterplot
Source: Own processing

4. Discussion

The results of the cluster and outlier analysis confirm a notable spatial concentration of investment incentives in specific regions of the Czech Republic, particularly in areas with established industrial bases or large-scale foreign direct investment. This spatial clustering suggests that the distribution of subsidies has not been entirely balanced, with certain regions repeatedly benefiting while others remain undersupported. While such concentration may reflect rational economic behavior, withinvestors gravitating towards infrastructure-ready or logistically favorable locations, it also reveals potential inefficiencies in the design of the support system from a regional policy perspective.

The analysis raises questions about the alignment between the intended goals of regional cohesion and the actual outcomes of incentive allocation. The presence of High–High clusters ssuggests that certain regions have a persistent advantage, which could excerbate regional disparities unless counterbalanced by policy adjustments. Conversely, Low–Low clusters may indicate structural barriers preventing certain municipalities from attracting investment, even when incentives are available. The presence of outliers—municipalities receiving unexpectedly high or low levels of support compared to neighboring areas suggests room for refining the targeting mechanisms of subsidies to better match regional development needs.

These findings highlight the need for a more nuanced and territorially sensitive approach to investment incentives. In future research, we plan to use the results of the cluster-and-outlier analysis to measure the impact of subsidies on respective regions and their neighbours. The identified High–High and Low–Low clusters are ideal treatment groups for difference-in-differences methods. These methods will enable us to precisely measure the impact of the government's industrial policy on employment and the overall prosperity of regions in the Czech Republic.

Conclusion

This paper provided an initial step in evaluating the regional dimension of investment incentives in the Czech Republic. Using cluster-and-outlier analysis at the level of municipalities with extended powers (AD MEP), significant spatial disparities in the distribution of public support were identified. Our findings confirm that investment incentives tend to be concentrated in specific regions, which are often influenced by strategic industrial locations and large-scale investment projects. However, the system's overall complexity, coupled with its lack of consistent alignment with national and regional development strategies, raise questions about its effectiveness and long-term contribution to balanced territorial development.

Furthemore, the study reveals an absence of systematic evaluation mechanisms and suggests that the distribution of incentives may not consistently align with the socio-economic requirements of recipient regions. This points to a broader institutional challenge and underlines the importance of refining targeting criteria and increasing transparency in the allocation process. While investment incentives are not the sole factor influencing location decisions, they play a significant role in the final stages of investor selection, particularly for marginal or contested locations. Future research will build on this analysis by using causal impact assessment methods to examine the actual effects of incentives on employment, fiscal capacity and economic performance in supported regions.

Acknowledgements

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Current State of Research on Administrative Capacity in Cohesion Policy: Topics and Unresolved Issues

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Abstract

Research background: EU Cohesion Policy is one of the largest EU investment policies. Several factors influence whether Cohesion Policy and specific investments implemented through the European Structural and Investment Funds (hereinafter referred to as "Structural funds") bring real territorial impacts. Among the key factors is administrative capacity.
Purpose of the article: The aim of the article is to point out, in the form of a review study, the current state of knowledge in the field of research on administrative capacities in relation to EU Cohesion policy and Structural funds, evaluate the research topics, questions, methods and key findings, and last but not least, to point out possible directions for further scientific research.
Methods: The article is of a theoretical nature and uses the method of content analysis of existing studies in the subject area.
Findings & Value added: The results show that the area of administrative capacities is a subject of interest for researchers, with the studies carried out assessing the impact of capacities within different programming periods, regions, or EU Member States. The authors use both quantitative and qualitative research methods, examining administrative capacities in relation to other variables, such as political factors, the level of governance, or the macroeconomic context and in the context of funds absorption, implementation, or effectiveness. Administrative capacity is among the factors necessary for enabling the successful implementation of the policy, but not the sole success factor. Therefore, the need for comprehensive research that further elucidates the interaction of multiple variables remains.

Keywords: Cohesion policy, Administrative capacity, Structural funds, Absorption, Implementation, Effectiveness

JEL classification: R58, H83

1. Introduction

The EU Cohesion Policy is the largest investment instrument of the European Union (Bachtrögler-Unger, 2024), yet its success is mixed (Polverari, 2023). Several factors influence whether specific investments made through the European Structural and Investment Funds (hereinafter referred to as the “Structural Funds”) deliver results. Administrative capacity is one of the key factors that enable policy implementation to be carried out efficiently and effectively (Bachtrögler-Unger, 2024; Smeriglio et al., 2016; Surubaru, 2017; Boeckhout et al., 2002). The importance of administrative capacity is acknowledged not only by researchers but also by policymakers (Gal et al., 2023). The impact of administrative capacity in terms of contributing to a successful Cohesion policy is not only about efficient absorption but also has a key role in programming or selecting the right projects and beneficiaries, especially according to territorial needs and resources (Bachtrögler-Unger, 2024). However, as we will show below, administrative capacity plays its role as one of several factors (Van Wolleghem, 2020) and this area is still under-researched (Bachtler et al., 2024).

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The aim of the article is to point out in the form of a review study the current state of knowledge in the field of administrative capacity research in relation to the Structural Funds - to evaluate the topics, research questions, methods, key findings and point out the existing research gap. Before presenting the results of the analysis, we will point out the diversity of approaches to defining administrative capacity by illustrating several cases, as this affects the entire research process.

Polverari (2023) considers the concept of administrative capacity to be vague and, moreover, very intricately linked to many factors. According to her, it is too often confused with concepts such as *"state capacity, good governance, government quality or institutional quality"* (Polverari, 2023, p. 6). According to Bachtler et al. (2024), we also encounter diverse approaches to this concept and measurement is often problematic (Bachtler et al., 2024).

As for specific approaches, according to Milio (2007) *"administrative capacity relates to the ability of the institutions to manage SFs policy according to their rules and procedures."* (Milio, 2007, p. 435). Its model (administrative capacity loop) measures the performance of several components (management, programming, monitoring, and evaluation) and their indicators, and according to them a specific phase of development is determined - absence, initiation, development and finally consolidation (Milio, 2007, p. 437). Moreover, each correctly implemented activity contributes to a higher level of implementation (Milio, 2007). Terracciano and Graziano (2016) developed this model into a regional administrative capacity matrix and added indicators "the number of supplementary programming documents", an indicator measuring competences, "use of monitoring data for management purposes" and "institutional role of evaluation units" (Terracciano & Graziano, 2016).

Among the frameworks used is the one from the Netherlands Economic Institute (used, for example, by Domorenok et al., 2021; Van Wolleghem, 2020), which defines administrative capacity *"as the ability and skill of central and local authorities to prepare suitable plans, programmes and projects in due time, to decide on programmes and projects, to arrange the co-ordination among principal partners, to cope with the administrative and reporting requirements, and to finance and supervise implementation properly"* (Boeckhout et al., 2002, p. 2). The authors of Domorenok et al. (2021) supplement the framework with indicators in relation to the criteria of an integrated approach to policies (coherence, consistency, and coordination). There are three levels (systems and tools, organisational structures, human resources), which include integration criteria, measured by a set of indicators for each criterion. Moreover, administrative absorptive capacity is mentioned as one of the key absorption variables, along with macroeconomic absorption capacity and financial absorption capacity (Boeckhout et al., 2002; Popescu et al., 2018). Incaltarau et al. (2020) in turn assessed administrative capacity as government efficiency and regulatory quality. Tiganasu et al. (2018, p. 45) mention under the term administrative capacity also the degree of compliance with EU law, the effort to develop institutions based on quality, but also a performance-oriented management system. According to the authors Bachtler et al., 2024, in a similar line of reasoning as Boeckhout et al., this concept can be viewed as the *"capacity of national and regional government authorities: to design regional development programmes to meet EU objectives and in accordance with local needs; to allocate funding to eligible projects in line with EU rules; and to account for the funding spent in financial terms (audit) and physical outcomes (evaluation)"* (p. 685). Lorvi (2013, p. 99) bases his definition of administrative capacity, which he examined at the municipal level, on the process of programming, preparation of suitable projects, co-financing, implementation, monitoring, and evaluation of effects.

The authors Bachtler et al. (2024, p. 686) also discuss so-called internal and external elements within the definition. Internal elements include human resources and related areas, organizational structures, physical resources (including ICT), systems and tools, leadership (e.g., goal setting) and openness to knowledge. On the other hand, external elements include the quality of public administration, legal stability/quality at the regulatory level, the level of (de)centralization of governance, and political influence. Surubaru (2017, p. 848) used the definition *"the institutional, bureaucratic and human resources capability of member states to manage SF [structural funds]"*. Tiganasu et al. (2018, p. 40) used two dimensions of administrative capacity in their research, which are also important with regard to implementation, namely institutional quality (i.e., the quality of formal and informal institutions exercising authority) and management performance (from a political perspective).

Based on the definitions provided, we can summarize that the approach to defining and measuring administrative capacity is truly diverse and usually contains multiple elements.

2. Methods

The method used was a qualitative content analysis of seventeen studies. The studies were searched through the Google Scholar and Web of Science databases using combinations of the keywords "administrative capacity," "administrative capacities," "structural funds" and "cohesion policy." The studies were then processed in the form of a summary table and analyzed with respect to topics, objectives (research questions, hypotheses), use of research methods, data collection and analysis, achieved results and recommendations.

3. Results

3.1 Study objectives, research questions and hypotheses

Even when analyzing the research objectives, it became clear that administrative capacities appear both as a factor in explaining individual aspects of Cohesion Policy (independent variable), and also as a research subject. The graphic representation shows the position of administrative capacities in the research, as well as some of the factors that influence them (left). The dependent variables, i.e., areas on which administrative capacities have a potential impact, are listed on the right.

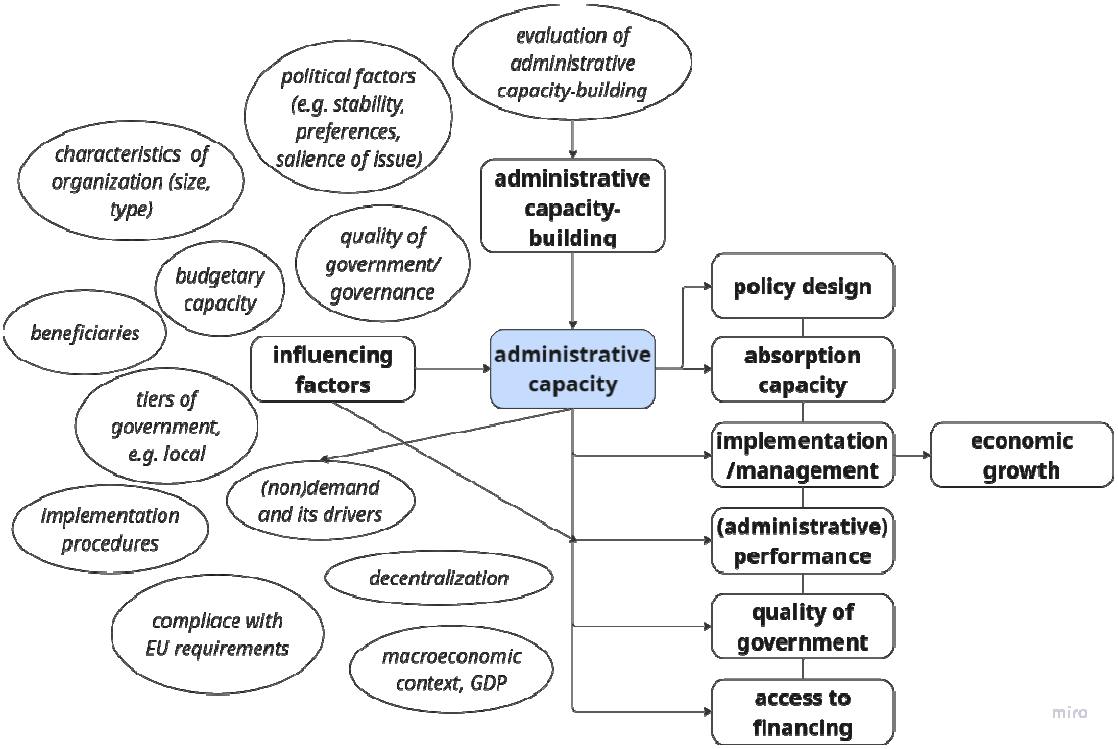

Figure 1. administrative capacity as a variable
source: own processing (2025)

Below the authors of the paper provide an overview of the studies analyzed:

- Bachtler et al. (2024) attempted to bring novel insights into the topic of Structural funds administrative capacity and their article is also aimed at the functioning of administrative capacity building activities and their effectiveness.
- Popescu et al. (2018) investigated the key factors influencing administrative capacity at the local authority level in Romania, in an attempt to shed light on the problem of low absorption. Their research addressed the shortcomings of previous studies that focused on the national and regional levels and different contexts (financing, macroeconomic factors). Their hypothesis was that local authorities with administrative capacities have better access to financing from the Structural Funds.
- Lorvi (2013) attempted to address the lack of research comparing municipalities of different sizes in terms of absorption and addressing the differences in administrative capacity of these

entities in relation to the management of Structural Funds. The hypotheses were that Structural Funds help improve the competitiveness of regions at NUTS 3 level in Estonia and that their use in all regions led to higher competitiveness (Lorvi, 2013).

- Terracciano & Graziano (2016) addressed administrative capacity as a basis for explaining why implementation at the level of 2 Italian regions – Campania and Puglia – differs and whether it can be explained by administrative capacity. They also assessed which variables lead to successful implementation, what problems occur, and the impact of activities aimed at capacity building.
- Hansum (2025) points out that attention should be paid not only to the problem of absorption and demand, but also to why there is no interest in financing from Structural (cohesion) funds. Therefore, he focused on creating an explanatory framework that could explain the lack of interest in finance, the so-called non-demand.
- Cunico et al. (2024) emphasize the demand side, since according to them, studies have not addressed how demand and related factors specifically affect absorption and absorption models/patterns at the macro level (in this research, regional). Therefore, in their research, they focus on the micro-level, i.e., the activities, decisions, and components within the implementation of projects, both in the environment of local governments and among eligible applicants and their clarification in relation to absorption patterns (Cunico et al., 2024). The added value of their research is the effort to merge the traditional top-down, macro approach with a lower, bottom-up level (Cunico et al., 2024).
- Van Wolleghem (2020) in his research, in the form of a case study, evaluated the European Fund for the Integration of third country nationals (EIF) – a fund that has similar characteristics to the Structural funds. The aim of the research was to analyze the reasons for the non-use of available funds even in the case of lower administrative burden (EIF), i.e., whether the low absorption can be explained not by capacity, but by preferences. In his hypotheses, he focused on the relationship of the implementation rate to other variables (administrative capacity, budgetary capacity, GDP, decentralization, capacity of the non-profit sector, political factors – attitude to the issue, conflict in the coalition, and the importance of the issue for the government). In the analysis of the participating Member States, he also included their mutual comparison and control variables (importance of the given problem and time development) (Van Wolleghem, 2020).
- Incaltarau et al. (2020) looked at administrative capacity and political governance as factors influencing the extent to which Structural funds are used and tried to explain the differences between Member States, also with regard to the length of EU membership (differences between older and new Member States) (Incaltarau et al., 2020). Within the framework of the hypotheses, they clarified the relationships between administrative capacity on the one hand and absorption, political governance (political stability and the diversion of public funds), the level of allocation relative to GDP (economic growth), the financial capacity of the state, the impact of the economic crisis (dummy variable) and decentralization on the other (Incaltarau et al., 2020).
- Surubaru (2017) was interested in the impact of administrative capacity, measured through several dimensions, and three political factors (political stability, political support, and clientele) on implementation performance in Member States that joined the EU later. He compared Romania and Bulgaria in order to clarify the differences that would explain the difference in the level of administrative capacity and the performance of the funds. He identified three research assumptions: that there is a connection between capacity (at the policy and administrative level) and being able to reach a performance level regarding the management and implementation of the policy; a higher level of capacity will allow for better performance; the policy framework has some impact on the ability to absorb financing from EU funds (Surubaru, 2017).
- Absorption is not sufficient in itself to achieve development, Tiganasu et al. (2018) therefore decided to examine not only the relationship between absorption and the impact of administrative capacity, but also to incorporate the development variable into the analysis. The aim of the research was to assess the effect of capacity on absorption in the environment of 10 Central and Eastern European countries, as well as the effects of funds on development (Tiganasu et al., 2018). The hypotheses focused on the relationships between institutional

quality and governance performance, as dimensions of administrative capacity, with the absorption and linkage of Structural funds with the economic development of countries (Tiganasu et al., 2018). Institutional quality was measured by indicators such as government effectiveness, rule of law or quality of regulations, and governance performance (GP) by indicators such as managerial skills or consensus building (Tiganasu et al., 2018).

- Smeriglio et al. (2016) provided an analytical framework for administrative capacity. They were interested in what the concept of administrative capacity within the framework of Cohesion policy includes, what the relationship of this capacity to the quality of government may be and which factors are key in a given area. They based their analysis on different perspectives – individual, socio-economic, and organizational, and focused on significant variables influencing performance functioning at the level of the managing authority (Smeriglio et al., 2016).
- Gal et al. (2023) dealt with the development of administrative capacity in the current programming period 2021-2027, evaluating means and measures.
- Polverari (2023) presents in a research article her reflections on administrative capacity and also the implementation of Cohesion policy after the end of the current programming period. The article addresses the questions of whether existing administrative capacities are sufficient and if not, what impact this has on policy performance; what are the causes of the lack of administrative capacities and what could past development efforts in this area have done better; what measures could be taken to strengthen administrative capacities and, last but not least, whether the RRF can serve as a source of learning for Cohesion policy (Polverari, 2023).
- Mendez & Bachtler (2022) in their research assess the connection between the quality of governance at regional level and individual dimensions within administrative performance. The theoretical hypothesis was that quality of regional government (which is also an indicator of administrative capacity) is positively related to the administrative performance of programmes implemented at regional level (172 regions in the territory of seventeen member states). They used regression analysis of administrative performance objectives, namely drawing resources at the right time, proper spending, and compliance with the law in costs (second dimension) and also financing results (output part). They used administrative performance (measured through the three dimensions mentioned above) as the dependent variable and the independent variable quality of government (measured through the EQI index - European Quality of Government Index). The control variables were regional authority (territorial autonomy), preferences and monitoring, goodness-of-fit (how well domestic policies and their objectives are consistent with those of the EU), membership in the European Union and the possible impact of the economic crisis (measured by GDP per capita) (Mendez & Bachtler, 2022).
- Domorenok et al. (2021) examined the importance of administrative capacities in relation to the development and implementation of policies based on an integrated approach. They assume that the greater the perception of benefits and sufficient knowledge to replace the sectoral approach with integrated policies among high-ranking officials in public administration, the more resources and efforts are directed towards building related administrative capacities (strategic motivation hypothesis) (Domorenok et al., 2021, p. 63). The second hypothesis is that, together with the political importance of regional policy in the territory, including the allocation available, the more likely public administration officials are to accept a design based on integration, which also includes settings and capacities (political relevance hypothesis) (Domorenok et al., 2021, p. 63). Based on the combinations of these factors, they speak of 4 potential scenarios in the context of sustainable urban development: administrative gap (there is no knowledge or motivation in public administration), cherry picking (expertise and knowledge are high, but regional policy is not seen as important), window-dressing (motivation and knowledge about the design of SUD strategies exist to a small extent, but this is a politically significant issue), full ownership (officials have the knowledge and are also motivated to reform human resources and this effort is supported by the political importance of the issue). Veneto and Scotland were chosen as case studies (Domorenok et al., 2021)
- Milio's (2007) research aimed to clarify the variables that cause absorption to be different in Italian regions and at the same time whether administrative capacity as a factor can influence these differences (Milio, 2007). She addressed why, despite experience, regions are not able to

absorb and why are activities related to the project cycle carried out with different efficiency, i.e., why are the administrative capacities of the regions different? She chose the regions of Sicily (absorbing problems) and Basilicata (effective implementation) as the research sample for the case study. She assumed that she would find a positive relationship between the available administrative capacity at the regional level and the implementation of the funds (determined spending rate) (Milio, 2007). Supported capacity should therefore lead to better (quantitative) implementation and, in turn, to results that will be reflected in GDP growth.

- Bachtrögler-Unger (2024) deals in her article with the effects of administrative capacity on the absorption of Structural funds and the efficiency of their use in the regional environment, based on existing research.

3.2 Research sample and methods of conducted research

The research sample depends on the objectives of the study, but it can be considered broad. Information was collected through questionnaires and interviews from various actors (individuals and organisations) who are in charge of tasks and competences within the whole cycle of the Structural Funds (e.g. managing authorities or intermediary bodies), but also from experts (e.g. academics, development specialists, policy makers), beneficiaries (e.g. city and municipal authorities, project preparation staff and project managers), consultants and consultancy firms, journalists or other socio-economic partners (e.g. interest groups, parliamentarians, non-profit organisations). As regards the hierarchical arrangement, administrative capacities are examined at various levels (local, regional, "meso" level, national or European – Member States). The studies covered programming periods from the 2004-2006 cycle to the current period, which will last until 2027, which also indicates a long-standing interest in the issue.

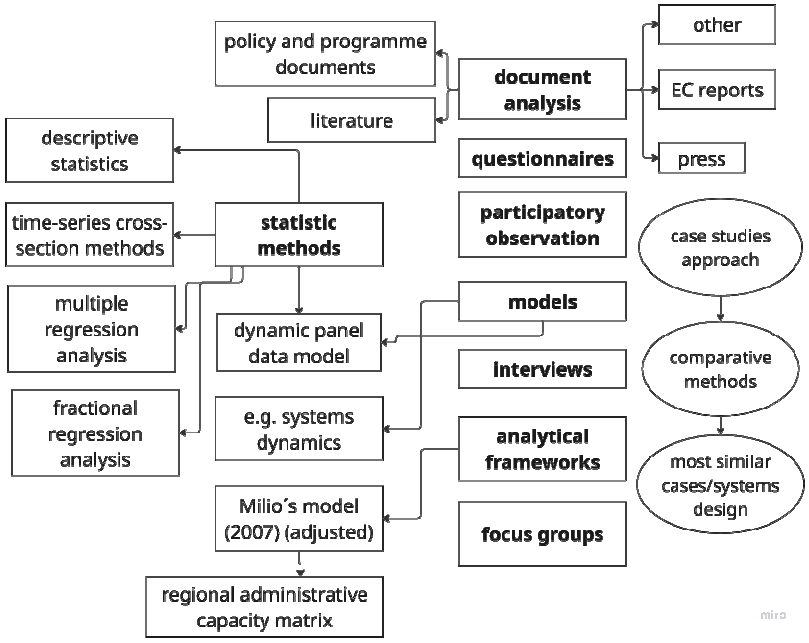

Figure 2. overview of research methods
source: own processing (2024)

The approaches to data collection and analysis are diverse and often involve a combination of qualitative and quantitative methods (e.g., Terracciano & Graziano, 2016; Surubaru, 2017) and also triangulation of data obtained from diverse sources. Below we present an overview of the authors' research approaches. The authors also base their work on primary, empirical data, or secondary data. Several authors also applied the approach of comparison based on similarity (similar systems/similar cases design), when cases that share similar characteristics, but differ in some key feature (variable), are analyzed (e.g., Surubaru, 2017; Domorenok et al., 2021; Milio, 2007). Hansum (2025) used the matching approach, in which he selected a similar "counterpart" of unsupported subjects for the sample of

recipients. Case studies were also used, providing a detailed description of the studied or compared regions or capacities.

Of the research approaches used, interviews (Popescu et al., 2018; Lorvi, 2013; Hansum, 2025; Cunico et al., 2024; Smeriglio et al., 2016; Gal et al., 2023; Domorenok et al., 2021; Milio, 2007) and document analysis (Terracciano & Graziano, 2016; Cunico et al., 2024; Surubaru, 2017; Smeriglio et al., 2016; Gal et al., 2023; Domorenok et al., 2021; Bachtrögler-Unger, 2024) were the most common. Other frequently used methods included questionnaires (Popescu et al., 2018; Lorvi, 2013; Surubaru, 2017; Milio, 2007), (participatory) observations (Popescu et al., 2018; Terracciano & Graziano, 2016) (Milio, 2007) and focus groups (Cunico et al., 2024). Many authors have also applied statistics, such as time-series cross-section methods and several models, e.g. mixed effects multilevel model (auto-correlation and REML estimation technique) (Van Wolleghem, 2020), regression analyses - multi-regression analysis (Tiganasu et al., 2018), fractional regression (Mendez & Bachtler, 2022) and macroeconomic approach - dynamic panel data model and the tobit estimation technique (Incaltarau et al., 2020). Other models have also emerged within the approaches, e.g., causal and system dynamics (Cunico et al., 2024) and explanatory frameworks, such as Milio's administrative capacity loop, and regional administrative capacity matrix (Milio, 2007; Terracciano & Graziano, 2016) or the "non-demand" framework (Hansum, 2025).

3.3 Research results

In this section, the authors of the paper summarize the results of research in which administrative capacity appeared as a variable. Only key results related to administrative capacity are presented.

The importance of administrative capacity was examined mainly in relation to the absorption rate, or absorption capacity. Milio's (2007) key finding was that regions where administrative capacity is insufficient experience less effective implementation (low expenditure rate) (Milio, 2007). In addition to administrative capacity, the causes of low absorption also include the unavailability of resources that could be used for co-financing at the national level (Popescu et al., 2018; Bachtrögler-Unger, 2024), as well as the insufficient budgetary capacity of beneficiaries (Popescu et al., 2018). Financial and macroeconomic capacity have also been shown to be crucial factors in absorption (Tiganasu et al., 2018; Van Wolleghem, 2020). At the regional level, in addition to capacity issues in managing or intermediate bodies, preparation and implementation capacity can also be a challenge (Bachtrögler-Unger, 2024), as well as the capacity of other, sub-regional actors (Smeriglio et al., 2016). Terracciano and Graziano (2016) also reached a similar conclusion – together with the level of administrative capacity at the regional level, expenditure also increases, i.e., the efficiency of implementation. Stronger administrative capacity and better information among local authorities lead to a higher number of Structural Funds (Popescu et al., 2018).

Tiganasu et al. (2018) showed that higher absorption is associated with higher institutional quality and better management performance in countries. The relationship between the absorption rate and the amount of allocation or GDP, i.e., that countries with higher allocations experience worse absorption, has not been confirmed (Incaltarau et al., 2020). The success of absorption can therefore be affected by the economic crisis, as well as the macroeconomic capacity of the country and differences between countries (Incaltarau et al., 2020). Cunico et al. (2024) showed that longer assessment times and other processes cause a decrease in the absorption rate, as does low demand. However, lack of administrative capacity is not the only cause of weak demand - it is associated, for example, with poor information or administrative burden (Hansum, 2025).

It should be noted that absorption is not only about the ability to spend available funds, but also about efficiency, i.e., the achievement of set goals (Bachtrögler-Unger, 2024). Effectiveness is also influenced by a large number of variables, so it is also necessary to examine the impact of interventions on economic growth (Tiganasu et al., 2018). The pace of the absorption rate has been shown to be directly proportional to economic growth (Mendez & Bachtler, 2022). In Van Wolleghem's (2020) research, decentralization has been shown to be statistically significant for implementation (directly proportional relationship).

The size of the entity can also be decisive for administrative capacity. For example, a survey of municipalities in Estonia showed that large municipalities, thanks to stronger administrative capacity, generated new projects to a greater extent, received more projects, had the advantage of higher co-financing resources and also had better educational opportunities available (Lorvi, 2013). Similarly

(Popescu et al., 2018) argue that the lack of staff or employees with insufficient skills, as well as cause local authorities to have lower access to funds. Hansum (2025) has shown that small organisations are less aware of new funding opportunities.

Administrative capacity and governance have been shown to be significant factors causing differences in the speed and extent of absorption across countries (Incaltarau et al., 2020). Administrative capacity alone (sufficient institutional quality and management performance) does not mean that absorption must be sufficient, nor does absorption necessarily lead to economic development (higher GDP per capita) (Tiganasu et al., 2018). At the same time, the assumption that Structural funds contribute to economic development (GDP per capita) was confirmed - the higher the absorption rate, the higher the GDP, but we should not forget about other interacting factors, such as supporting competitiveness or introducing innovations (Tiganasu et al., 2018). With macroeconomic stability and economic openness, their positive effects were confirmed (Tiganasu et al., 2018). The second model showed that the better the managerial performance, the better the absorption (Tiganasu et al., 2018). Mendez & Bachtler (2022) pointed out a positive and statistically significant relationship between government quality at the regional level and administrative performance. It was found that regional programs in which management powers are more regionalized do not lead to better results and therefore administrative performance than in the case of programs where management is centralized (Mendez & Bachtler, 2022). Monitoring of compliance in the area of expenditure proved to be related only to the spending dimension, which meant that spending did not lead to an efficient use of funds Mendez & Bachtler, 2022).

4. Discussion

Research on administrative capacity encompasses a wide range of variables and methods that can be used. In addition to building on existing knowledge and testing already used hypotheses and models in other locations (Surubaru, 2017; Cunico et al., 2024; Hansum, 2025) or levels (e.g. regional) (Incaltarau et al., 2020), on a different research sample (Popescu et al., 2018), for another programming period (Mendez & Bachtler, 2022; Incaltarau et al., 2020) or by applying novel or distinct methodologies (Surubaru, 2017; Hansum, 2025), the following gaps and opportunities for future research have been identified:

- Developing indicators and benchmarking data for specific focus on elements of administrative capacity and examining their effects on policy performance over time (Bachtler et al., 2024).
- Applying an ecosystem approach beyond managing authorities, including also other important actors in Cohesion policy, such as beneficiaries and intermediary bodies, as each of them has specific roles and pursues its own objectives (Bachtler et al., 2024; Polverari, 2023) and, as Cunico et al. (2024) add, including private sector organisations in the analysis. Implementation research therefore needs to examine not only the “supply” but also the demand side, including issues of interest in funding, as the relationship between administrative capacity and absorption is not able to sufficiently explain the dynamics and behaviour of actors (Hansum, 2025).
- Attention needs to be paid to the interplay between factors operating at European and national level (Bachtler et al., 2024).
- Cunico et al. (2024) recommend further developing their model of the Cohesion policy system map and applying it to different European settings. Last but not least, it is appropriate to focus not only on commonly used macro-approaches, but also on the micro-level (e.g. the impact of applicants’ decision-making). On the contrary, Van Wolleghem (2020) draws attention to the issue of economic governance and recommends analysing the impact of macroeconomic conditions.
- Incaltarau et al. (2020, p. 957) recommend, among other things, a qualitative approach to assessing specific problems related to absorption, administrative capacity, and political governance, focusing on the regional level or using diverse types of measurements.
- According to Tiganasu et al. (2018, p. 53), it is necessary to focus on research into the impact of Structural funds, as well as other factors that positively influence absorption, especially in the Central and Eastern European environment. Similarly, Popescu et al. (2018) recommend further development in this direction.

- Addressing the relationship between political governance, in particular the role of the political and institutional environment at Member State level and administrative capacities is also recommended by Surubaru (2017). Similarly, Mendez & Bachtler (2022, p. 700) recommend focusing on the political area and related data (such as political regionalism).
- Last but not least, analyzing and using findings from the implementation of the recovery and resilience plan is recommended (Bachtler et al., 2024; Bachtrögler-Unger, 2024).

Conclusion

In the article, we tried to elucidate to zoom in on the current state of research on administrative capacity within the framework of Cohesion Policy, which can be assessed as overly complex. Administrative capacity is one of the necessary factors enabling successful policy implementation, but it is not the only factor of success (Hansum, 2025; Van Wolleghem, 2020; Smeriglio et al., 2016) and focusing only on administrative capacity and related causes while avoiding the effects of other factors is a challenging research task (Surubaru, 2017). As noted, for example, by Cunico et al. (2024), a lot of empirical data is still missing. In conclusion, we note that there is still a need for comprehensive research that will further clarify the mutual interaction of administrative capacity and related variables (such as political, economic, financial, or institutional factors), including their impact on the implementation of Cohesion Policy.

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Development of Municipalities under the Influence of Fiscal Imbalance in Slovakia

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Abstract

Research background: The implementation challenges of fiscal decentralization bring vertical and horizontal fiscal imbalances, which stem from the mismatch between revenues and expenditures at various government levels in relation to their assigned responsibilities.
Purpose of the article: This paper aims to assess the impact of legislation on the local and regional development of selected municipalities from the perspective of the quality and quantity of municipal competencies.
Methods: By using historical and classification analysis we map the fiscal decentralization in Slovakia after 1989 with focus on original and delegated competences. Based on data from DataCentre we calculate the ratio of vertical fiscal imbalance caused by the fiscal decentralization for selected municipalities.
Findings & Value added: The results indicate that municipalities depend on transfer payments from the state budget, as transfers constitute almost one-third of the total revenues for executing the competences. Added value of the research lies in connecting the vertical fiscal imbalance with the development of municipalities.

Keywords: Vertical fiscal imbalance, Municipal development, Original and assigned competencies, Slovakia

JEL classification: H77, E62

1. Introduction

The current public administration and its activities are determined by a multi-level government system, which is characterized by the sharing of government power among individual levels. Several authors such as Blank (2010), Geys and Konrad (2010), Hallerberg (2010), Harmes (2019), Stein and Turkewitsch (2008), Cibík (2020), Dujičová and Sochorová (2017), Koreňová (2022), Papcunová et al. (2020) or Petrániková (2015) associate the issue of a multi-level government system with a fiscal system, based on the foundations of the theory of fiscal federalism. When defining fiscal federalism, we base our work on the ideas of authors such as Agrawal, Brueckner and Brulhart (2023) and Gillette (2012), who argue that it is an economic theory that deals with the existence of lower levels of government that are necessary for the implementation of public administration in the context of general economics.

The main feature of fiscal federalism is the process of delegation of not only political powers, but also fiscal powers, while it is necessary to pay attention to the adequate distribution of public finance functions and the decentralization of financial resources to individual lower levels of public administration (Peková, 2004; Sopkuliak, 2012). The result should be the maximization of social welfare through the decentralization of competencies and financial resources between levels of public administration in ensuring needs and the subsequent provision of public services. (Bird, 1999)

The theory of fiscal federalism is closely related to fiscal decentralization (Cibík, 2020; Giertz, 2008; Hanif, Wallace, Gago-de-Santos, 2020; Musgrave, 1959), as they use the same hypothesis, namely that the provision of public services is more efficient at lower levels of government than at the central level of government. However, while fiscal federalism represents a set of principles that serve to modify the structure of financial relations between individual levels of public administration, fiscal decentralization determines the course of implementation of these principles with an emphasis on the transfer of decision-

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making power to lower levels of public administration. (Cibík, 2020) Authors such as Ahmad and Tanzi (2002), Vo (2010), Bahl and Martinez-Vazquez (2023) and Letelier (2005) consider fiscal decentralization to be a basic form of decentralization, which is strongly linked to political and administrative decentralization, stating that it concerns financial flows and their decentralization in the fiscal context of a given country.

Research studies by Martinez-Vazquez and McNab (2003) and Rodriguez-Posea and Ezcurra (2010) point to the implementation challenges of fiscal decentralization affecting efficiency, in the form of vertical and horizontal fiscal imbalances. They state that these are fiscal imbalances that result from the mismatch between the revenues and expenditures of individual budgets of government levels in relation to the implementation of assigned competencies. The area of vertical fiscal imbalance is defined by authors such as Boadway and Tremblay (2006), Čapková and Zeleňák (2015), Dahlby (2005), Maličká (2019) and Martinez-Vazquez et al. (2016), while agreeing with the idea that this is a situation of inconsistency between local government revenues and its expenditures, since the scope of expenditure decentralization is not identical to the scope of revenue decentralization, i.e. there is a difference between local government revenues and their expenditure responsibilities within the framework of legally established competencies. (Cibík, 2020)

Blöchliger and Charbit (2008), Boadway and Tremblay (2006), Collins (2002), De Carvalho Filho and Litschig (2022) and Karpowicz (2012) present vertical fiscal imbalance in connection with the significance of transfers, when the idea of the need to implement transfer payments comes to the fore, since individual expenditures of local governments are covered precisely through transfer revenues, payments that are directed from the central level of government. Boadway and Tremblay (2006) also add that this is a stage when the distributed volume of transfers from the central level of government towards lower levels of government, does not represent the real value of the state's tax revenues.

The article presents the existence of links between the theory of fiscal federalism, fiscal decentralization and fiscal imbalance. The purpose of the paper is to assess the impact of legislation on the local and regional development of selected municipalities from the perspective of the quantity and financing of municipal competencies.

1.1 Fiscal decentralization in Slovakia

The historical excursion of fiscal decentralization begins in the territory of today's Slovak Republic in 1989, when significant changes occurred in the entire society and in the system of governance. The long-known centralized model of governance faced sharp criticism and an initiative process of public administration reform came onto the scene, part of which is fiscal decentralization itself. (Cibík, 2020)

The first stage of public administration reform is characterized by the building of institutional foundations, the emergence of a dual model of public administration, which is characterized by the presence of state administration and territorial self-government. (Sekula, Adamowicz, 2021) The disadvantage of the first stage is the relatively strong centralization of public finances, as territorial self-governments usually received special-purpose subsidies, almost did not make decisions about finances at all, and therefore their financial autonomy was almost zero. (Maličká, 2019)

The change in the political spectrum has made decentralization a significant area of several government documents and concepts, the primary goal of which was effective local governments. (Andrlík et al., 2021) The components of the budget of individual local governments were considered to be tax and non-tax revenues, subsidies, grants, funds from the sale of property and loans (Cibík, 2020), with the main area being tax revenues, divided into own tax revenues, i.e. local taxes and fees, and share taxes. (Visković et al., 2021)

The creation of the level of territorial self-government was mainly subject to the rational determination of competencies, rights and obligations, for which the regional and local levels of self-government are responsible (Sekula, Adamowicz, 2021). Buriachenko et al. (2022) state that the number of territorial self-governments, regional and local, is not important, since the decentralization of the allocation function plays a significant role in determining the spectrum of decentralized powers and determining the method of financing lower levels of public administration, so that they are able to exercise the assigned competencies.

The years 2002 to 2004 are typical of an increase in the expenditures of individual territorial self-governments, as there was a significant transfer of competencies to regional and local governments. (Maličká, 2019) However, the problem arose in the financing system, which did not take the above situation into account and the insufficient own revenues of self-governments were covered by funds from

the central level. (Cibík, 2020). In other words, subsidies from the state budget were mainly used to finance assigned, transferred, competencies.

Due to the quantitative increase in transferred competencies and the related problem of their financing, it was necessary for the state to introduce a change regarding the financial system of local governments through fiscal decentralization, the purpose of which was to replace transfers - subsidies from the state budget to the budgets of local and regional governments (municipalities and higher territorial units), for the exercise of their original competencies, with tax revenues, the use of which local governments have the right to decide completely independently. (Medveď et al., 2011) For this reason, a significant milestone for the Slovak Republic is the year 2005, when fiscal decentralization took place through the decentralization of the revenue part of budgets and the transfer of powers in the area of financial resources within regional and local governments. (Cibík, 2020) Municipalities generally carry out two types of activities. One of them is the activities that are within the self-governing competence of local government, i.e. these are original competencies, or these are activities that are classified as decentralized, transferred state administration, i.e. transferred competencies. (Bizoňová et al., 2020) The following table 1 presents an overview of original and transferred competencies in individual sections in the conditions of the Slovak Republic.

Table 1. Original and delegated competences in Slovakia

Competences	Section
Original	• education • spatial planning • geodesy, cartography and real estate cadastre • social services • financial management • local tax and fee administration, and municipal property management • road transport, land communications and public lighting • environment • sports • culture • healthcare • funerals • security • fire protection
Delegated	• education • building regulations • local and special purpose communications • special building office for local and special purpose communications • housing • registers • residence declarations and population registers • elections and referendums • environment • social services

Source: authors based on Bizoňová et al., (2020), Mederly et al., (2019)

As Mederly et al. (2019) state, local governments ensure the financing of original competencies independently, i.e. based on their revenues, which largely consist of their own local taxes and fees. Local taxes and fees, such as waste fees and development fees, are managed and coordinated independently by governments, and therefore they also act as tax and fee administrators. On the other hand, tax revenues of local governments also consist of personal income tax, but only proportionally, since it is a nationwide tax, where the tax administrator is the state (Papcunová et al., 2016).

In the case of transferred competencies, financing is ensured through the state, financial resources from the state budget, where these are transfer payments that are purposefully tied to the implementation of activities within individual sections (Bizoňová et al., 2020). A more detailed description of the financing of sections of transferred competencies is provided by Mederly et al. (2019): for a given section, a coefficient was determined expressing the amount provided by the state per capita, which was

subsequently multiplied by the number of inhabitants of the respective municipality, resulting in the resulting amount, which was intended for the transferred performance of state administration in a given section implemented by the municipality.

2. Methods

This paper aims to assess the impact of legislation on the local and development of selected municipalities from the perspective of the quality and quantity of municipal competencies.

The level of vertical fiscal imbalance can be determined in several ways. The most commonly used percentage indicator of vertical fiscal imbalance is the ratio of subsidies and share taxes in relation to the total revenues of local governments. (Rodden, 2002) Eyraud and Lusinyan (2011) propose to determine the level of vertical fiscal imbalance using the ratio of own expenditures of lower levels of government, local governments, while they consider own expenditures to be those that are not covered by own revenues. Bird and Tarasov (2004) point out the connection between vertical fiscal imbalance and fiscal gap, since when determining its level they are based on the difference between own revenues and own expenditures, which also represents a fiscal gap. The fiscal gap is characterized by Jílek (2008) through the difference between the expenditures that must be implemented by the decentralized level of government to ensure a standard, or at least acceptable level of services, and its own revenues that the decentralized level of government can obtain from its own resources. Authors such as Ahmad and Craig (1997), Jia et al. (2020), Meloni (2016), Rodden (2002) or Schroeder and Smoke (2003), generally speak of vertical fiscal imbalance as a ratio that reflects the relationship of the volume of transfers to the total revenues of local governments, regional and local governments.

Inspired by the above research studies, we use the following method in our work to calculate the rate of vertical fiscal imbalance (Ebel, Yilmaz, 2002):

$$VFI = \frac{TR}{R} \qquad (1)$$

Where the left part of the formula presents the vertical fiscal imbalance as the share of domestic current transfers from the state budget to cover the costs of transferred state administration performance in the total revenues of the municipalities. Using the indicator of dependence on transfers referred to as the ratio of transfers to total revenues, we analyze the vertical fiscal imbalance in selected municipalities of the Slovak Republic.

The municipalites were chosen based on their distance to the urban centers. We presume that urban center, i.e. bigger towns (population 50k+) have more sources of revenues. Therefore we focused on so-called commuter zones that fall within 10 km of an urban center. This range extends to 15 km if a divided highway connects it to the urban center. Commuter zones are on rising interest of research in municipal planning and development, being nor urban nor rural (Mazúrová et al., 2020; Cole et al., 2025). The research sample consists of 152 municipalities, grouped within the regions (Table 2).

The necessary data is provided by the DataCentre of the Slovak Republic in cooperation with academia. The structure of the data obtained from the DataCentre is based on 15 columns, which present information regarding the year, district code, district name, municipality code, municipality name, population, organization identification number, organization name, legal form, source of income, name of source of income, type of source of income, sub-item within the economic classification of the budget classification, name of sub-item within the economic classification of the budget classification and the actual value of income. On the other hand, it is important to point out the limits of the obtained data in terms of incomplete accuracy of the data. Also, the latest available data is for 2021.

Table 2. Commuter zones in Slovakia

Region	Municipality		Region	Municipality		Region	Municipality	Region	Municipality	
Bratislava (BA)	Dunajská Lužná	Dubová pri Modre	Žilina (ZA)	Dolná Tižina	Snežnica	Banská Bystrica (BB)	Zvolenská Slatina	Trnava (TT)	Zavar	Hviezdoslavov
	Gajary	Častá		Belá pri Martine	Košťany n Turcom		Budča		Trakovice	Vlčkovce
	Budmerice	Senec		Horný Vadičov	Vrútky		Poniky		Jelka	Bohdanovce n TT
	Jablonové	Jakubov		Strečno	Bystrička		Selce pri BB		Biely Kostol	Špačince
	Veľký Biel	Pezinok 1		Gbeľany pri ZA	Teplička nVáhom		Sliač		Malženice	Suchá nad Parnou
	Doľany pri Častej	Pernek pri Malackách		Rudina	Dražkovce pri MT		Slovenská Ľupča		Križovany nad Dudváhom	Hrnčiarovce nad Parnou
	Nová Dedinka	Kuchyňa		Divina	Rosina		Dobrá Niva		Dolná Krupá	x
	Rovinka	Čataj		Rajecké Teplice	Višňové pri ZA		Harmanec		Štvrtok na Ostrove	
	Tomášov	Stupava		Radoľa	Turany nVáhom		Staré Hory		Šúrovce	
	Šenkvice	Ivanka pri Dunaji		Sučany	Dlhé Pole		Vlkanová		Bučany	
	Kráľová pri SC	Most pri Bratislave		Dolný Hričov	Lietava		Lieskovec		Dolné Orešany	
	Kostolište	Modra 1		Stráňavy	Turie		Kováčová pri ZV		Majcichov	
	Hamuliakovo	Viničné pri Pezinku		Kotešová	Príbovce		Tajov		Zeleneč pri Trnave	
	Svätý Jur	Malinovo		Lietavská Lúčka	Žabokreky		Badín		Brestovany	
Region	**Municipality**		**Region**	**Municipality**		**Region**	**Municipality**	**Region**	**Municipality**	
Košice (KE)	Hrabušice	Družstevná pri Hornáde	Nitra (NR)	Lužianky	Veľké Zálužie	Trenčín (TN)	Dolná Súča	Prešov (PO)	Žehňa	Petrovany
	Letanovce	Nižná Myšľa		Alekšince	Jelšovce		Trenč. Teplice		Šariš. Bohdanovce	Bzenov
	Veľká Ida	Valaliky		Čechynce	Veľký Lapáš		Skalka nad Váhom		Spišský Štiavnik	Bajerov
	Bohdanovce pri KE	Čaňa		Zbehy	Nitr. Hrnčiarovce		Trenč.Teplá		Vikartovce	Fintice
	Bidovce	Haniska pri KE		Ivanka pri NR	Podhorany pri NR		Soblahov		Jánovce pri PO	Veľký Šariš
	Ruskov	Šemša		Pohranice	Jarok		Trenč. Stankovce		Hranovnica	Matejovce
	Košická Belá	Rozhanovce		Kolíňany	Golianovo		Drietoma		Kendice	Batizovce
	Malá Ida	Budimír		Cabaj-Čápor			Trenčianska Turná		Kapušany pri PO	Hôrka pri Poprade
	Kráľovce pri KE	Sady nad Torysou		Lehota pri NR			Chocholná-Velčice		Spišské Bystré	Spišská Teplica
x									Svit 1	x

Source: authors

3. Results

We can verify the idea of a lack of financial resources and the issue of vertical fiscal imbalance at the local level of commuter zones of the Slovak Republic through the following tables 3 and 4, which define the rate of vertical fiscal imbalance as a percentage of transfers in the total revenues of a given commuter zone for 2021.

Table 3. Vertical fiscal imbalance in municipalities - commuter zones of the Slovak Republic in 2021

Rate of vertical fiscal imbalance rate in 2021	
Mean	29,69%
Standard deviation	20,57%
Median	27,89%
Maximum	96,20%
Minimum	0,16%

Source: authors

Based on Table 3, we can confirm the presence of vertical fiscal imbalance in the conditions of commuter zones of the Slovak Republic, as it is on average at the level of 29.69% for 2021, while the standard deviation is 20.57%. In other words, commuter zones represented by local governments are dependent on transfer payments from the state budget, since transfers account for almost one third of the total revenues of local governments of the Slovak Republic on average. Approximately half of the commuter zones of the Slovak Republic reached a vertical fiscal imbalance rate of 27.89% in 2021. On the other hand, it is necessary to point out the deepening differences in the issues of the rate of vertical fiscal imbalance within individual municipalitties with the status of commuter zones.

The analysis of the rate of vertical fiscal imbalance in individual commuter zones in more detail is in the following table 4. We base our analysis on the inclusion of commuter zones into individual self-governing regions of the Slovak Republic, while applying elements of descriptive statistics and the connection with the issue of the rate of registered unemployment and the number of population at the level of self-governing regions.

Table 4. Vertical fiscal imbalance of municipalities - the commuter zones for the regions in 2021 in %

Region	Mean	Standard deviation	Mean	Maximum	Minimum
BA	24,20	16,58	21,81	64,58	0,16
TT	31,29	15,04	34,90	57,11	4,88
TN	21,60	16,17	18,87	47,16	2,79
NR	40,31	26,16	46,73	95,40	3,27
BB	30,39	13,83	29,99	49,06	5,96
ZA	34,15	19,12	36,55	74,88	0,52
PO	26,54	24,96	21,82	96,20	1,41
KE	29,04	32,73	12,47	92,63	1,16

Source: authors

Following Table 4, we can identify the Nitra Region as the region with the highest rate of vertical fiscal imbalance of individual commuter zones, which is on average at the level of 40.31% and the standard deviation is 26.16%. We also draw attention to the fact that for approximately half of the commuter zones of the Nitra Region, we record a rate of vertical fiscal imbalance at the level of 46.73%.

On the other hand, the Trenčín Region can be considered as the region with the lowest rate of vertical fiscal imbalance within individual commuter zones, which is on average at the level of 21.60%, while the standard deviation is 16.17%. At the same time, we draw attention to the fact that approximately half of the commuter zones of the Trenčín Region achieve a rate of vertical fiscal imbalance at the level of 18.87%.

4. Discussion

Financing of original and transferred competencies is a relatively important area in the context of fiscal decentralization, which is also confirmed by studies by several authors. (Čapková, Zeleňák, 2015; Holíková et al., 2022; Papcunová et al., 2016)

However, practice shows an unflattering situation, a problem where local governments pay for the performance of transferred competencies from their own funds, i.e. they finance the competencies of the state, which they also implement on its behalf (Mederly et al., 2019). Similar conclusions are also brought by studies such as Čapková and Zeleňák (2015), Holíková et al. (2022) or Papcunová et al. (2016), drawing attention to the idea that the universal transfer of competences to all local governments, regardless of their size, represents an automatic source of disruption in the conditions of excessive territorial fragmentation of the Slovak Republic (Mederly et al., 2019).

These findings were also confirmed by our research. We consider the main reasons determining the different levels of vertical fiscal imbalance rates in individual commuter zones to be a combination of economic and non-economic factors, while we agree with the idea of the research study by Mederly et al. (2019) that each commuter zone has a unique combination of factors influencing its rate of vertical fiscal imbalance. Based on the research study by Aldasoro and Seiferling (2014), we also agree that a significant factor is the demographic situation in a given commuter zone, especially the number of inhabitants and their age structure in terms of the representation of the productive population and the population over 65 years of age, which significantly determines the volume of the own revenues of a given municipality. In addition to demographic areas, the overall characteristics of the commuter zones, such as geographical location, tourism opportunities, local government management (in the person of mayor), unemployment and various other economic and non-economic indicators, play an important role in vertical fiscal imbalance.

Bizoňová et al. (2020) consider whether the transfer of competences, for which the state continues to bear responsibility, represents true decentralization for local governments, or rather deconcentration, i.e. only delegation of power without independence in decision-making, powers, and financing. (Mederly et al., 2019) On the other hand, we can state that fiscal decentralization is undeniable for the effective provision of public services, but its necessity is the rational determination of adequate spending and tax powers for individual local governments, given their structure of economic and non-economic factors. (Aldasoro, Seiferling, 2014)

Several authors (Blöchliger, Charbit, 2008; De Carvalho, Litschig, 2022) view the issue of vertical fiscal imbalance through the significance of transfer payments as an adequate way of financing a certain part of local government expenditures in a multi-level government environment, where individual local government expenditures are covered precisely through transfer revenues, payments that come from the central level of government. Given the importance of intergovernmental transfers, it is important to note their direction, while in the case of the Slovak Republic they are distributed from the state budget to individual local governments with the intention of financing and covering their expenditure responsibilities in connection with ensuring the exercise of transferred competencies based on Act No. 416/2001 Coll. on the transfer of certain powers from state administration bodies to municipalities and higher territorial units.

In general, we can state that the main goal of intergovernmental transfer payments is to minimize vertical fiscal imbalances. On the other hand, we point out a situation where local governments will not be forced to deal with increasing their own revenues, spending their funds efficiently, but on the contrary, they will increase their expenditures regardless of their tax revenue status, since they rely on the inflow of intergovernmental transfers. The above situation is also pointed out by Ahmad and Craig (1997), and therefore we consider it important to objectively examine the individual needs and key factors of individual commuter zones in order to set an adequate level of intergovernmental transfers.

Conclusion

We can assess the impact of legislation on the local and regional development of municipalities in the areas of commuter zones in terms of quantity and financing of municipal competencies based on the results of the analysis of vertical fiscal imbalance. We conclude that in individual commuter zones of the Slovak Republic the rate of vertical fiscal imbalance is different, as it is determined by a combination of several factors that are typical for a given municipality. An important factor can be considered the distance from the regional capital and the associated active presence of tourism, which positively affects the issue of vertical fiscal imbalance in terms of reducing its rate in a given municipality.

In general, a significant factor is the demographic aspect of a given commuter zone, in terms of population, where we proceed from the idea that with a smaller number of inhabitants, a given commuter zone tends to achieve a higher rate of vertical fiscal imbalance than with a larger number of inhabitants. However, the results of the analysis point more to the significance of the structural distribution of the population by age than to the number of inhabitants of the commuter zone itself. We agree with the idea that in commuter zones with a predominant population component of the productive age from 15 to 64 years, the rate of vertical fiscal imbalance is lower than in the case of commuter zones, where a significant part of the population is made up of people older than 65 years.

A limitation of the research is the availability of data from the DataCentrum (on request for a fee), which are not always complete and not always up-to-date. The latest available data was provided for 2021. Future research will focus on all municipalities and identify vertical fiscal imbalance within Slovakia.

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The Development of the Standard of Living in Slovakia

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Abstract

Research background: Based on available data and research, a significant correlation can be observed between the growth of material security and the development of the population's standard of living. However, the findings also suggest that while material conditions in Slovakia have objectively improved, the subjective perception of quality of life does not always reflect this progress. Notable regional disparities further challenge the validity of aggregated indicators when assessing quality of life across the country.
Purpose of the article: The aim of this article is to analyze the standard of living in Slovakia between 2013 and 2023 using a combination of quantitative and qualitative indicators, including GDP per capita, the Human Development Index (HDI), and the Happiness Index (GNH). The article also emphasizes the need to consider regional disparities and subjective dimensions when assessing the standard of living. In conclusion, the article calls for the implementation of targeted regional policies to address stagnation within Slovakia and to foster sustainable development for the country and its population.
Methods: This article is theoretical in its nature and employs mainly content analysis of available data and existing literature within the relevant field.
Findings & Value added: The analysis demonstrates that quality of life is shaped not only by economic factors, but also by intangible elements such as a sense of security, trust, traditions, and social cohesion. These results highlight the limitations of conventional indicators in capturing the multifaceted nature of human well-being and support the adoption of multidimensional approaches that integrate both objective data and subjective evaluations.

Keywords: Living standard, Quality of life, Regional disparities

JEL classification: E01**,** I31

1. Introduction

Many global institutions and governments address living standards, expressing their commitment to ensuring good living conditions and growth opportunities for their populations (Grimsley, 2021). Modern society generally upholds every individual's right to a dignified and quality life. However, social inequalities persist, often perpetuated by modern market economies. No society has yet fully succeeded in providing equal living standards and opportunities for all, as even attempts at equalization in non-market economies have failed historically (Laluha et al., 2005).

The motivation to study living standards lies primarily in informing and developing socio-economic policies (Sen, 1984). These standards are typically defined by a set of material requirements essential for human life and development, including access to basic needs and dignified living conditions (Rao & Min, 2018). In the discourse on living standards and quality of life, there is increasing advocacy for incorporating expanded qualitative and quantitative indicators to create a unified measurement standard. This study does not propose new indicators or evaluate existing ones but aims to analyze Slovakia's living standards based on currently available data, reflecting on the relevance of comparative assessments.

1.1 Living Standard and its incompleteness

Living standard is a complex socio-economic concept describing the degree to which physical, spiritual, and material needs are satisfied at a given time (Nemec et al., 2022). It is often defined as the

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measure of quality of life, prosperity, and material well-being of a country, group, or individual (Grimsley, 2021). Primarily, living standard is viewed as an economic concept reflecting overall life quality based on economic, social, and environmental factors (Sen, 1984).

After World War II, living standards were closely associated with material prosperity and consumption. Classical economics equated higher income with better life quality, using real GDP per capita as the key indicator. However, increases in GDP did not correspond with higher life satisfaction (Klamár & Gavaľová, 2018), revealing GDP's limitations in capturing human well-being (Easterlin, 2000). This discrepancy, known as the "Easterlin paradox," highlights that growing material wealth does not always lead to greater happiness (Blanchflower & Bryson, 2024; Klamár & Gavaľová, 2018). The multidisciplinary approach challenged this view by emphasizing other factors like life expectancy and education. This led to the development of the Human Development Index (HDI) by the United Nations, which integrates material conditions, health, education, and personal factors, reflecting a broader understanding of well-being (Easterlin, 2000). Consequently, the study of living standards now includes qualitative dimensions such as subjective well-being and life satisfaction, complicating evaluation due to the subjective nature of such data (Klamár & Gavaľová, 2018).

While living standards traditionally focus on measurable, quantitative aspects, recognition that material wealth alone does not ensure life satisfaction has led to a shift towards the broader concept of quality of life (Matis, 2002).

1.2 Quality of life

Living standard and quality of life are related but distinct concepts, primarily differentiated by the factors they encompass. These terms are often mistakenly used interchangeably. Those who treat them as synonyms tend to overlook qualitative approaches to evaluating human life, equating high quality of life mainly with material success (Krys et. al., 2024; Nemec et al., 2022). While understandable, this perspective is insufficient. Experts have repeatedly shown that economic progress alone does not guarantee fulfillment of all key aspects of human well-being, such as safety or absence of crime. Assessing a good life solely through economic factors neglects crucial elements like love, personal growth, and life meaning. Consequently, researchers increasingly adopt multidimensional approaches to define and measure quality of life. As a complex and multifaceted concept, quality of life requires openness to diverse perspectives until a universally accepted definition emerges (Diener & Suh, 1997; Iezzi & Polistena, 2006). Based on this discussion, living standards can be regarded as a subset of the broader concept of quality of life.

2. Methods

When measuring living standards in a country like Slovakia, comparative analysis, either cross-country or over time, is essential because quality of life is inherently relative. A critical question is whether the same social indicators are appropriate across diverse regions (e.g., eastern vs. western Slovakia) or social subsystems (urban vs. rural). Expanding indicators to include traditions, mindsets, or rituals could enrich analysis but would reduce comparability (Ondrejkovič & Bednárik, 2010). Most researchers aim for generalization rather than specificity, which explains the continued widespread use of GDP and HDI despite criticism. These indices offer simplicity and relative stability, even within fairly homogeneous populations like Slovakia's. Yet, perceptions of well-being evolve over time, demanding indicators that integrate both subjective and objective happiness factors. Studies show strong correlations between happiness and variables such as health, unemployment, income, and inequality (Gawlik & Gołębiowski, 2014).

To test the proposition of this paper that there is a strong relationship between the growth of material well-being in Slovakia and improvements in living standards, Slovakia's living standards from 2013 to 2023 are analyzed using established indicators such as GDP per capita, the Human Development Index (HDI), Purchasing Power Parity (PPP) and the Happiness Index (HI). This approach seeks to explore both objective changes in material wealth and subjective life satisfaction. Data sources include UN human development reports, World Bank databases, EUROSTAT, the Statistical Office of the Slovak Republic, and relevant literature analyzing prior studies on Slovakia's living standards.

Limitations of this research arise mainly from data quality and availability. Ideally, multiple established indicators would be compared to validate whether quantitative measures align with qualitative assessments. Additionally, the researcher's subjective bias is acknowledged, recognizing that science cannot be entirely value-neutral.

3. Results

Numerous studies have attempted to evaluate the standard of living through both quantitative and qualitative indicators, which assist in assessing the living conditions of the population within a given country or region. The quantitative approach primarily focuses on economic, measurable variables such as GDP per capita, wages, inflation rate, unemployment rate, poverty rate, health status of the population, educational attainment, and housing availability. These variables facilitate direct comparisons across different countries. In contrast, the qualitative approach offers an in-depth analysis of intangible aspects of life, including life satisfaction, subjective health quality, sense of security, environmental quality, accessibility of public services, social mobility, cultural and social participation, family life, and housing quality, factors that often significantly influence individuals' well-being and satisfaction.

While GDP has traditionally measured quality of life through income, recent research challenges this link, highlighting that social, environmental, and structural factors strongly influence health outcomes. Income correlates with life expectancy up to a point, but beyond certain levels, additional income has little effect. Interestingly, an increasing poverty gap may lead to improved health outcomes by driving the expansion of medical support systems for disadvantaged populations (Han, 2024).

Regardless of whether human welfare is evaluated based on material, psychological, or health-related categories, there is a consistent and growing interest in measuring people’s happiness rather than solely their material conditions. This shift brings forth a debate centered on the reliability of research methodologies, as happiness, and consequently its assessment, may vary considerably across different countries. The principal limitation in studying quality of life thus lies within the human subject itself, and the inherently relative nature of the data involved. For instance, Steckel (2008) suggests that future advancements, such as the use of nanotechnologies to measure brain activity and analyze biochemical markers, could potentially address this issue by providing more objective data on individuals’ subjective perceptions.

When measuring the standard of living in a country such as the Slovak Republic, the true informative value is obtained through comparison, either between Slovakia and other countries or across different time periods, since quality of life is intrinsically relative. The fundamental question pertains to whether it is appropriate and meaningful to employ identical social indicators for measuring social phenomena across diverse contexts, such as eastern versus western Slovakia, or between various subsystems of society like Slovak cities and rural villages. It might be conceivable to further develop and supplement indicators by incorporating criteria related to traditions, modes of thinking, rituals, and so forth. However, such an approach would ultimately result in a lack of comparability (Ondrejkovič & Bednárik, 2010). Most researchers tend to favor generalization over specificity. It can therefore be inferred that this is why GDP, or the Human Development Index (HDI), continues to be widely used, despite significant criticism, as a key indicator of living standards. Numerical indicators are more challenging to interpret in multiple ways. Even when comparing Slovakia alone, whose population is relatively homogeneous compared to many other European countries, it must be acknowledged that human perceptions of the world and what constitutes satisfaction evolve over time. Consequently, there is a need for an indicator that integrates both subjective and objective factors of happiness into a single aggregated index. Various studies have demonstrated a strong correlation between happiness and factors such as health, unemployment, income, and inequality (Gawlik & Gołębiowski, 2014).

3.1 Standard of living in Slovakia

Following the challenging period of economic transformation in the 1990s, most aspects of the standard of living began to improve for a large portion of the Slovak population, although not uniformly for all individuals. Some were adversely affected by changes, as education, several years of work experience, or skills acquired under the previous political and economic system became obsolete after the regime shift. The market economy does not guarantee employment or income security anymore. Since the establishment of an independent Slovakia, an increase in the size of the impoverished segment has been observed, while the size of the wealthiest segment has remained nearly unchanged (Kišš & Šiškovič, 2006).

The National Bank of Slovakia (2022) succinctly assessed the current state of the country as follows: over the past 30 years, the Slovak population has aged but is living longer, becoming better educated and relatively wealthier. The relative wealth, however, is tempered by the increasing indebtedness of both the state and households. Slovakia has become a cleaner country, with its population reporting better health, greater happiness, and higher trust in institutions. Conversely, trust in people and perceptions regarding the role of women in society have deteriorated since a certain point in time.

The Statistical Office of the European Union evaluated Slovakia's development status by stating that Slovakia is the second poorest country within the Union (Toma, 2023). Slovakia ranks among countries where female employment is growing faster than the EU average, a trend not mirrored in the employment of older adults, which is declining. Although the population has increased, younger generations are emigrating, and birth rates are decreasing. Seniors neither engage in further education nor exhibit entrepreneurial activity comparable to the EU average. Women with children under six years of age face significant challenges entering the labor market, and overall population health remains below the EU average (Pilková & Mikuš, 2020).

These observations demonstrate that temporal self-comparisons yield different perspectives than comparisons with other countries. While satisfaction and happiness are inherently subjective, when evaluated through frameworks such as the Gross National Happiness Index (GNH), the results can provide valuable signals and feedback for institutions and policymakers.

Regarding the outcomes of the GNH Index, the authors identified Žilina Region as the least satisfied, followed by Trenčín, Košice, and Prešov Regions. The average satisfaction rate across Slovakia stands at 78.9%. Only Banská Bystrica and Bratislava Regions scored above this average. The happiest regions are Nitra and Trnava (see Figure 1). A correlation between GDP and GNH indicators was confirmed: economically strongest regions, as measured by GDP, also recorded the highest GNH scores, with inhabitants reporting greater satisfaction and happiness.

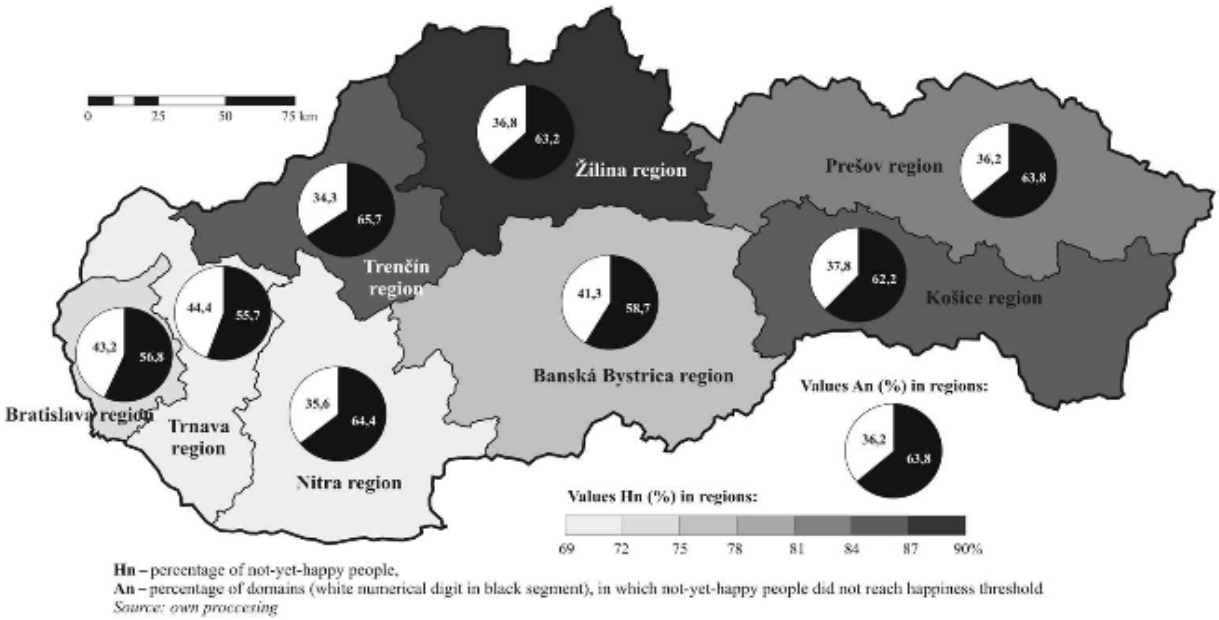

Figure 1. Percentage of not-yet happy people within the regions in Slovakia
Source: (Klamár & Gavaľová, 2018, p.325)

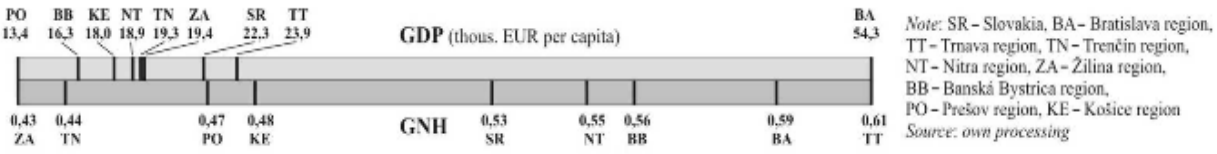

Figure 2. Comparison of the GNH Index values and regional GDP per capita within the regions in Slovakia
Source: (Klamár & Gavaľová, 2018, p.327)

The distribution of regional GDP values in Slovakia is irregular, as evidenced by the fact that, apart from the Bratislava region, only the Trnava region slightly exceeds the national average GDP (Klamár & Gavaľová, 2018). In contrast, the National Happiness Index exhibits a more balanced distribution: four regions reported values below the national average, while four regions scored above it. Another study (Murgaš et al., 2023) identified the happiest districts as Košice-okolie (KE), Humenné (PO), Prešov (PO), Martin (ZA), Kežmarok (PO), Nitra (NR), Stará Ľubovňa (PO), Košice (KE), Gelnica (KE), and Piešťany

(TT). Conversely, the least happy districts included Senica (TT), Bardejov (PO), Pezinok (BA), Krupina (BB), Komárno (TT), Rožňava (KE), Veľký Krtíš (BB), Tvrdošín (ZA), Dunajská Streda (TT), and Banská Bystrica (BB).

A comparison of these two studies' findings on happiness in Slovakia yields ambiguous results. Notably, five of the happiest districts are located in regions previously classified as less happy. Conversely, five of the least happy districts, except for Bardejov, belong to regions identified as the happiest. Furthermore, some of the happier districts, such as Košice-okolie, Kežmarok, and Gelnica, are among those with the highest levels of poverty in the country.

This cursory comparison of happiness research outcomes in Slovakia confirms that while population satisfaction is strongly correlated with income, it is not exclusively determined by it. For instance, the wealthiest Bratislava region exhibits only average happiness levels (Oláh et al., 2020). Additionally, a significant portion of the happier districts is situated within the so-called Eastern Slovak micro-region of poverty (Michalek, 2004).

Research conducted by the Center for the Study of Ethnicity and Culture has demonstrated that factors such as security, trust, and traditions constitute a crucial value-based foundation for the inhabitants of Slovakia. These elements represent key criteria for a high quality of life, and the gradual erosion of many of these aspects within society has consequently led to a deterioration in the overall quality of life. Furthermore, self-sufficiency is perceived as an essential condition for a quality life, which is closely linked to the perception of money as a necessary means to secure services that may be inaccessible to the population due to institutional dysfunctions. The majority of Slovak residents perceive a quality life as one supported by safety nets. However, this perception is not uniform across the country. What constitutes a safety net for individuals living in Slovakia varies; for some, it may be a stable, albeit modest, income and shelter, while for others, it may involve family support or a sense of personal freedom. Notably, a prevailing sense of distrust exists among the Slovak population, accompanied by a declining perception of security, a view of their traditions and culture as threatened, and a tendency to endorse repression towards perceived differences (Kriglerová et al., 2017). Based on these findings, it can be assessed that Slovak citizens generally perceive the quality of their lives as insufficient.

Given the information presented thus far, it is not yet possible to unequivocally evaluate the standard of living in the Slovak Republic. The aggregate results from various studies and the available literature do not irrefutably confirm the initial premise that a fundamental correlation exists between the development of GDP and the well-being of the population in Slovakia. Therefore, as a final component of our analysis, we incorporate a comparative examination of the development of GDP per capita, the Human Development Index (HDI), and Purchasing Power Parity (PPP) alongside the Happiness Index (HI). The depicted simple graph illustrates that higher GDP and purchasing power correspond with Slovakia's elevated ranking among countries worldwide in terms of the Happiness Index.

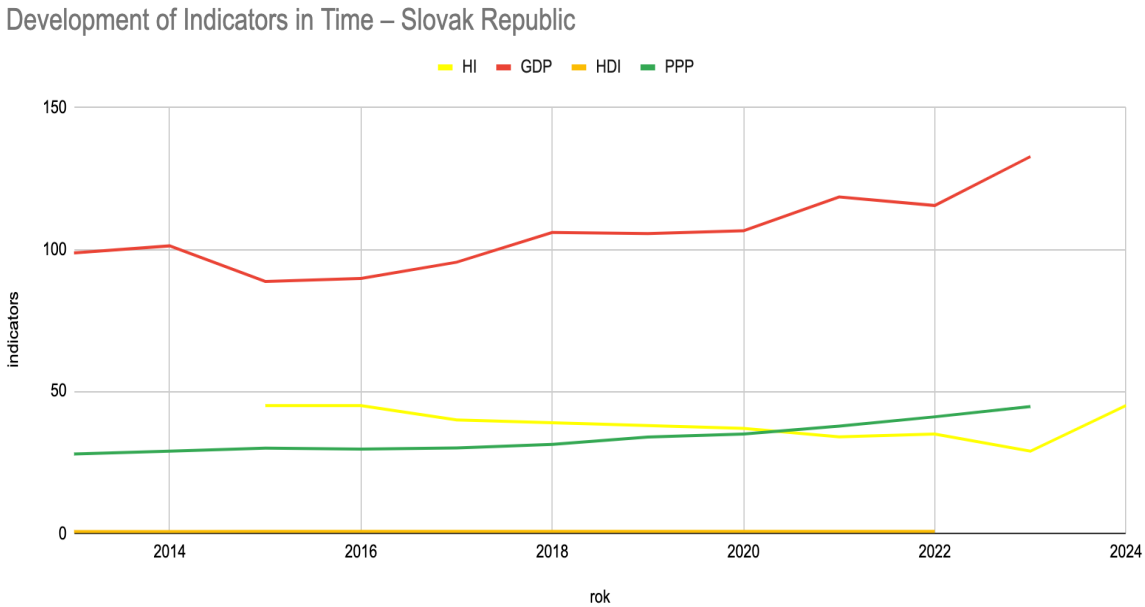

Figure 3. Development of Indicators in Time - Slovak Republic
Source: own processing (2025)

4. Discussion

Most individuals reflect at some point on whether they are better off than others, their past selves, or previous generations. Questions such as whether one is better off than one's parents or whether there is a realistic prospect that future generations will experience improved living standards are central to such reflections. Due to the wide-ranging complexity of the subject and the diversity of perspectives, definitive conclusions remain elusive. Comparisons may function as encouragement when made against less advantaged groups, and as motivation when made against more privileged ones, applying not only to individuals but also to entire nations.

In the context of Slovakia, current observations reveal an expansion of the impoverished segment of the population, while the size of the wealthiest has remained virtually unchanged since the establishment of the independent Slovak Republic. Although this may not be immediately evident from a domestic viewpoint, international comparisons indicate that income inequality in Slovakia is comparatively moderate, which might suggest a relatively balanced distribution of living standards. To put this into perspective, one might conclude that a majority of Slovakia's inhabitants experience a similar level of economic deprivation. While purchasing power in Slovakia has increased over time, paralleling trends observed in Western countries, residents still face extended working periods to afford basic necessities such as housing and energy. It is anticipated that these trends will persist, accompanied by improvements in environmental quality and longevity (Kišš & Šiškovič, 2006).

The analysis undertaken in this study identifies regional disparities as the principal challenge impacting the quality of life in Slovakia. A high national Quality of Life Index does not necessarily imply uniformity of living standards across all regions. Hence, it is essential to measure and compare living standards not only internationally but also within national borders. Investigating economic, social, and regional differentials enables the identification of less developed areas and specific inequalities, thereby informing targeted allocation of investment resources and development initiatives. Prominent disparities in Slovakia include low competitiveness in production and services across certain regions, deficiencies in human capital quality, and inadequate public infrastructure in terms of quality and accessibility. Conversely, factors conducive to regional development include the enhancement of human potential and workforce utilization, adoption of innovations and information technologies, infrastructural improvements and increased accessibility, as well as the improved labor market integration of marginalized groups (Oláh et al., 2020). Evidently, Slovakia exhibits marked regional variation in living standards, rendering aggregate national comparisons insufficiently informative or directive for formulating effective national and regional policies.

Slovakia's accession to the European Union and the Eurozone has facilitated higher economic growth, improved trade and investment climates, and an objective enhancement of living standards. However, after two decades within these structures, economic stagnation is apparent, with increasing evidence that political and economic elites lack the capacity to generate new opportunities or to fully exploit those presented, for example, by the European Union. A prevailing reluctance to adapt to societal transformations inherent in normal developmental processes seemingly contributes to the country's relative underdevelopment, a condition, one can propose, is largely self-imposed.

Empirical research underscores that social inequalities adversely affect perceived quality of life and simultaneously erect barriers to social cohesion, which is indispensable for national advancement. Slovakia thus appears caught in a paradox: on one hand, it struggles to progress, while on the other, it resists the establishment and flourishing of positive innovations and reforms. Regardless of subjective evaluations of socio-economic policies enacted, it is unrealistic to expect substantial improvements in living standards within short temporal horizons of three to four years, which correlates with the term of an elected government. Achievements, particularly in social policy, family support, and the business environment, are frequently reversed by new political establishments before their positive impacts on population's well-being can be realized. Consequently, one can argue that comparisons of living standards in Slovakia contribute little to expert socio-economic planning and more to political polarization and societal fragmentation.

Conclusion

The objective of this study was to analyze the standard of living in Slovakia, based on the premise that there is a significant relationship between the population's material well-being and their overall standard of living. Findings from available data support this assumption, revealing that higher GDP and PPP correlate with a higher ranking in the Happiness Index.

Although the terms *standard of living* and *quality of life* are often used interchangeably, a closer examination reveals a nuanced distinction: the standard of living reflects what individuals possess and can afford, whereas quality of life relates to how they feel about these conditions. Both concepts are inherently relative and gain meaning primarily through comparison.

This raises critical questions: What is the purpose of evaluating a population's standard of living? Does it raise citizens' expectations, or temper them? Do governments actually utilize these insights to inform policy? These questions suggest the need for continued research, particularly focused on regional disparities within Slovakia.

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Analysis of Electromobility Development in the Slovak Republic from a Regional Perspective

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Abstract

Research background: Electromobility plays an increasingly important role in sustainable transport policies across the European Union. In Slovakia, its development varies significantly by region, particularly in the adoption of battery electric vehicles (BEVs) and the availability of charging infrastructure. This study is based on the assumption that more urbanized and economically developed regions, namely Bratislava and Košice, should lead in electromobility. The research aims to identify regional disparities and support more effective policies for green mobility.
Purpose of the article: The presented article focuses on the development of electromobility in the Slovak Republic from a regional perspective, with emphasis on the relationship between the growing number of electric vehicles and the availability of charging infrastructure. The aim of this paper is to identify regional disparities, assess the current state and development dynamics across different regions, and support more effective promotion of electromobility. The analysis includes graphically processed statistical indicators and a predictive model of electric vehicle growth.
Methods: A composite index was created to evaluate the level of electromobility development across the eight regions of Slovakia, incorporating the number of BEVs and the number of public charging points per 1,000 inhabitants. Regional differences were visualized and ranked in order to test the proposed hypothesis. Subsequently, a multiple linear regression analysis was conducted to examine the impact of charging infrastructure and the total number of registered vehicles on the number of BEVs. To forecast future trends, three models: linear, exponential, and ARIMA (1,1,1), were applied based on historical data (2018–2024), with their accuracy evaluated using the MAPE indicator.
Findings & Value added: This comprehensive analytical approach enables an objective assessment of regional disparities and the identification of relationships between the development of electromobility and charging infrastructure within Slovakia.

Keywords: Electromobility, Regional development, Supporting infrastructure, Sustainable transport

JEL classification: O13, P48, Q56

1. Introduction

Electric vehicles represent a dynamically developing segment of the automotive industry, responding to the need to reduce emissions, increase energy efficiency, and support sustainable mobility. Battery electric vehicles (BEVs) are powered exclusively by electricity and use rechargeable batteries to supply energy to the electric motor. They can be charged via a home socket or a public charging station, with charging speed depending on the power output of the charger. Most models also include a regenerative braking system, which recharges the battery when braking or decelerating. Compared to combustion engine vehicles, they are more environmentally friendly, quieter, and have lower maintenance costs. (Iberdrola, 2024)

The key element of electromobility is the electric vehicle, complemented by charging infrastructure, information technology, and legislation. Aside from the construction of charging points, it does not require major changes to road infrastructure. Electromobility has significant potential to reduce emissions, particularly

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in freight transport, which accounts for more than one-third of road transport emissions, despite representing only 13% of vehicles. In passenger transport, which makes up over 83% of inland passenger transport in the EU, emissions account for approximately two-thirds of the total from road transport. (Rovňák a kol., 2022)

Public charging stations complement private charging to ensure accessibility in high-traffic areas such as shopping centers, office buildings, or urban parking lots. They are categorized based on access: limited (time-restricted) or unlimited. While public chargers are an essential part of the electromobility ecosystem, their influence on consumer decisions to purchase electric vehicles is only moderate and does not replace the need for private home charging. (Ministry of Economy of SR, 2019)

Road transport is responsible for more than 71% of transport-related CO_2 emissions, with the majority coming from passenger cars. The goal is therefore to significantly limit or even ban internal combustion engine vehicles in cities by 2050. Electric vehicles do not cause local air pollution, and their widespread use can significantly reduce the environmental impacts of transport. Reducing greenhouse gas emissions - particularly in the transport sector - has become a priority. This sector accounts for approximately one-quarter of total emissions in the EU. Electromobility, including battery electric vehicles (BEVs), is thus seen as one of the solutions at both national and international levels. BEVs are quiet, locally emission-free, and safer in traffic accidents. (Sendek-Matysiak a kol., 2019)

While in 2014 battery and plug-in hybrid vehicles accounted for only 0.5% of new registrations in the EU, we are currently witnessing a sharp increase in electric vehicle sales, particularly in China, Europe, and the USA, which together make up more than 90% of the global market. (Skrabulakova a kol., 2021)

The growth in the number of electric vehicles (EVs) and the expansion of the charging station network are key indicators of electromobility development. At the same time, one of the main barriers is the insufficient availability of charging infrastructure, which discourages potential users, while owners of suitable locations are hesitant to invest due to the still low number of BEVs. Given the varying economic, legislative, and technical conditions across regions, there is a growing need to compare electromobility development on multiple levels - including regional disparities within a single country. This highlights the importance of analytical approaches such as the creation of composite indices, which enable objective evaluation of electromobility development in specific areas. (Zema a kol., 2023)

The study integrates literature on electric vehicles to analyze consumer perception and acceptance of BEVs. It examines factors such as performance, design, ease of use, charging options, driving characteristics, and user image. It also considers emotional, social, and environmental aspects, including emission reduction, availability of service centers, and safety. (Knapčíková, 2019)

Leading global car manufacturers - including Volkswagen, Honda, Toyota, Ford, and GM - plan to significantly increase the share of BEVs and PHEVs in their sales by 2030. For example, Volkswagen expects to sell 2–3 million electric vehicles by 2025, while Honda plans for BEVs to make up 50% of its total sales. The development of electromobility is also supported by studies emphasizing the importance of consumer perception, barriers to faster adoption, and the role of infrastructure. (He a kol., 2018)

Public policies and support measures also play a key role, as they can significantly accelerate the adoption of electric vehicles. (Degirmenci & Breitner, 2017)

The article also discusses the importance of a national strategic framework, including the Action Plan for Electromobility, and its transfer to the regional level - emphasizing that without the involvement of local governments, the concept of electromobility may be ineffective. (Hrudkay & Jaroš, 2019)

2. Methods

The objective of this study is to evaluate the level of electromobility development across the eight regions of Slovakia and to verify the hypothesis H1: *The Bratislava and Košice regions are among the leaders in electromobility development*. The hypothesis is based on the assumption that these regions, as major urban and economic centers, should exhibit above-average adoption of battery electric vehicles (BEVs) and higher availability of charging infrastructure. To test this hypothesis and provide a comprehensive regional comparison, a **composite index of electromobility development** was constructed. The index integrates two core indicators:

- the number of registered BEVs per 1,000 inhabitants, and
- the number of public charging points per 1,000 inhabitants.

Each region received a unique index score representing its relative level of electromobility development. A higher index value indicates a greater concentration of electric vehicles and charging infrastructure per capita. The leader region (Bratislava) was assigned a reference value of 100%, and the

values for other regions were expressed as a percentage of this benchmark. Following the construction of the index, regional disparities were visualized using comparative graphs, and the hypothesis was evaluated based on the ranking and index scores.

To further investigate the factors influencing the number of BEVs across regions, a **multiple linear regression analysis** was conducted. The dependent variable was the number of registered BEVs per region (2024) and the independent variables were:

- the number of public charging points,
- the total number of registered vehicles (as a proxy for market size).

Statistical computations were performed using **JASP 0.18.3.0**. The model's assumptions, normality of residuals, homoscedasticity, and multicollinearity, were verified using standard diagnostic tests (Shapiro-Wilk test, Breusch-Pagan test, and VIF values).

Finally, to estimate future trends in electromobility, three forecasting models were applied to historical BEV registration data from 2018 to 2024:

- a **linear model** assuming constant absolute growth,
- an **exponential model** assuming constant relative growth, and
- an **ARIMA(1,1,1) model**, incorporating trends and autoregressive patterns.

Each model provided forecasts for the number of BEVs up to the year 2030. Model accuracy was evaluated using the Mean Absolute Percentage Error (MAPE), and the results were compared to assess the reliability of each forecasting approach.

3. Results

In order to assess regional differences in the development of electromobility in Slovakia, a composite index was created, integrating the number of registered battery electric vehicles (BEVs) and the number of public charging points per capita. This index allows for a quantitative comparison of electromobility levels across individual regions and helps identify those with the highest level of development in this area. Based on this, hypothesis H1 was formulated.

Hypothesis H1: The Bratislava and Košice regions are among the leaders in electromobility development.

This hypothesis is based on the fact that the Bratislava and Košice regions represent the most significant urban centers in Slovakia, characterized by higher population density, greater economic activity, and potentially better access to infrastructure that supports the development of electromobility. The aim is to identify which regions lead in the adoption of battery electric vehicles (BEVs) and the expansion of charging infrastructure, and which regions are lagging behind. A composite index of electromobility development was constructed, integrating the number of registered BEVs and the availability of public charging points per capita. Each Slovak region received a specific index value reflecting its level of electromobility development. A higher index value indicates a greater concentration of electric vehicles and charging infrastructure relative to the population size.

Table 1. Combined Index of Electromobility Development in Slovakia 2024

Rank	Region	BEVs/1000 inhabitants	Charging points/1000 inhabitants	Combined Index	% of Leader's V
1.	Bratislava	3,35	0,97	4,33	100,00%
2.	Trnava	1,08	0,41	1,49	34,40%
3.	Žilina	0,9	0,35	1,25	28,90%
4.	Nitra	0,8	0,36	1,16	26,80%
5.	Trenčín	0,75	0,38	1,13	26,10%
6.	Prešov	0,69	0,4	1,09	25,20%
7.	Košice	0,69	0,3	0,99	22,90%
8.	Banská Bystrica	0,51	0,41	0,92	21,20%
National AVG (SK)		1,09	0,45	1,54	35,60%

Source: Ministry of Economy of the Slovak Republic, SEVA, own processing (2025)

Table 1 of the composite electromobility index reveals significant differences among Slovak regions. The Bratislava region, with a score of 4.33, clearly dominates in electromobility development, significantly outperforming all other regions. The Trnava and Žilina regions ranked next, showing a relatively balanced development in both BEV adoption and charging infrastructure. In contrast, the Košice and Prešov regions recorded some of the lowest index values, indicating a lag in electromobility adoption and infrastructure deployment. The Banská Bystrica and Nitra regions also achieved below-average results. All regions, however, show significantly lower index values compared to Bratislava, highlighting substantial regional disparities in electromobility development.

The Košice region, with a score of 0.99, ranked seventh out of eight, reaching only 22.9% of Bratislava's index value. These findings suggest that Hypothesis H1 is only partially confirmed: while the Bratislava region is clearly the leader, the Košice region, despite its large urban character, does not reach above-average levels of electromobility development.

Figure 1 illustrates the values of the composite electromobility index across the regions of Slovakia. The aim is to visually compare the level of electromobility development across regions and identify both leading and lagging areas.

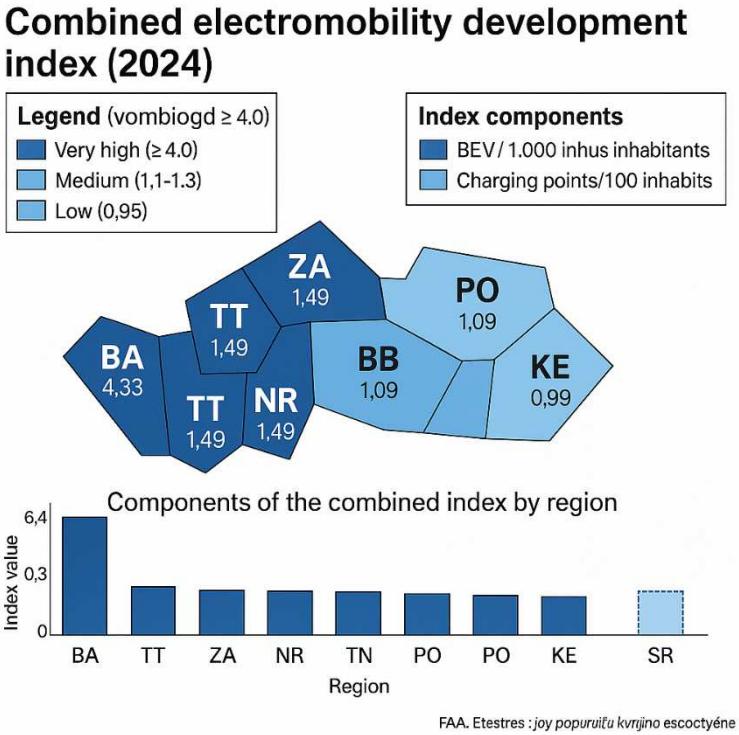

Figure 1. Composite Index of Electromobility Development in Slovakia (2024)
Source: Ministry of Economy of the Slovak Republic, SEVA, own processing (2025)

Figure 1 clearly shows the strong dominance of the Bratislava region in the development of electromobility, with its index significantly exceeding the values of other regions. In contrast, most other regions display values well below the average, with the Košice, Prešov, and Banská Bystrica regions ranking among those with the lowest levels of electromobility development. The values of the composite index confirm substantial regional disparities, with the development of electromobility being most intensive in the western part of the country.

To evaluate electromobility development across regions and to gain a deeper understanding of the factors influencing the number of registered battery electric vehicles, a multiple regression analysis was conducted. The aim of this analysis is to examine the extent to which the number of BEVs in each region can be explained by two key variables:

- the number of public charging points,
- the total number of registered vehicles (as an indicator of the size of the regional car market).

Calculations were performed using the statistical software JASP 0.18.3.0.

Table 2 presents the output of a multiple linear regression analysis, which examines the impact of two independent variables - namely the number of charging points and the total number of vehicles in 2024 - on the number of battery electric vehicles (BEVs) in each region.

Table 2. Results of Multiple Regression Analysis

Variable	B Coefficient	Standard Error	t	p	CI Lower 95%	CI Upper 95%
Constatnt	-24,73	35,21	-0,7	0,513	-115,12	65,66
Points 2024	-0,36	0,51	-0,71	0,51	-1,69	0,96
All Cars 2024	0,152	0,005	32,41	<0,001	0,139	0,164

Source: Ministry of Economy of the Slovak Republic, SEVA, own processing (2025)

The overall model demonstrates a high level of statistical significance ($F(2,5) = 545.1$; $p < 0.001$) and explains up to 99.5% of the variation in the number of BEVs across regions ($R^2 = 0.995$). This indicates that nearly all differences in BEV counts between regions can be explained by the two variables - the number of charging points and the total number of registered vehicles. Among the analyzed variables, only the coefficient for the total number of vehicles proved statistically significant ($B = 0.152$; $p < 0.001$), suggesting that as the number of registered vehicles increases in a region, so does the number of BEVs. In contrast, the number of charging points ($B = -0.36$; $p = 0.510$) was not statistically significant, and its negative coefficient may be influenced by other related variables or external factors.

The model also meets all key assumptions of regression analysis: the distribution of residuals is normal (Shapiro-Wilk test: $W = 0.953$; $p = 0.738$), there is no heteroscedasticity (Breusch-Pagan test: $p = 0.241$), and multicollinearity is within an acceptable range (VIF = 3.2 for both variables). The regression analysis indicates that the total number of vehicles in a region has a strong and statistically significant impact on the number of battery electric vehicles - i.e., the more vehicles overall, the more BEVs. The model as a whole is highly significant and explains up to 99.5% of the variability in BEV numbers across regions. These results suggest that electromobility development is more closely related to the size of the car market than to the number of charging stations.

Based on data from the years 2018 to 2024, three forecasting models were developed - linear, exponential, and ARIMA (1,1,1) - each offering different scenarios for the future growth of electromobility in Slovakia up to the year 2030.

The linear model assumes that the number of BEVs will grow by the same absolute amount each year. This approach reflects a stable development without significant fluctuations or acceleration. According to this model, the number of BEVs would increase from 5,873 (in 2024) to 8,130 by 2030, representing a moderate growth scenario. The model shows a Mean Absolute Percentage Error (MAPE) of 3.25%, indicating relatively accurate predictions, although slightly underestimating the actual trend. The values were calculated based on the average annual absolute increase in BEVs during the 2018–2024 period, which was then added to the 2024 figure for each subsequent year through 2030.

$BEVt + 1 = \mathrm{BEVt} + \Delta$, where Δ represents the average annual increase (absolute value).

The exponential model, on the other hand, assumes that the year-over-year growth rate remains constant in relative (percentage) terms. The model applies the same annual percentage growth rate each year, which leads to a faster increase in the number of BEVs - reaching 12,720 by 2030. However, this model recorded the highest MAPE value (5.78%), indicating lower accuracy compared to the other approaches. The calculation was based on the average annual growth rate coefficient from the period 2018–2024.

$BEVt + 1 = BEVt \times (1 + r)$, where r is the average annual growth rate (expressed as a decimal).

The ARIMA (1,1,1) model is the most sophisticated of the three analyzed approaches, as it considers not only the overall trend but also recurring patterns in the data. This model predicts an increase in the number of BEVs to 8,994 units by 2030, representing a growth of approximately 53.1% compared to

2024. It achieved the lowest MAPE value (2.84%), identifying it as the most accurate model. The values were automatically calculated using the statistical software JASP 0.18.3.0.

The following Table 3 presents the results of the three forecasting models for the development of battery electric vehicles (BEVs) in Slovakia for the period 2025 to 2030. Each model offers a different growth scenario based on distinct computational methods.

Table 3. Results of Multiple Regression Analysis

Year	Linear Model	Exponential model	ARIMA (1,1,1)
2025	7080	7350	7105
2026	7290	8205	7456
2027	7500	9160	7820
2028	7710	10220	8197
2029	7920	11400	8588
2030	8130	12720	8994
MAPE	**3,25%**	**5,78%**	**2,84%**

Source: Ministry of Economy of the Slovak Republic, own processing (2025)

The table clearly shows that all three models predict an increase in the number of BEVs in Slovakia by 2030, but they differ in the dynamics of this growth. The linear model forecasts the slowest, steady growth - reaching 8,130 vehicles by 2030. The exponential model anticipates a sharper increase, projecting up to 12,720 vehicles, which is nearly double the baseline level in 2024, but it also has the highest prediction error (MAPE = 5.78%).

The most accurate model is ARIMA (1,1,1), which predicts a more moderate yet continuous growth, reaching 8,994 vehicles by 2030. This scenario can be considered moderately optimistic, as it lies between the more conservative linear and the highly optimistic exponential approaches. The ARIMA model's results are also the closest to the historical development and exhibit the lowest error rate (MAPE = 2.84%).

Figure 2 visualizes the comparison of the three forecasting models for the development of battery electric vehicles in Slovakia through 2030, based on the trend from 2018 to 2024. The chart displays the projected growth trajectories of the linear, exponential, and ARIMA models, including historical data and the 95% confidence interval. The aim is to illustrate the differences in projected outcomes depending on the modeling approach used.

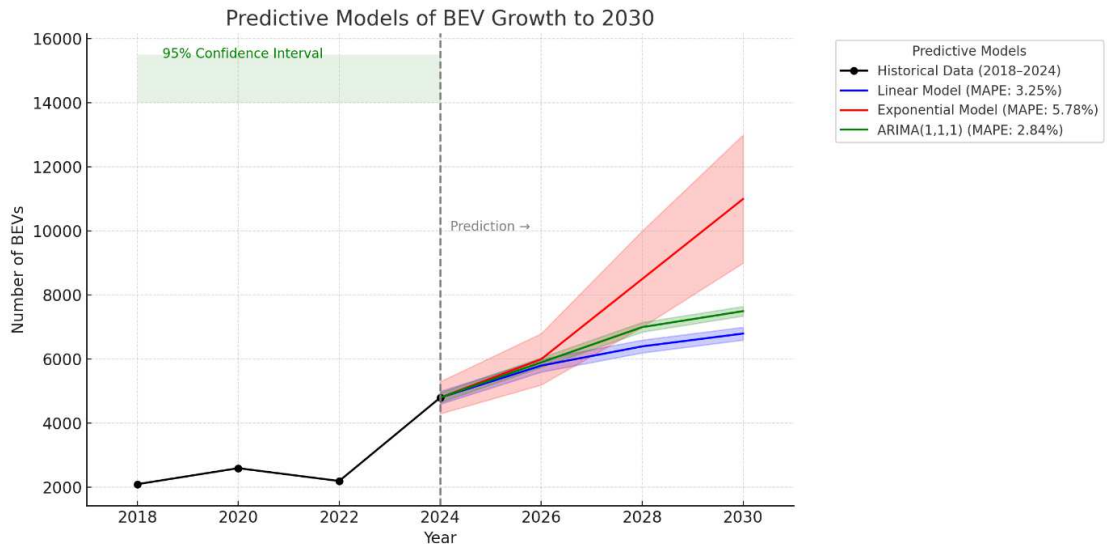

Figure 2. Comparison of prediction models for the growth of the number of BEVs in Slovakia by 2030
Source: Ministry of the Environment of the Slovak Republic, own processing (2025)

Based on the analysis of three different forecasting approaches, it can be concluded that the ARIMA (1,1,1) model provided the most accurate and balanced prediction of electromobility development in the Slovak Republic. With the lowest error rate (MAPE = 2.84%) and a projected total of 8,994 registered BEVs by 2030, this model represents a moderately optimistic growth scenario. While the linear model, although less accurate, offers a conservative estimate, the exponential model shows the highest deviation due to overestimation of growth.

4. Discussion

The results of the composite electromobility index highlight significant regional disparities in the development of electromobility in Slovakia. The Bratislava region clearly dominates, which can be attributed to its level of urbanization, economic strength, infrastructure concentration, and higher purchasing power of the population. In contrast, eastern regions such as Prešov, Košice, and Banská Bystrica are lagging behind, indicating uneven accessibility and support for electromobility.

The results of the regression analysis confirm that the main determinant of the number of BEVs in the regions is the total number of registered vehicles - that is, the size of the car market. Surprisingly, the number of public charging points did not prove to be a statistically significant factor. This may be due either to low demand for infrastructure in regions with a low share of BEVs, or to a delayed effect of newly built infrastructure that has yet to translate into increased adoption of electric vehicles.

The forecasting models offer three different scenarios for the future development of electromobility. While the linear model suggests a conservative growth pattern, the exponential model assumes a more aggressive scenario, which is not fully consistent with historical trends. The most reliable model proved to be ARIMA (1,1,1), which balances historical trends with predictive accuracy and may serve as a useful tool for planning public policies in the fields of transport and environmental sustainability.

Conclusion

This study confirmed substantial regional disparities in the development of electromobility in Slovakia. The Bratislava region significantly outperforms all other regions, which can be attributed to its high level of urbanization, economic activity, and better accessibility to infrastructure. In contrast, several eastern and central regions, such as Prešov, Košice, and Banská Bystrica, continue to lag behind, highlighting the persistent imbalance in electromobility adoption across the country.

The multiple regression analysis revealed that the total number of registered vehicles in a region is a strong and statistically significant predictor of BEV adoption, suggesting that the size of the automotive market plays a crucial role in shaping electromobility trends. On the other hand, the availability of public charging infrastructure did not show a significant influence, which may be due to its still-developing state or delayed impact on consumer behavior.

Among the three forecasting approaches analyzed, the ARIMA (1,1,1) model proved to be the most accurate, projecting that the number of BEVs in Slovakia could reach approximately 8,994 by 2030. This model offers a balanced scenario that aligns closely with past trends and provides reliable guidance for future planning.

The findings emphasize the importance of addressing regional disparities through targeted policy measures and investment, particularly in underdeveloped areas. Furthermore, they highlight the strategic value of integrating predictive modeling into transport and environmental planning to ensure more data-driven, efficient, and equitable support for the transition to sustainable mobility.

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The Concepts of Regional Innovation Ecosystems

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Abstract

Research background: Achieving a higher level of innovation in regions requires identifying key actors within a given region and establishing networks and linkages among them that enable effective knowledge exchange and collective responses to emerging challenges. An important conceptual approach for understanding these connections is the Triple Helix model, which describes the interactions between academia, industry, and government. Over time, this model has been expanded to include additional dimensions addressing societal and environmental aspects, leading to the development of the Quadruple and Quintuple Helix models. Currently, their further evolution and relevance are being explored through the so-called neo-Triple Helix model. Various studies indicate that these models benefit from integration with other scientific disciplines, as also evidenced by their very emergence. This interdisciplinary integration ensures the relevance and adaptability of regional innovation ecosystems. This paper focuses on linking the Triple Helix model with the dynamic SEIR model, originally derived from the field of epidemiology, which offers an intriguing framework for conceptualizing the diffusion of knowledge and innovation within the context of digital transformation.
Purpose of the article: The aim of the article is to analyze and characterize models and concepts of regional innovation ecosystems, to assess their practical applicability, and to examine the factors and challenges that influence their functioning within the collaborative environment of the public sector, businesses, academia, and civil society.
Methods: Our analysis primarily focused on articles from the Web of Science database, using search terms such as "regional innovation ecosystem" and "Triple Helix model".
Findings & Value added: The results of our research highlight the diversity in how various models are integrated into the development and functioning of regional innovation ecosystem models. A key added value of the paper lies in the integration of the theoretical Triple Helix and SEIR models with practical challenges related to collaboration, digitalization and policy support. The findings indicate that clearly defined roles of actors, high-quality digital infrastructure and an active governmental role are essential for the effective transfer of innovation. Identified challenges, such as reluctance to share knowledge or uneven levels of digitalization, represent barriers that must be addressed in order to enhance the performance and adaptability of ecosystems in the context of sustainable development.

Keywords: Regional innovation ecosystem, Triple Helix models, SEIR model, Regional development, Innovation policy

JEL classification: O32, R15

1. Introduction

The aim of the paper is to explore the functioning of the regional innovation ecosystem as a complex system in which various actors interact and influence the emergence and diffusion of innovations. The paper focuses on the analysis and description of models and concepts applicable to the study of such systems, drawing from multiple scientific disciplines. Special attention is given to the Triple Helix model and the SEIR model, with the aim of examining their ability to explain collaboration, knowledge transfer, and the dynamics of innovation processes in a regional context. Furthermore, the paper identifies key factors and challenges that affect the effectiveness of these models within regional innovation ecosystems, particularly in relation to ongoing digitalization processes.

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1.1 Models and Concepts of Regional Innovation Ecosystems

One of the first theoretical foundations in the field of innovation policy was proposed by the Austrian-American economist J. A. Schumpeter. According to Schumpeter (Hospers, 2005), the economic system is in a constant state of change and evolves over historical time, old firms and technologies disappear, while new ones emerge. He referred to this process as creative destruction, the continuous replacement of the old with the new. The driving force behind this change is innovation, understood as the fundamental recombination of new ideas, products, or methods of production. Innovation does not occur randomly, it builds on existing elements within the economy and is the result of deliberate actions by entrepreneurs who disrupt established structures. Schumpeter conceptualized this process as wave-like movements of innovative activity, which he regarded as crucial for economic transformation and the implementation of innovation. He also distinguished between different types of innovations at the time (Hospers, 2005, p.23):

- introduction of new products,
- new production methods,
- new forms of business organization,
- entry into new input or output markets.

The latest edition of the Oslo Manual simplifies the classification of innovations from the original four types (product, process, marketing, and organizational) to two main categories, product innovations and business process innovations. A product innovation refers to a new or improved good or service that significantly differs from previous offerings and has been introduced to the market. A business process innovation involves a new or improved method for performing business activities, which has been implemented by the firm in practice. The new definition emphasizes the significance of change in comparison to the firm's existing state (Eurostat, 2018, p.20-21).

In the context of technology studies, Etzkowitz and Leydesdorff (1995) identify three main sources of variation that drive technological development and innovation:

- differences in the key technologies used for development across industrial sectors,
- diversity of technologies influences innovation patterns and their diffusion,
- innovation systems possess different functions in different ways.

These sources of variation are specified not only functionally but also institutionally, and they may unfold differently across sectors, technologies, and systems. They suggest that innovation does not diffuse evenly and that individual innovation ecosystems evolve in diverse ways. The authors argue that functional communication among the public, private, and academic sectors increasingly leads to new forms of institutional collaboration, which take the shape of spiral-like linkages across various phases of the innovation process (Etzkowitz and Leydesdorff, 1995, p.3). Innovation ecosystems are generally rooted in economic theory, although the concept of ecosystems originates in ecology, where it refers to a set of interrelated organisms functioning within a shared natural environment (Asakawa & Clegg, 2024). This originally ecological concept has since been adopted by the innovation domain in the form of the innovation ecosystem idea. The term "ecosystem" was first introduced by Tansley in 1935 to describe an interconnected system of living organisms and their physical environment (Stasiškienė et al., 2021).

There are various advantages to using the terminology of innovation systems, one of which is the recognition that an innovation ecosystem demonstrates a willingness to learn from biological systems (Oh et al., 2016). Research on innovation ecosystems can benefit from a deeper and more realistic understanding when it is grounded in ecological thinking (e.g., the concept of co-evolution) and systems thinking (e.g., the concept of complex adaptive systems) (Ritala & Almpanopoulou, 2017). We align with the view that concepts derived from a multidimensional framework enable a more holistic understanding of innovation ecosystems, better capturing their dynamic and interconnected nature.

The emergence of such ecosystems allows participating actors to align their interests and combine available resources to overcome barriers hindering their development. In today's open economy, the ecosystem-based approach has become the dominant mode of thinking. It offers an effective framework for understanding how firms shape their strategies to gain competitive advantage. Many companies now operate as part of ecosystems on various levels-local, regional, or global, while also participating in multiple global value chains. Their position within these chains may vary depending on whether they are on the supply or demand side and on the specific roles they play within these structures (Asakawa & Clegg, 2024). This fact was also noted by Etzkowitz and Leydesdorff (1995) in their study, where they

stated that national innovation systems were becoming increasingly regionalized and internationalized. This was due to the fact that innovation processes were already, at that time, increasingly taking place across borders through collaboration between regions and firms. Ecosystem-based business represents a strategy, particularly used by technology companies, in which firms invest venture capital into their surrounding environment (such as suppliers, customers, and partners) in order to foster the development of the entire innovation ecosystem. Unlike traditional CVC (corporate venture capital) investments the goal of this approach is to actively shape and manage the ecosystem in which the company operates (Chen, Yang & Wei, 2024).

In every ecosystem, actors create value by structuring relationships and adapting to their environment. Ecosystems can be categorized into several types, including platform ecosystems, business ecosystems, and innovation ecosystems. Each of these has specific characteristics and operates according to different principles. For the purposes of this article, it is essential to clearly distinguish between these types in order to accurately identify their functions, the actors involved and the mechanisms of value creation. Business and platform ecosystems typically involve interactions among independent firms that jointly deliver products or services. In contrast, innovation ecosystems include university research centers and government agencies focused on the development and diffusion of technologies. Whereas business ecosystems focus on value creation and capture, innovation ecosystems are primarily concerned with the process of value generation. This process often follows a linear model: basic research conducted at universities is transformed into applied research through intermediary organizations, followed by experimental development in firms, ultimately leading to commercial applications. As a result, the role of businesses in shaping innovation ecosystems tends to be limited (Drori & Lavie, 2023).

From the above, there arises a need to introduce the Triple Helix model, which provides an important framework for understanding the functioning of regional innovation ecosystems. In this context, we focus on the three strands that constitute these ecosystems. The three strands of regional innovation ecosystems must collaborate in a coordinated manner to minimize mutual constraints and achieve higher overall efficiency through resource sharing and active information exchange. Due to the continuously changing social context, the boundaries between institutional spheres increasingly overlap, blurring their original distinctions. The functions of actors complement and transcend each other, so that each institutional sphere acquires not only its traditional characteristics but also new properties adopted from collaborating spheres (Pan & Guo, 2022). The spiral form of interconnection, known as the Triple Helix model, can be approached in various ways:

- It can be analyzed based on network analysis or a non-institutional arrangement of relational networks between universities, industry, and government through segmentation into different sectors, regions, or countries.
- Innovation networks among universities, industry, and government exhibit a certain structure (architecture). Each relationship holds a specific role and position within the whole. Such an arrangement enables systematic monitoring and understanding of how knowledge-based innovations emerge and spread. New technologies may develop in various directions across all three actors while exhibiting different types of dynamics (Leydesdorff, 2013).

It can be asserted that the Triple Helix model is the primary conceptual framework for analyzing interactions among academia, industry and government in the context of innovation processes. The Triple Helix model has further evolved into extended models, namely the Quadruple Helix (which includes civil society) and the Quintuple Helix (which incorporates sustainability and environmental aspects). These models emerged to address contemporary societal challenges, particularly the need for democracy and planetary protection amid rapid technological changes and climate issues. Currently, these expanded models are significant because they integrate social and ecological dimensions into innovation processes, promoting sustainable and equitable development. They emphasize that genuine progress in innovation cannot be achieved without democracy and ecological responsibility, thereby helping to shape strategies suited for today's world in the Anthropocene era (Carayannis, Campbell & Grigoroudis, 2022).

The recently proposed neo-Triple Helix model (Cai, 2022) represents a conceptual integration of the Triple, Quadruple, and Quintuple Helix models, based on three fundamental elements of innovation ecosystems:

1. innovation dynamics (as the genetic component),
2. social structures,
3. and the natural environment.

Unlike the original Triple Helix model, which uses the metaphor of a three-stranded DNA helix, the neo-Triple Helix draws on Lewontin's metaphor of gene–organism–environment relationships, allowing a deeper understanding of complex innovation processes. While the Quadruple and Quintuple Helix models are grounded in ecological metaphors, the neo-Triple Helix model was proposed to rethink and strengthen theoretical foundations in light of new characteristics of innovation systems and to clarify the relationships between them (Cai, 2022).

In the context of regional innovation, system modeling enables a clear depiction of the interrelationships among actors within the Triple and Quadruple Helix frameworks. The applied approach is based on system dynamics methodology and serves primarily to structure the problem rather than provide detailed quantitative modeling. The modeling process follows a top-down approach to identify key leverage points where policy interventions can be most effective in fostering growth, innovation, and entrepreneurship. The main goal is to enhance system understanding and facilitate effective communication among stakeholders. The fifth analyzed model is the causal loop model, applied to regional innovation ecosystems, which has a positive impact on their development and sustainability. The outcome of applying this model is the identification of the most significant leverage point that fosters interaction between the academic and business sectors. Universities should systematically develop institutional infrastructure to support collaboration with enterprises by establishing technology transfer offices, business incubators, and providing professional consulting for translating research outputs into practice. At the macro level, state support plays a crucial role, particularly through targeted public investment policies aimed at building regional innovation centers, science parks, and research platforms in cooperation with universities (Arthur, Moizer & Lean, 2022). By applying alternative models and concepts to regional innovation ecosystems, particularly through the BCC DEA (Data Envelopment Analysis) method, which allows for more realistic modeling of actual situations, the efficiency of resource utilization for innovation support was analyzed in a sample of 30 developed OECD countries over the period from 2006 to 2018. The analysis was initially based on the Triple Helix model, which was subsequently extended to the Quintuple Helix by incorporating indicators related to civil society (participation index) and the environment (CO_2 emissions per capita) (Fidanoski et al., 2022). An examination of innovation research progress in business has shown that government support creates synergies for growth, specifically by promoting the development of multidimensional economic systems at the regional level through the use of models such as the Triple Helix and Quadruple Helix. Furthermore, it can be emphasized that regional transformation through open and shared innovation models facilitates entrepreneurship when supported by appropriate policy. Human behavior, culture, and the environment are also important and significant factors for the regional economic ecosystem (Kumar et al., 2024). It can be argued that the importance of innovation also extends to the creation of social innovation ecosystems, which partially overlap with traditional entrepreneurial ecosystems. The model of a social innovation ecosystem is based on the pillars of the traditional entrepreneurial ecosystem by Isenberg namely policy, finance, culture, support, human capital and markets (Audretsch, Eichler & Schwarz, 2022). This implies that the development of social innovation ecosystems is both important and connectable to models of regional innovation ecosystems. Communication and collaboration are significant factors in the development of regional innovation models and their subsequent sustainability.

It can be argued that regional innovation ecosystems require active government participation and a commitment to democracy, as highlighted by the Quadruple Helix and neo-Triple Helix models. The crucial role of the state in supporting innovation is also confirmed by the application of the causal loop model, as presented by Arthur, Moizer, and Lean (2022). Similarly, analysis using the BCC DEA model underscores the importance of participation and state intervention, particularly in cases where the participation index is included in the efficiency calculation (Fidanoski et al., 2022). In addition to state support, governmental assistance is also essential (Kumar et al., 2024), which is further emphasized in the context of social innovation by recent research (Audretsch, Eichler & Schwarz, 2022) through the development of social innovation ecosystem models. It can be concluded that various concepts and models point to the fact that without active, democratically anchored, and strategically guided state support and governmental assistance, it is impossible to achieve sustainable innovation development or ensure a balance between economic growth, social stability and environmental responsibility.

Another model that can be included in the analysis is the SEIR model (Susceptible–Exposed–Infected–Recovered), which examines the process of knowledge diffusion within regional innovation ecosystems in the context of digitalization. Knowledge transfer in innovation ecosystems is often compared to the spread of infectious diseases due to its similar patterns and dynamics. Based on this

analogy, epidemic models can be employed to study how knowledge spreads among actors within the ecosystem. Despite the potential of this approach, there is still limited literature that systematically applies such modeling to the diffusion of knowledge. Epidemic models offer an effective tool for capturing the dynamics of knowledge dissemination within systems. In a regional innovation ecosystem, actors can be categorized according to their relationship to knowledge and its dissemination as follows (He, Wang, Hu et al., 2024):

S - represents knowledge holders who possess knowledge but do not disseminate it.
E - refers to potential disseminators who possess knowledge but lack the willingness or capacity to share it.
I - indicates active disseminators who both possess knowledge and have the ability to transfer it to others.
R - are immune to the dissemination of specific knowledge.

This model provides a better understanding of the dynamics of innovation diffusion within the complex networks of regional environments.

Current knowledge and studies indicate the need to expand the theoretical foundation of regional innovation ecosystems through the inclusion of additional conceptual approaches. Given the increasing complexity and dynamism of these ecosystems, it is appropriate to apply alternative models and concepts originating from various academic disciplines. Based on available studies (Leydesdorff, 2013; Carayannis, Campbell & Grigoroudis, 2022; Cai, 2022; Arthur, Moizer & Lean, 2022; Fidanoski et al., 2022; Audretsch, Eichler & Schwarz, 2022; He, Wang, Hu et al., 2024), it is possible to identify innovation ecosystem frameworks that are applicable at the regional level and that derive from the fields of ecology, economics, sociology, and political science. This paper focused on the Triple Helix model and its extended forms the Quadruple and Quintuple Helix, as well as their conceptual integration in the neo-Triple Helix model. Additionally, it examined the interconnection with other models and approaches, such as the causal loop model, the BCC DEA model, the social innovation ecosystem framework in relation to the traditional entrepreneurial ecosystem, and the SEIR model. Together, these demonstrate the multidimensional nature of regional innovation ecosystems. Their emergence has been shaped by theories from other scientific domains, and their development continues to be influenced by a variety of concepts and models from diverse disciplines, offering new insights and perspectives.

2. Methods

This paper employs a qualitative research approach to gain a deeper understanding of the multidimensional nature of regional innovation ecosystems by applying theoretical models and concepts from various scientific disciplines. It analyzes the Triple Helix, Quadruple Helix, Quintuple Helix, and neo-Triple Helix models, as well as the causal loop model, the DEA BCC method, the social innovation ecosystem model and the SEIR model. The chosen approach is based on a systematic analysis of secondary sources, including scholarly articles, expert publications, and relevant theoretical frameworks. Within the methodological framework, the Triple Helix and SEIR models were integrated in order to better understand the functioning of regional innovation ecosystems. This integration enabled the identification of key factors and challenges that influence their performance and contribute to sustainable development.

3. Results

Based on the analysis of various concepts and models of regional innovation ecosystems, there emerges an opportunity to identify key factors and challenges. The models and concepts, originating from diverse academic disciplines, are applicable to the study of regional innovation ecosystems. The integration of the Triple Helix and SEIR models simultaneously highlights the positioning of innovation within the processes of knowledge diffusion and digital transformation in regional innovation ecosystems. The Triple Helix model establishes the structural conditions (space) for the emergence of innovations through the relationships among actors. The SEIR model captures the dynamics of innovation processes, specifically how innovation spreads across temporal and spatial dimensions (dynamics). It can be concluded that innovation, as the core element of regional innovation ecosystems, is not merely a goal but also a process occurring within a defined space among specific actors and under particular conditions. The following table provides an overview of how innovations arise within the Triple Helix model, in relation

to Schumpeter's classification of innovations. Table 1 also illustrates which actors and relationships are critical for different types of innovations.

Table 1. The emergence of innovation within the Triple Helix framework in relation to Schumpeter's classification of innovations

Type of innovation	Triple Helix process	Innovation emergence
Introduction of new products	University-Industry-Government	Research
New production methods	Industry-University-Government	Enterprise
New forms of business organization	Industry	Inside the company
Penetration of new input and output markets	-	-

Source: own processing (2025)

By integrating the Triple Helix and SEIR models, a better understanding can be achieved of how innovations originate and spread within regional innovation ecosystems. The Triple Helix clarifies the relationships among regional actors, while the SEIR model captures the dynamics and speed of innovation diffusion. Building on the work of Etzkowitz and Leydesdorff (1995), this integration can be linked to three main sources of variation. The following Table 2 illustrates how these factors influence the structure and process of innovation diffusion in regions.

Table 2. The linkage of the Triple Helix and SEIR models to the three main sources of variation according to Leydesdorff and Etzkowitz

Sources of variation/Factors	Triple Helix	SEIR
Different technologies in industries	Each industry requires a different type of collaboration	Some actors face greater challenges in digitalization
The diversity of technologies influences patterns of innovation and their diffusion	It influences where innovations originate	It influences how quickly and where innovations spread
Individual innovation systems possess different functions in distinct ways	Not every RIE has a diverse composition or strength of actors	Diversity of actors in the region who disseminate innovations

Source: own processing (2025)

The Triple Helix model is spatially adaptable to a specific region. The integration of the Triple Helix and SEIR models at the regional level highlights how the structure of relationships among actors (universities, industry, public sector) influences the dynamics of innovation diffusion. The following figure illustrates how these models jointly explain the emergence, diffusion, and absorption of innovations within a regional innovation ecosystem.

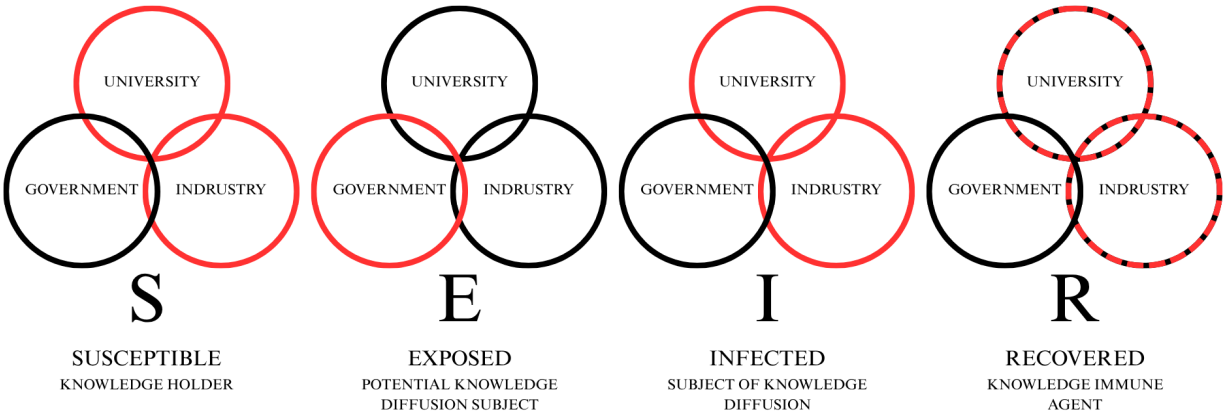

Figure 1. Integration of the Triple Helix and SEIR models at the regional level
Source: own processing (2025)

Figure 1 illustrates the SEIR model, representing the process of innovation emergence and diffusion within the regional innovation ecosystem among the Triple Helix actors: government, universities, and industry. In each phase of the SEIR process, the location of the innovation is marked with a red circle. A

dashed red circle indicates whether the innovation is accessible or not at that phase, i.e., it is not clearly available to other actors. Based on Figure 1, it can be highlighted that innovations related to the digitalization process significantly occur in every phase of the SEIR model across different Triple Helix actors. The holders of knowledge, i.e., innovations, and also active disseminators are the university and industry actors. The government acts as a potential disseminator, facilitating the transition of innovations throughout the digitalization process across all SEIR phases (S-E-I-R). An important aspect is the immune status in the R phase, where three situations may arise:

1. Industry may choose to be immune to the diffusion of innovations, indicating that it does not want to share its knowledge and know-how with other actors.
2. Universities may decide to patent the innovations they create and subsequently sell them to others. Even in the I phase of active innovation diffusion, it is common for universities to transfer innovations to industry. It remains an open question whether universities, in the patenting process, are immune or not to the diffusion of innovations.
3. This represents an extreme scenario where both industry and university actors within a region decide to be immune and do not support the diffusion of innovations. Such a situation would be critical if it involved key regional actors. The consequence would be a halt in technological and economic progress, low regional competitiveness, and an overall negative impact on the innovation performance of the region. In this case, state support and government intervention would become essential tools for regulating and influencing regional development.

4. Discussion

If innovations were not disseminated, the functioning of regional innovation ecosystems would not be possible. The importance of spreading innovations among individual actors today must be ensured through the implementation of digital processes, as highlighted by the application of the SEIR model in the context of innovation diffusion during digitalization. Based on the integration of the Triple Helix and SEIR models, various factors and challenges influencing the functioning of regional innovation ecosystems can be identified. These models demonstrate that the efficiency of innovation processes depends not only on the interactions between actors but also on the dynamics of knowledge and innovation diffusion across time and space. The following section of the paper focuses on the factors and challenges affecting regional innovation ecosystems. Among the identified factors are:

Collaboration among Actors

The effective functioning of a regional innovation ecosystem requires clearly defined roles for the actors and their active mutual interaction. Universities play a crucial role in generating and disseminating knowledge and insights, thereby entering phase I within the SEIR model. Collaboration is essential to ensure the transfer of innovations among actors. In phase R universities have a dual role: on one hand, they generate new ideas and research outputs; on the other hand, they must decide which of these will be shared and which will remain protected (e.g., through patents). This openness versus closedness of universities is a key topic when assessing the degree of collaboration. Not all knowledge is automatically shared, and thus the decision to share significantly influences the flow of innovations within the ecosystem as well as the collaboration itself.

Political Support

The role of government, as one of the Triple Helix actors, is essential in creating the framework conditions for innovation, especially concerning the support of digitalization and funding. It can be stated that the government influences the transition of Triple Helix actors between the phases of the SEIR model, particularly from phase E (Exposed) to phase I (Active Spreaders of Innovation).

Digital Infrastructure

The availability and quality of digital infrastructure represent a significant factor enabling actors to enter the active phase I. Without adequate digital infrastructure, actors are limited in their capacity to disseminate knowledge, which overall weakens the performance of the regional innovation ecosystem.

Diversity in Actors' Development Levels

Regional innovation ecosystems are characterized by the heterogeneity of their actors, differing in size, industry specialization, technological level, and digital maturity. This diversity influences their

ability and willingness to participate in the innovation process, as well as the speed of transition through the various phases of the SEIR model.

Degree of Openness to Innovation

Some Triple Helix actors exhibit a low level of openness to innovation and may remain in phase R (Immune). The decision to remain immune may either be an alternative solution or simply reflect that the given innovations do not generate added value for them.

Among the most significant identified challenges of regional innovation ecosystems are:

1. Reluctance to Share Knowledge or Lack of Motivation

Some actors possess innovative knowledge but consciously choose not to share it, meaning they do not enter the active dissemination phase (phase I). This reluctance is often driven by the desire to protect their own know-how. Actors in phase E have knowledge but lack the motivation, skills, or tools necessary to spread innovations.

2. Level of Digitalization Among Actors

Actors within the Triple Helix do not possess the same level of digitalization. This asymmetry can lead to uneven distribution of knowledge, thereby reducing the overall innovation potential of the ecosystem.

3. Insufficient Political Support

If the government is not an active player in supporting the regional innovation ecosystem as a whole, it may weaken the system. The absence of political measures can hinder relationships and collaboration between the Triple Helix actors.

By linking the Triple Helix model with the SEIR model, beyond the identified factors and challenges, we concluded that in the R phase of the SEIR model, the question arises regarding the openness of universities specifically, whether they are willing to share research results or keep them as internal know-how. Unpatented innovations often remain inaccessible, and only through patenting do they become fully shareable (indicated by the red circle). This aspect opens a broader discussion on the degree of transparency and knowledge sharing by academic institutions. Not everything created by universities is automatically publicly available. Therefore, it is necessary to conduct dedicated research on the extent to which universities, as actors, are open to sharing innovations and which factors influence their decision-making in this area. Such research could significantly contribute to understanding barriers in the innovation diffusion process and support more effective collaboration between universities, government and industry.

Conclusion

The results of the analysis confirm that the application of models from various scientific disciplines, specifically the Triple Helix model and the SEIR model provides a deeper and more comprehensive understanding of the functioning of regional innovation ecosystems. The Triple Helix model enables the identification of key actors and their interactions in the creation and diffusion of innovations, while the SEIR model enriches the understanding of knowledge transfer processes among these actors. The combination of these models represents a multidisciplinary analytical framework that highlights the complexity of real innovation processes within regional contexts. At the same time, it allows for better identification of factors and challenges such as uneven levels of digitalization, varying willingness of actors to share knowledge, and the absence of political support. In conclusion, it can be stated that integrating insights from multiple disciplines leads to a more effective understanding and management of the innovation potential of regions. For policymakers, researchers, and practitioners alike, this creates a valuable tool for better targeting interventions and strategic development in the context of an increasingly digital society.

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6. Tourism, Hotel Management and Spa Industry

Educational Indicators as Determinants of Motivation for Participation in Tourism: An Analysis of Selected European Union Countries

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Abstract

Research background: Tourism is a key driver of economic growth and cultural exchange in the European Union, significantly contributing to GDP, employment, and regional development. As the tourism sector continues to evolve, understanding the socio-economic factors that influence participation is essential for policymakers, businesses, and regional planners. Education, as an often-underexplored factor, plays a crucial role not only in enhancing individuals' income potential and access to travel but also in shaping their travel preferences and behavior.
Purpose of the article: This study examines the relationship between educational indicators and tourism performance across selected EU countries, aiming to explore how investments in human capital can impact tourism dynamics.
Methods: The article assesses the strength of the link between educational and tourism indicators using multiple linear regression models, based on data from Eurostat and other international data sources for the period 2014–2024.
Findings & Value added: The analysis highlights several key findings: First, higher education levels do not always correlate positively with tourism participation, particularly in countries like Slovakia, Sweden, and the Netherlands, where a negative impact of higher education on tourism performance is observed. Second, increased expenditure on education, better teacher-pupil ratios, and enhanced digital skills are shown to have a positive effect on tourism outcomes. Third, countries such as the Netherlands, Slovakia, Sweden, Finland, Malta, and Lithuania exhibit strong model fits, suggesting a more direct influence of educational factors on tourism success. These findings underscore the importance of contextualizing educational policies when designing strategies for tourism development. By understanding the role of education in tourism behavior, policymakers can tailor strategies that align educational investments with tourism goals, fostering a more sustainable and competitive tourism sector across EU member states.

Keywords: Educational indicators, Tourism participation, Education-tourism relationship, Multiple linear regression

JEL classification: C21, I21, I23, L83, O15

1. Introduction

Tourism plays a crucial role in the economic and cultural development of the European Union (EU), driving GDP growth, employment, and regional progress. Understanding the socio-economic factors that influence tourism is essential for policymakers, businesses, and tourism organizations. Among these, education is a key yet often underexplored factor, shaping individuals' travel behavior, preferences, and overall awareness of global destinations. This study aims to explore the link between educational indicators and tourism performance across selected EU countries.

The goal of this analysis is to assess the impact of educational factors, such as educational attainment, teacher-pupil ratios, and digital skills, on tourism participation. By examining these relationships, the study aims to identify how investments in education could influence tourism outcomes and inform effective policies that support sustainable tourism development.

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Utilizing data from Eurostat and other sources, this study employs multiple linear regression models to explore the connection between educational variables and tourism performance. The findings offer important insights for policymakers and tourism organizations, highlighting how educational strategies can enhance tourism competitiveness and support long-term growth in the sector.

1.1 Literature Review and Theoretical Framework

Several authors examine the relationship between education and tourism. According to Toffolo et al. (2022), the relationship between education and tourism is multifaceted, with education playing a crucial role in promoting sustainable tourism. Informal educational activities contribute not only to environmental literacy but also to fostering tourist loyalty. Ejiofor et al. (2012) explored the impact of education on tourism development, with a focus on the relationship between environmental awareness and residents' involvement in tourism activities and identified significant relationship between education and tourism participation. The study also highlighted that residents with lower levels of environmental awareness were less committed to tourism-related activities. The findings of Moisescu et al. (2020) show that tourism education has a positive impact on tourism destination performance, influencing factors like nights spent, turnover, and added value, with a more significant effect observed in developing countries. Tomasi et al. (2020) explore how higher education institutions can support local development through educational tourism. The research highlights that international students can bring benefits to the destination, enhancing the sustainability of the local economy. This also illustrates the broader impact of education on tourism activities and the local tourism industry. According to Tovar et al. (2023), college students' beliefs about the social, economic, and environmental effects of tourism change after receiving educational training, leading them to become more concerned about the negative impacts of cruise tourism, particularly environmental externalities. This shift in concern impacts their attitudes towards this segment of tourism. The perceptions of tourism impacts are also explored by Nghiêm-Phú et al. (2024). The authors investigate how young tourists perceive both the positive and negative impacts of tourism, focusing on economic, sociocultural, and environmental aspects. The study emphasizes the importance of incorporating a more comprehensive and explicit understanding of tourism impacts into the education curriculum. Sirivadhanawaravachara (2024) notes the growth of educational tourism, emphasizing that while it offers significant economic benefits and fosters cultural understanding, challenges such as infrastructure, quality assurance, and sustainability must be addressed to unlock its full potential. Wang et al. (2024) emphasize the impact of daily and situational environmental education on tourists' responsible behavior, highlighting how personal factors such as attitudes, subjective norms, and perceived behavior control shape their intentions and actions. Adongo et al. (2017) study the impacts and benefits of tourism, focusing on the relationship between community attachment and support for tourism. Viana-Lora et al. (2023) found no significant differences in residents' support for sustainable tourism based on education level in their study. However, the general relationship between universities and tourism impacts is often underestimated (Menon et al., 2022). Gavurova et al. (2021) explore the impact of education and research and development (R&D) on tourism spending, finding a positive influence and identifying that Latvia and Hungary, among EU countries, have significant potential to increase tourism spending by enhancing their education and R&D efforts. This study identifies the relationship between education indicators and tourism activity.

2. Methods

The analysis utilizes secondary data collected from Eurostat and the World Bank, covering the period 2014–2024, depending on data availability. The dataset was processed using mathematical and statistical methods, including descriptive statistics and multiple linear regression models. The following variables were specified and analyzed:

- ***TourPR*** – ***Tour****ism* ***P****articipation* ***R****ate* – serves as the dependent variable in the applied regression models. It reflects the proportion of the total population engaged in tourism for personal purposes, encompassing both domestic and international travel. The analysis is based on data collected from Eurostat for the period 2014–2023.
- ***HighEdu*** – ***Edu****cational Attainment (****High*** *levels)* – represents the share of the population aged 15–64 who have completed at least upper secondary education, including post-secondary non-tertiary and all levels of tertiary education, according to the UNESCO International Standard Classification of Education (ISCED levels 3–8). *HighEdu* serves as an independent variable in the models, and its values for the period from 2015 to 2024 were collected from the Eurostat database.

- ***EduExp*** – ***Exp****enditure on* ***Edu****cation* – represents government expenditure on education as a percentage of GDP. Data for this independent variable were sourced from Eurostat and cover the period 2014–2023.
- ***LifeLR*** – ***Life****long* ***L****earning* ***R****ate* – represents the percentage of the population aged 25 to 74 who participated in education or training in the four weeks preceding the survey. This indicator reflects the level of lifelong learning engagement within the working-age population. The data for this independent variable were obtained from Eurostat and cover the period from 2014 to 2023.
- ***EarLeav*** – ***Ear****ly* ***Leav****ers* – this independent variable represents the percentage of early leavers from education and training, defined as the share of the population aged 18–24 who have not completed upper secondary education and are not currently engaged in further education or training. These data, covering the period 2015–2024, originate from the Eurostat database.
- ***Pup2Tch*** – ***Pup****il-****to****-****T****eac****h****er Ratio* – represents the pupil-to-teacher and teacher aide ratio by education level and programme orientation. In this study, it is applied to both primary and secondary education levels, indicating the average number of pupils per teaching staff involved at these stages. The *Pup2Tch* indicator reflects the quality aspect of education systems, with lower ratios typically indicating more favorable learning conditions and better student support. Data for this independent variable are sourced from Eurostat, covering 2014–2023.
- ***LowRead*** – ***Low*** *Achieving Students in* ***Read****ing* – represents the percentage of 15-year-old students performing below proficiency level 2 in reading literacy, based on OECD PISA assessments. It serves as an outcome indicator of educational effectiveness. The data are sourced from Eurostat and cover the period 2015–2022, depending on availability.
- ***DESIhc*** – ***D****igital* ***E****conomy and* ***S****ociety* ***I****ndex (DESI),* ***h****uman* ***c****apital Dimension* – reflects the population's digital skills and the availability of ICT specialists, which are essential components of modern education and lifelong learning, influencing employability and the ability to participate effectively in the digital economy. It is considered an independent variable in the models, sourced from the European Commission, and covers the period 2017–2022.
- ***DigiSk*** – *Level of* ***Digi****tal* ***Sk****ills* – represents the percentage of individuals aged 16–74 possessing basic or above basic overall digital skills in all five specific areas: Information and data literacy, Communication and collaboration, Digital content creation, Safety, and Problem solving. Independent variable *DigiSk* reflects the digital literacy level of the population and is sourced from Eurostat for the years 2021 and 2023.
- ***HCI*** – ***H****uman* ***C****apital* ***I****ndex* – developed by the World Bank, measures the potential productivity of the next generation based on education and health outcomes. Values range from 0 to 1, with higher values indicating better human capital development. Data for this independent variable are utilized for the years 2017, 2018, and 2020.

According to data availability, the independent variables are divided into primary indicators with predominant availability over the observed period (*HighEdu, EduExp, LifeLR, EarLeav, and Pup2Tch*) and secondary indicators with less frequent availability (*LowRead, DESIhc, DigiSk, and HCI*). Based on the previously mentioned dataset of defined variables, two main research questions are addressed:

Q1 – Is there a statistically significant effect of independent *primary* predictors on the percentage of the population active in tourism for selected EU countries?

Q2 – Is there a statistically significant effect of independent predictors (primary *and* secondary) on the percentage of the population active in tourism in EU countries?

The research questions are answered in the subsequent chapter, together with the analysis of the specified variables.

3. Results

The variables were analyzed using descriptive statistical methods, presented in the following tables. Subsequently, the research questions were addressed by employing multiple linear regression models. In the following tables, EU countries are indicated by their country codes, namely: Austria (*AT*), Belgium (*BE*), Bulgaria (*BG*), Croatia (*HR*), Cyprus (*CY*), Czechia (*CZ*), Denmark (*DK*), Estonia (*EE*), Finland (*FI*), France (*FR*), Germany (*DE*), Greece (*GR*), Hungary (*HU*), Ireland (*IE*), Italy (*IT*), Latvia (*LV*), Lithuania (*LT*), Luxembourg (*LU*), Malta (*MT*), Netherlands (*NL*), Poland (*PL*), Portugal (*PT*), Romania (*RO*), Slovakia (*SK*), Slovenia (*SI*), Spain (*ES*), and Sweden (*SE*). The *mean* share of the population

participating in domestic and outbound tourism (*TourPR*), along with the minimum (*min*), maximum (*max*), and standard deviation (*std*) over the period 2014–2023, is presented in *Table 1*. The data are sorted in descending order according to the *mean* value.

Table 1. Share of population participating in tourism trips for personal purposes

code	*mean*	*min*	*max*	*std*	*code*	*mean*	*min*	*max*	*std*	*code*	*mean*	*min*	*max*	*std*
FI	***84.67***	71.19	***91.45***	7.10	DK	**70.36**	52.50	82.07	9.89	LV	**54.96**	42.68	61.66	5.98
NL	***82.55***	68.97	85.52	4.69	SI	**63.82**	56.21	69.30	3.57	HU	**52.51**	40.26	58.75	5.94
LU	***80.42***	70.31	83.07	3.84	ES	**63.74**	53.93	69.66	5.23	LT	**51.97**	***32.00***	58.24	9.30
SE	**77.61**	69.17	84.94	5.32	CY	**63.39**	49.81	72.51	7.07	HR	**45.40**	37.64	54.04	4.70
CZ	**77.11**	68.17	83.91	4.74	SK	**60.66**	43.08	75.27	10.64	PT	**39.98**	23.87	49.35	8.71
FR	**76.02**	73.11	84.59	3.34	BE	**58.43**	44.45	67.53	6.90	GR	**39.54**	34.08	45.11	3.45
AT	**74.01**	60.30	78.70	5.73	EE	**58.29**	25.02	79.48	***17.14***	IT	***39.14***	25.88	44.88	5.65
IE	**72.76**	60.04	77.94	4.48	PL	**57.01**	43.56	65.65	6.19	BG	***29.78***	***22.70***	37.20	4.25
DE	**72.32**	60.00	77.51	5.43	MT	**56.04**	35.04	66.93	9.58	RO	***26.33***	***23.72***	28.60	***1.52***

Note: Numerical values referenced in the text are marked in bold and italics for clarity.
Source: Calculated from Eurostat data.

The highest mean value was observed in Finland (*FI*) at 84.67, followed by the Netherlands (*NL*) with 82.55, and Luxembourg (*LU*) with 80.42. In contrast, Romania (*RO*) recorded the lowest mean at 26.33, with Bulgaria (*BG*) and Italy (*IT*) also showing relatively low mean values of 29.78 and 39.14, respectively. Regarding variability, Estonia (*EE*) exhibited the highest standard deviation (17.14), indicating significant fluctuations in values over the observed period. On the other hand, Romania (*RO*) had the lowest standard deviation (1.52), suggesting a stable trend in its values. The data also show that *Finland* reached the highest maximum value (91.45), while the lowest minimum values were recorded in in *Bulgaria* (22.70), followed by *Romania* (23.72) and *Lithuania* (32.00). *Table 2* presents the *mean* values for EU countries across three key education-related indicators: *HighEdu* (share of population with at least upper secondary education), *EduExp* (government expenditure on education as % of GDP), and *LifeLR* (lifelong learning rate). The data are arranged alphabetically by country code in ascending order.

Table 2. Mean values of variables *HighEdu, EduExp,* and *LifeLR*

code	*HighEdu*	*EduExp*	*LifeLR*	*code*	*HighEdu*	*EduExp*	*LifeLR*	*code*	*HighEdu*	*EduExp*	*LifeLR*
AT	81.13	4.91	13.43	**FI**	81.98	6.06	***23.94***	**LV**	84.79	5.95	6.96
BE	74.93	6.26	8.14	**FR**	76.79	5.23	14.25	**MT**	61.95	4.53	10.60
BG	79.45	3.84	***1.54***	**GR**	73.99	4.09	***3.32***	**NL**	74.77	5.05	19.19
CY	79.10	5.28	7.21	**HR**	82.27	5.12	3.36	**PL**	86.73	4.98	4.94
CZ	***87.52***	4.33	7.51	**HU**	80.21	5.01	6.04	**PT**	***53.45***	4.68	9.87
DE	79.05	4.31	7.09	**IE**	80.05	***3.17***	10.13	**RO**	75.35	***3.23***	***2.71***
DK	73.86	***6.28***	***24.83***	**IT**	***60.58***	4.04	7.49	**SE**	79.59	***7.38***	***30.18***
EE	82.54	5.86	16.20	**LT**	***88.25***	4.84	6.70	**SI**	84.23	5.60	13.34
ES	***60.24***	4.17	10.80	**LU**	73.37	4.68	16.08	**SK**	***86.24***	4.36	5.22

Note: Numerical values referenced in the text are marked in bold and italics for clarity.
Source: Calculated from Eurostat data.

The highest average level of educational attainment (*HighEdu*) was recorded in *Lithuania* (88.25%), followed by the *Czechia* (87.52%) and *Slovakia* (86.24%). In contrast, the lowest mean value of *HighEdu* was observed in *Portugal* (53.45%), *Italy* (60.58%), and *Spain* (60.24%). Most countries exhibited values above 70%, suggesting a generally high level of formal education attainment across the EU countries. Regarding *EduExp*, *Sweden* (7.38%) and *Denmark* (6.28%) reported the highest average government expenditure on education relative to GDP, while *Ireland* (3.17%) and *Romania* (3.23%) had the lowest. The majority of countries fall within the 4–6% range, indicating moderate but varied investment levels in national education systems. The *LifeLR* indicator, which reflects participation in lifelong learning, revealed the greatest disparities. *Sweden* (30.18%) and *Denmark* (24.83%) exhibited the highest

engagement in lifelong learning activities, followed by *Finland* (23.94%). On the other hand, *Bulgaria* (1.54%), *Romania* (2.71%), and *Greece* (3.32%) recorded the lowest rates, pointing to substantial gaps in adult education and continuing training opportunities across Europe. *Table 3* presents the mean values of three educational indicators across selected EU countries: Early Leavers from education and training (*EarLeav*), the ratio of pupils to teachers in primary and secondary education (*Pup2Tch*), and the percentage of low-achieving 15-year-olds in reading (*LowRead*). The data are sorted in ascending alphabetical order by country code.

Table 3. Mean values for *EarLeav*, *Pup2Tch*, and *LowRead*

code	*EarLeav*	*Pup2Tch*	*LowRead*	*code*	*EarLeav*	*Pup2Tch*	*LowRead*	*code*	*EarLeav*	*Pup2Tch*	*LowRead*
AT	7.79	–	23.80	**FI**	8.49	11.16	***15.33***	**LV**	8.23	–	20.97
BE	7.92	10.27	22.03	**FR**	8.24	***14.18***	23.10	**MT**	***12.81***	***6.20***	***35.93***
BG	***11.91***	12.09	***47.17***	**GR**	***4.67***	***8.50***	31.80	**NL**	6.90	***13.81***	25.60
CY	8.94	–	***46.63***	**HR**	***2.52***	–	21.40	**PL**	***4.90***	–	17.10
CZ	6.44	12.23	21.33	**HU**	11.89	10.87	26.23	**PT**	9.86	–	20.17
DE	11.16	***13.73***	20.80	**IE**	***4.67***	10.80	***11.13***	**RO**	***16.73***	***12.90***	***40.40***
DK	9.46	11.76	16.67	**IT**	***12.88***	10.29	21.90	**SE**	7.56	10.88	20.37
EE	10.99	–	***11.83***	**LT**	5.48	9.56	24.80	**SI**	***4.46***	11.40	19.70
ES	***16.24***	–	20.30	**LU**	7.59	***9.41***	27.45	**SK**	7.72	***12.98***	***32.97***

Note: (–) denotes unavailable data. Numerical values referenced in the text are marked in bold and italics for clarity.
Source: Calculated from Eurostat data.

The average rate of early leavers (*EarLeav*) varies substantially among countries, ranging from a low of 2.52% in Croatia (*HR*) to a high of 16.73% in *Romania*. Countries such as *Spain* (16.24%), *Italy* (12.88%), *Malta* (12.81%), and *Bulgaria* (11.91%) also exhibit relatively high early leaving rates. Conversely, countries including *Croatia* (2.52%), *Slovenia* (4.46%), *Greece* (4.67%), *Ireland* (4.67%), and *Poland* (4.90%) demonstrate notably lower values, indicating stronger retention in education. Regarding the pupil-to-teacher ratio (*Pup2Tch*), data are missing for several countries; however, among those reported, *Netherlands* (13.81), *Germany* (13.73), *Slovakia* (12.98), and *Romania* (12.90) have higher ratios, suggesting larger class sizes or fewer teachers per pupil. Conversely, countries such as *Malta* (6.20), *Greece* (8.50), and *Luxembourg* (9.41) maintain lower ratios, which may reflect smaller class sizes or better teacher availability. The proportion of low-achieving 15-year-olds in reading also varies considerably, from a low of 11.13% in *Ireland* to a high of 47.17% in *Bulgaria*. Other countries with elevated percentages include Cyprus (46.63%), Romania (40.40%), Malta (35.93%), and Slovakia (32.97%). In contrast, Finland (15.33%), Estonia (11.83%), and Ireland (11.13%) exhibit comparatively better performance in reading proficiency. *Table 4* presents the *mean* values of three indicators across EU countries – the Digital Economy and Society Index for Human Capital (*DESIhc*), the digital literacy level of the population (*DigiSk*), and the Human Capital Index (*HCI*) – sorted in ascending alphabetical order by country code.

Table 4. Mean values for *DESIhc*, *DigiSk*, and *HCI*

code	*DESIhc*	*DigiSk*	*HCI*	*code*	*DESIhc*	*DigiSk*	*HCI*	*code*	*DESIhc*	*DigiSk*	*HCI*
AT	12.58	64.01	0.769	**FI**	***16.91***	***80.59***	***0.808***	**LV**	10.41	48.07	0.723
BE	11.41	56.81	0.760	**FR**	11.94	60.82	0.761	**MT**	12.82	62.13	0.706
BG	***7.82***	***33.35***	***0.653***	**GR**	9.50	52.44	0.689	**NL**	***14.67***	***80.82***	***0.798***
CY	9.92	49.84	0.754	**HR**	12.28	61.16	0.721	**PL**	***8.62***	***43.62***	0.753
CZ	10.77	64.40	0.766	**HU**	9.30	53.99	0.697	**PT**	10.42	55.64	0.776
DE	10.69	50.57	0.770	**IE**	***14.81***	***71.70***	0.804	**RO**	***7.20***	***27.78***	***0.593***
DK	13.96	69.14	0.767	**IT**	8.71	45.68	0.750	**SE**	14.43	66.52	***0.799***
EE	12.57	59.49	0.766	**LT**	9.81	50.88	0.715	**SI**	10.57	48.19	0.784
ES	12.28	65.17	0.736	**LU**	13.45	61.97	0.690	**SK**	10.25	53.25	***0.680***

Note: Numerical values referenced in the text are marked in bold and italics for clarity.
Source: Calculations based on data from the European Commission, Eurostat, and World Bank.

The data show considerable variation in these indicators across the countries analyzed. Regarding *DESIhc*, *Finland* (16.91) ranks the highest, followed by *Ireland* (14.81) and the *Netherlands* (14.67). Conversely, *Romania* (7.20), *Bulgaria* (7.82), and *Poland* (8.62) exhibit the lowest values in this category, suggesting a significant disparity in human capital development related to the digital economy within the EU.

For *DigiSk*, *Netherlands* (80.82) leads, reflecting a high level of digital literacy in the population, with countries like *Finland* (80.59) and *Ireland* (71.70) following behind. On the other hand, *Romania* (27.78), *Bulgaria* (33.35), and *Poland* (43.62) report much lower values, indicating room for improvement in digital skills within these nations.

The Human Capital Index (*HCI*) shows *Finland* (0.808) again leading, followed by *Sweden* (0.799) and the *Netherlands* (0.798), signaling higher human capital development overall. In contrast, *Romania* (0.593), *Bulgaria* (0.653), and *Slovakia* (0.680) have the lowest *HCI* values, suggesting lower levels of human capital as a determinant of overall socioeconomic development.

For further analyses, and to ensure the representativeness of the selection, EU countries were chosen based on the following criteria: (1) the country exhibited either the highest or lowest mean value in at least one of the predictors (primary or secondary), and (2) the country had available numeric data for all predictors. *Slovakia*, as the home country, along with the comparable *Czechia*, was also included in the analyses. *Romania* exhibited extreme values five times (four minima and one maximum), *Finland* three times (all maxima), *Sweden* twice (maxima), *Bulgaria* twice (one minimum and one maximum), and *Ireland* twice (minima). Additionally, extreme values were observed in *Malta*, *Lithuania*, *France*, and the *Netherlands*.

***Q1* – Is there a statistically significant effect of independent *primary* predictors on the percentage of the population active in tourism for selected EU countries?**

Research question ***Q1*** is investigated through multiple linear regression analyses. Separate models were estimated for each selected EU country to evaluate the impact of independent *primary* predictors on the Tourism Participation Rate (*TourPR*). The suggested models in the following form, where u_i denotes the residual ($i = 1, 2, \ldots, n$ observed years), are presented in *Table 5*:

$$TourPR = \beta_0 + \beta_1 \times HighEdu_i + \beta_2 \times EduExp_i + \beta_3 \times LifeLR_i + \beta_4 \times EarLeav_i + \beta_5 \times Pup2Tch_i + u_i.$$

Table 5. Multiple linear regression models for *TourPR* in selected EU countries

	BG	***CZ***	***FI***	***FR***	***IE***	***LT***	***MT***	***NL***	***RO***	***SE***	***SK***
***const* (β_0)**	80.05	−237.0	286.2	***112.7*** [c]	380.9	516.3	***538.6*** [b]	***924.8*** [a]	182.7	***1223*** [a]	1337.1
***HighEdu* (β_1)**	.	3.1	−3.33	.	−3.03	−5.24	.	***−6.69*** [a]	−0.69	***−16.9*** [a]	***−18.9*** [c]
***EduExp* (β_2)**	−10.67	−1.0	−3.1	1.77	−15.07	25.97	***−70.7*** [b]	***−50.1*** [b]	−5.32	9.85	4.16
***LifeLR* (β_3)**	0.01	2.09	−1.59	0.27	−0.38	10.74	−6.36	.	.	***3.03*** [b]	***4.81*** [b]
***EarLeav* (β_4)**	0.23	−0.62	0.14	−5.98	−3.48	−21.43	1.53	***−4.78*** [b]	−1.33	4.15	3.54
***Pup2Tch* (β_5)**	−1.0	2.79	***11.29*** [c]	.	.	−9.45	***−19.8*** [b]	−4.22	−5.03	.	18.72
R^2	0.324	0.910	0.947	0.534	0.197	0.916	0.866	0.949	0.488	0.920	***0.955***
adj. R^2	−0.576	0.462	0.816	0.255	−0.605	0.708	0.731	0.881	−0.194	0.840	0.842

Note: [a] *significant at 0.01 level* [b] *significant at 0.05 level* [c] *significant at 0.1 level*
Source: Author's own calculations.

No issues with heteroscedasticity of the residuals were identified. The problem of multicollinearity was addressed by eliminating certain variables.

All predictors exhibit both positive and negative impacts on *TourPR*. A higher frequency of positive influences is observed with the *LifeLR* variable, while the other variables tend to exhibit predominantly negative effects, particularly *HighEdu*. The models vary considerably in their fit across different countries. *Slovakia* (R^2 = 0.955, *adj*. R^2 = 0.842) shows the highest model fit, making it the most suitable for predicting *TourPR*. The model for *Slovakia* is particularly strong due to its high R^2 and adjusted R^2 values, which indicate a good proportion of explained variance in *TourPR*. Models for *Finland*, *Lithuania*, *Malta*, *Netherlands*, and *Sweden* also demonstrate a good fit, with several statistically significant predictors. The highest number of statistically significant predictors were found in the *Netherlands*, *Sweden*, and *Malta*.

Countries such as *Bulgaria*, *Ireland*, and *Romania* exhibit lower R^2 and adjusted R^2 values, indicating poor model fit and limited explanatory power of the predictors, suggesting that the models are less effective in predicting *TourPR* in these countries.

***Q2* – Is there a statistically significant effect of independent predictors (primary *and* secondary) on the percentage of the population active in tourism in EU countries?**

Several multiple linear regression models are employed to investigate the second research question. The population consists of EU countries; the sample includes the selected countries mentioned above, whose data are included in the models. The suggested models *M1*−*M7* in the following form, where u_i denotes the residual ($i = 1, 2, \ldots, n$ selected countries), are presented in *Table 6*:

$$TourPR = \beta_0 + \beta_1 \times HighEdu_i + \beta_2 \times EduExp_i + \beta_3 \times LifeLR_i + \beta_4 \times EarLeav_i + \beta_5 \times Pup2Tch_i + \\ + \beta_6 \times LowRead_i + \beta_7 \times DESIhc_i + \beta_8 \times DigiSk_i + \beta_9 \times HCI_i + u_i.$$

Table 6. Multiple linear regression models for *TourPR*

	const β_0	*HighEdu* β_1	*EduExp* β_2	*LifeLR* β_3	*EarLeav* β_4	*Pup2Tch* β_5	*LowRead* β_6	*DESIhc* β_7	*DigiSk* β_8	*HCI* β_9	R^2	adj. R^2
M1	−18.28	−0.35	8.61	−1.13	0.58	1.94	−0.75	−1.5	1.07	39.85	***0.985***	0.855
M2	14.21	−0.39	8.39	−1.01	0.28	1.97	−0.8	−1.51	1.12	.	0.985	0.924
M3	25.56	−0.19	3.64	.	0.11	1.34	−0.62	−3.29	***1.27*** [c]	.	0.980	0.934
M4	28.42	−0.22	***3.64*** [c]	.	.	1.36	−0.61	−3.21	***1.24*** [b]	.	0.980	0.950
M5	4.16	.	***3.29*** [c]	.	.	1.22	***−0.46*** [c]	−2.55	***1.22*** [a]	.	0.978	***0.955***
M6	−6.49	.	2.56	.	.	***1.58*** [c]	−0.4	.	***0.85*** [a]	.	0.964	0.940
M7	***−30.83*** [b]	.	2.47	.	.	***1.71*** [c]	.	.	***1.06*** [a]	.	0.948	0.926

Note: [a] significant at 0.01 level [b] significant at 0.05 level [c] significant at 0.1 level
Source: Author's own calculations.

No issues with heteroscedasticity of the residuals were identified. The problem of multicollinearity was addressed by eliminating certain variables. The variables *HCI*, *EduExp*, *Pup2Tch*, *DigiSk*, and *EarLeav* exhibit a positive influence on the dependent variable *TourPR* across all models, while a negative impact can be observed for the independent predictors *DESIhc*, *LifeLR*, *LowRead*, and *HighEdu*.

Among models *M1–M7*, model *M5* is the most suitable, as it has the highest adjusted R^2 (0.955) and includes three significant predictors (*EduExp*, *LowRead*, and *DigiSk*). Model *M4* also performs well with two significant predictors (*EduExp* and *DigiSk*) and a high adjusted R^2 of 0.950. Model *M6* is another strong contender, with an adjusted R^2 of 0.940 and one significant predictor (*DigiSk*), but it does not outperform *M5* or *M4* in terms of explanatory power. The final best model describing *TourPR* as a function of educational predictors is:

$$TourPR = 4.16 + 3.29\ EduExp_i + 1.22\ Pup2Tch_i - 0.46\ LowRead_i - 2.55\ DESIhc_i + 1.22\ DigiSk_i + u_i.$$

4. Discussion

The results presented in *Table 1* reveal substantial disparities in the indicator *TourPR* across EU countries, both in terms of mean values and year-to-year variation. The statistics for the variables *HighEdu*, *EduExp*, and *LifeLR* (*Table 2*) demonstrate a heterogeneous landscape of educational performance and policy emphasis within the EU, particularly with regard to investment and engagement beyond formal education. The summary of *Table 3*, which presents the mean values for *EarLeav*, *Pup2Tch*, and *LowRead*, underscores significant disparities in educational outcomes and resource allocation across the EU, highlighting the need for targeted policy interventions focused on reducing early school leaving, optimizing teacher deployment, and enhancing literacy skills. According to *Table 4*, the data (mean values) for *DESIhc*, *DigiSk*, and *HCI* illustrate considerable variation in human capital indicators across EU countries, particularly in relation to digital skills and overall human capital. These variations may inform policy development aimed at improving these areas in countries with lower rankings.

Models in *Table 5* for the research question ***Q1*** show that national specifics are reflected not only in the area of educational indicators. The most suitable model is for *Slovakia*. *Finland*, *Lithuania*, *Malta*,

Netherlands, and *Sweden* also had models with good fit, R^2, and *adj*. R^2. The data suggest a negative impact of the variable *HighEdu* on *TourPR*.

According to models in research question ***Q2***, several variables exhibit varying impacts on *TourPR*. *EduExp* (education expenditure), *Pup2Tch* (pupil-to-teacher ratio), and *DigiSk* (digital skills) all have a positive influence, with coefficients of 3.29, 1.22, and 1.22, respectively, indicating that higher levels of these predictors contribute to an increase in *TourPR*. On the other hand, *LowRead* (low reading achievement), *DESIhc* (digital economy index), and *LifeLR* (life-long learning) show negative effects, with coefficients of −0.46, −2.55, and −1.13, respectively, suggesting that higher values of these variables are associated with lower *TourPR* outcomes.

More precise results, stronger models, and greater consistency in the findings of ***Q1*** and ***Q2*** could be ensured by selecting different educational independent predictors, a different subset of EU countries, and also by testing nonlinear regression models.

Conclusion

The analysis of multiple linear regression models for the *TourPR* variable across selected EU countries reveals significant disparities in the influence of educational predictors. Several variables, particularly *HighEdu*, exhibit a predominantly negative impact across many countries. This suggests that the level of higher education may not always positively correlate with *TourPR*, highlighting the importance of contextualizing educational indicators in the analysis of tourism performance.

Countries like *Slovakia*, *Finland*, *Lithuania*, *Malta*, *Netherlands*, and *Sweden* show strong model fits, with significant predictors contributing to the explanation of *TourPR*. Notably, *Netherlands*, *Sweden*, and *Malta* feature the highest number of statistically significant predictors, suggesting that these countries are more influenced by educational variables in their tourism performance. In contrast, countries such as *Bulgaria*, *Ireland*, and *Romania* demonstrate lower model fits, with R^2 and adjusted R^2 values indicating weaker explanatory power and less effective prediction of *TourPR*.

Models *M3–M6* for the *TourPR* variable indicate that certain aspects of education, such as increased expenditure (*EduExp*), better teacher-pupil ratios (*Pup2Tch*), and enhanced digital skills (*DigiSk*), have a *positive impact* on tourism performance. Conversely, lower literacy rates (*LowRead*) and certain human capital indicators (*DESIhc*) show a *negative correlation* with tourism success. This suggests that investments in education, particularly in areas like digital skills and teacher resources, could foster better tourism outcomes, while challenges related to literacy and human capital should be addressed to improve overall performance.

The findings outlined above have important implications for policymakers, regional educational authorities, and organizations involved in tourism management. Governments and decision-makers can leverage this knowledge to tailor educational policies and strategies that enhance tourism outcomes. Specifically, understanding the role of higher education, digital skills, and other educational factors can guide investments and initiatives that improve both the quality of education and tourism development. Regional educational authorities may focus on integrating tourism-relevant curricula and skills development to optimize the human capital that supports tourism growth. Additionally, tourism organizations can use these insights to better align their marketing and service offerings with the specific educational contexts of different regions.

Overall, the results suggest that while educational factors play a role in influencing *TourPR*, the relationship is complex, with some countries showing positive and others negative impacts. Further research incorporating other relevant variables and exploring potential non-linear relationships could improve the models and provide a deeper understanding of the factors driving tourism performance in the EU.

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Investigating Generation Z's Preferences in Sustainable Tourism in Slovakia

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Abstract

Research background: The concept of sustainable tourism has gained increasing attention among researchers, policymakers, and tourism stakeholders. Sustainable tourism aims to minimise the negative effects of tourism on the environment and local communities while maximising its benefits for present and future generations. It emphasises responsible travel practices, the use of local resources, cultural preservation, and environmental protection.
Purpose of the article: The objective of this research is to analyse the tourism behaviour of Generation Z in Slovakia, with particular emphasis on their travel patterns, the key factors influencing destination choice, their accommodation and transport mode preferences, and the perceived importance of sustainable practices implemented in accommodation facilities.
Methods: The study is based on a questionnaire survey targeting respondents of Generation Z in Slovakia. In total, 210 respondents participated in the survey. The Friedman test was applied to identify which factors most influence Generation Z's decision-making when selecting a destination and transport mode.
Findings & Value added: The results revealed that 79% of the respondents of Generation Z reported participating in both domestic and international tourism, whereas 9% indicated a preference for domestic tourism. Approximately 12% of respondents prioritised international destinations. Moreover, the majority of the young tourists are familiar with the concept of sustainable tourism. Friedman test results revealed that new experiences, price, and online reviews were the most influential factors in destination choices among Generation Z. In contrast, sustainability-related aspects such as eco-certification were ranked as least important. Moreover, findings indicate that plastic waste reduction (22%), support for local and organic products (20%), and composting and recycling options (17%) were considered the most important sustainability practices in accommodation facilities. These findings offer practical recommendations for tourism service providers who want to attract younger travellers by responding to their expectations for more sustainable services.

Keywords: Consumer Behaviour, Generation Z, Sustainable Tourism, Slovakia

JEL classification: M31, Z32

1. Introduction

Tourism represents a crucial driver of global economic growth, stimulating regional development, creating job opportunities, and promoting cultural exchange (Li et al., 2018). Although, according to Higgins-Desbiolles (2020), the rapid expansion of the tourism sector has also led to significant environmental and sustainability challenges, particularly in destinations with high numbers of visitors and limited resources. Sfodera et al. (2024) reported that there has been substantial progress in incorporating sustainability concepts into the tourism industry recently. As stated by Kim & Park (2020), sustainable tourism has emerged as a critical issue in the modern era, reflecting the growing awareness of the need to preserve the environment, protect cultural heritage, and support the economic well-being of local communities.

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Within this context, recent studies highlight that sustainability is becoming an increasingly important factor shaping consumer behaviour, especially among younger generations (Yamane & Kaneko, 2021). Giachino et al. (2022) emphasise that consumers of Generation Z perceive sustainability as a fundamental value, affected by environmental crises and global movements. Therefore, there has been expanding research focusing on the sustainability-oriented behaviours and consumption patterns of Gen Z across various contexts (Orea-Giner & Fusté-Forné, 2023). Regarding the tourism sector, young Generation Z travellers represent a noticeable and demanding market segment (Rosanto & Carennia, 2022). Similarly, Liu et al. (2023) report that consumers of this generation play a crucial role in forming the sector of tourism. They are characterised by looking for not only relaxation but also unique, eco-friendly experiences. Travel decisions are mostly driven by social media (Liu et al., 2023; Tănase et al., 2023). Furthermore, the integration of advanced technologies, including virtual reality and artificial intelligence, has become an important factor in their choice of resorts, highlighting the increasing relevance of digital innovation in meeting the expectations of this generation (Kaikara, 2024). As reported by Kılıç et al. (2021), young travellers are complex and intelligent, and they are known for having high expectations for their travels. Moreover, this generation shows a strong interest in unique travel experiences and accommodation choices, as well as their interest in meaningful interactions with the environment and local communities. When travelling, they actively look for connecting with locals and other travellers, making experiences that contribute to personal growth and self-development (Robinson & Schänzel, 2019). According to Veronica (2025), young tourists' behaviour is influenced mostly by the costs, accessibility and social media-based experiences. Finally, Rosanto & Carennia (2022) highlight that awareness of Generation Z and their understanding of sustainable tourism can significantly affect their travel decisions and behaviours, which will impact the overall advancement of sustainable tourism development.

The presented study focuses on the tourism behaviour of Generation Z in Slovakia, with particular emphasis on their travel patterns, the key factors influencing destination choice, their accommodation and transport mode preferences, and the perceived importance of sustainable practices implemented in accommodation facilities. The paper is structured into four main sections. The first part provides an overview of the importance of the topic, outlining the objectives of the research. In the second section, methods, data collection and hypothesis formulation are presented. The following section highlights results and discussion. The final section includes the practical contributions of the research.

2. Methods

The primary objective of this paper is to investigate the tourism behaviour of Generation Z in Slovakia, with a particular emphasis on their travel patterns, key factors influencing destination choice, accommodation preferences, and the perceived importance of sustainable practices implemented in accommodation facilities. In this study, the target population represented Generation Z, defined as individuals born between 1997 and 2012 (Theocharis et al., 2025). Recent literature suggests that Generation Z is the generation that is most committed to adopting sustainable practices (Dabija et al., 2020).

The research is based on the primary data collected through an online questionnaire survey in March 2025. However, all participants under the age of 18 within Generation Z were excluded from the survey, which represents a research limitation for studying this generation. The final research sample included 210 Slovak respondents of Generation Z (aged between 18 - 27 years).

Table 1 provides an overview of the demographic and socioeconomic characteristics of the respondents. In terms of gender distribution, the majority were female (54 %) while men represented 46 % of the sample. Regarding economic activity, the largest proportion were students (61 %), followed by employed participants (36 %). A small proportion of the sample were unemployed (1 %) or on maternity leave (2 %). In terms of place of residence, 57 % of the respondents lived in urban areas and 43 % in rural areas. With respect to education, none of the respondents reported having only primary education. Moreover, the majority of the sample held a secondary education qualification (60 %). Finally, 40 % of the participants had a university degree.

Table 1. Socio-demographic profile of respondents

Variable	Category	Frequency in %
Gender	Female	54%
	Men	46%
Economic activity	Student	61%
	Employed	36%
	Unemployed	1%
	Maternity leave	2%
Place of residence	Urban areas	57%
	Rural areas	43%
Education	Primary	0%
	Secondary	60%
	University degree	40%

Source: authors (2025)

The collected data were processed using Microsoft Excel and XLSTAT software. To analyse differences in the evaluation of factors, the Friedman test was applied, followed by Nemenyi's post-hoc method to identify statistically significant pairwise differences. To fulfil the main objective of the research, two hypotheses were determined:

H_1: There are statistically significant differences in the evaluation of factors influencing respondents' choice of destination.

H_2: There are statistically significant differences in the evaluation of factors influencing respondents' choice of means of transport within the destination.

3. Results

At the beginning of the questionnaire, respondents were asked about their general travel preferences. A total of 12 % of respondents reported travelling exclusively abroad, while 9 % preferred domestic tourism only. The majority (79 % of respondents) indicated that they combine both domestic and international travel. This distribution demonstrates that most Generation Z respondents participate in both types of tourism, with only a minority focusing exclusively on one.

Regarding awareness of the concept of sustainable tourism, 89 % of respondents indicated that they were familiar with the term, while the remaining 11 % were not. This result indicates that the majority of respondents are aware of the concept of sustainable tourism, suggesting a generally high level of environmental and social consciousness among the targeted generation. Although the fact that a minority of 11 % remain unfamiliar with the concept of sustainable tourism highlights the need for further education and communication efforts to promote sustainability principles more widely within the target population.

Moreover, the presented study aimed to identify the key factors influencing destination decisions. Respondents evaluated various determinants using a 7-point Likert scale, where 1 indicated the lowest level of importance and 7 the most important determinant. The first hypothesis, H_1, assumed statistically significant differences in evaluation among selected determinants when choosing a destination. Using Friedman's test (Table 2) and Nemenyi's method, we discovered eight groups of factors based on their importance. The findings show statistically significant differences between selected determinants (p-value = <0.001).

Table 2. Results of the Friedman test

Sample	Frequency
Q (Observed value)	633,921
Q (Critical value)	24,996
DF	15
p-value (one-tailed)	<0,0001
alpha	0,05

Source: authors (2025)

Furthermore, Nemenyi's post-hoc test was applied to determine the differences in the importance assigned to various factors influencing destination choice. The results revealed which factors differ significantly from each other, with factors labelled as group H being the most significant and those in group A the least significant (Table 3). The factor rated as the most important by respondents was new experiences. This was followed closely by price and reviews (TripAdvisor, Google Reviews, Booking), facilities available at the accommodation, previous experiences, and recommendations from family and friends. These factors suggest that practical and experiential aspects are highly valued when selecting a destination. On the other hand, ecological accommodation certificates (e.g., Green Key) were rated as the least important factor. Similarly, trends in society and pressure from social media and support for the local economy ranked low. To conclude, the findings show that Generation Z respondents prioritise personal experiences, cost considerations, and trusted recommendations when choosing a destination, whereas environmental certifications and societal trends play a relatively minor role in their decision-making process.

Table 3. Results of Nemenyi's method: Differences Between Factors Influencing Destination Choice

Sample	Frequency	Sum of ranks	Mean of ranks	Groups							
Ecological accommodation certificates (e.g., Green Key)	210	959,500	4,569	A							
Trends in society and pressure from social media	210	1227,000	5,843	A	B						
Support for the local economy	210	1289,500	6,140	A	B	C					
Support for local communities and preservation of cultural heritage	210	1399,500	6,664		B	C					
Personal interest in nature conservation, cultural heritage, and supporting local communities	210	1471,500	7,007		B	C	D				
Availability of services (e.g., wellness, massages)	210	1600,500	7,621			C	D	E			
Availability of public transport	210	1769,000	8,424				D	E	F		
Information on websites	210	1916,500	9,126					E	F		
Information on social media and in the media	210	1987,000	9,462						F	G	
Experiencing local culture and traditions	210	1990,000	9,476						F	G	
Recommendations from family and friends	210	2055,000	9,786						F	G	H
Previous experiences, e.g., past visits	210	2060,000	9,810						F	G	H
Facilities available at the accommodation	210	2078,500	9,898						F	G	H
Reviews (TripAdvisor, Google Reviews, Booking)	210	2082,000	9,914						F	G	H
Price	210	2303,000	10,967							G	H
New experiences	210	2371,500	11,293								H

Source: authors (2025)

In terms of accommodation preferences, 49 % of respondents reported staying most frequently in hotels. Moreover, young travellers show a tendency toward staying in apartment houses, chosen by 21 % of respondents. Other accommodation types were selected less frequently. Only 5% of respondents prefer staying at holiday houses (5%). Approximately 9% of the sample show a preference for cottages and 7% for resorts. Finally, based on the results, guesthouses (7%), campsites (2%) and hostels (less than 1%) were among the least frequently chosen accommodation types.

In the next question, respondents were asked to indicate which sustainable measures they consider the most important in accommodation facilities. The results show that the highest priority was given to

minimising plastic waste, selected by 22 % of participants. Supporting local and organic products was determined by 20% of respondents. Approximately 17% of the sample consider composting and waste recycling options, and water and energy-saving systems as the most important sustainable measures in accommodation facilities. The use of renewable energy sources was highlighted by 35 respondents (17%). Sustainability certificates such as Green Key or EU Ecolabel were considered the least important among the listed measures, evaluated by 11 respondents (5%).

Regarding the most frequently used method of transportation while travelling, nearly half of the respondents (43%) indicated that they primarily use a rented car. Furthermore, 19% of the sample reported using a combination of different transport modes. Air travel was selected by 18% of respondents, and 15% of participants most often use trains. Only 5 % of the sample stated that they mostly travel by bus. The results of the Friedman test confirmed statistically significant differences between determinants affecting the choice of transport mode (p-value = <0.001). Table 4 highlights the results of Nemenyi's method, the ranking of factors affecting respondents' choice of mode of transport within a destination. The results show statistically significant differences in importance, divided into three groups. Based on the results, the most important factors identified by respondents were the availability of transport connections, followed by travel time and environmental impact (Group C). On the contrary, safety was rated as the least important factor (Group A). To conclude, the results suggest that safety is generally taken for granted or perceived as less decisive compared to convenience and environmental considerations. Moreover, respondents focus primarily on practical availability, speed, environmental responsibility, and comfort when deciding how to travel within a destination.

Table 4. Results of Nemenyi's method: Differences Between Factors Influencing Destination Choice

Sample	Frequency	Sum of ranks	Mean of ranks	Groups		
Safety	210	470,500	2,240	A		
Ticket or fuel price	210	667,000	3,176		B	
Comfort during travel	210	795,000	3,786			C
Environmental impact	210	815,000	3,881			C
Travel time	210	821,500	3,912			C
Availability of transport connections	210	841,000	4,005			C

Source: authors (2025)

4. Discussion

The findings of the study confirm that Slovak travellers from Generation Z are primarily influenced by new experiences, affordability, and reviews (Booking, TripAdvisor, etc.) when selecting a destination, while environmental certifications and trends tend to play a relatively minor role. Likewise, when deciding on a method of transportation in the destination, practical aspects such as the availability of connections, travel time, and environmental impact came out as key priorities, whereas safety was perceived as least important for Slovak Generation Z travellers.

Moreover, based on the results, the majority of Generation Z respondents were familiar with the concept of sustainable tourism, while a small proportion indicated that they did not know the term sustainable tourism. In this context, Generation Z can be regarded as an active and dynamic driver of sustainable tourism development. According to Çetin & Karalar (2016), Generation Z is collaborative yet less loyal and must cope with complex environmental, social and economic challenges. A study by Romera & Le Bigot (2023) revealed that Generation Z demonstrates a stronger commitment to sustainable and responsible practices than Millennials in terms of sustainable tourism.

The results of the Friedman test and Nemenyi's method indicate that new experiences, price and reviews are the most important factors influencing destination choices. In the study by Asandului et al. (2025), results show that choices of Generation Z in Romania are primarily influenced by family, mass media, social networks, and travel agencies. Furthermore, the results of the study carried out in Indonesia revealed that friends and relatives are the most influential sources of information in destination and accommodation choices (Pitanatri et al., 2024). Gurning et al. (2024) stated that social media considerably

affects the decision-making process of Generation Z. Moreover, reviews and recommendations play a significant role in shaping the travel choices of this generation. On the other hand, the study by Mutmainah et al. (2024) revealed that Generation Z is mostly influenced by trends and general preferences when choosing a destination. The results of Bačík et al. (2025) highlight that digital marketing is increasingly influencing consumer behaviour, particularly among the younger generation. Veronica (2025) stated that understanding sustainability in tourism positively influences the behaviour of young tourists. Furthermore, the author suggests a need for more targeted education on sustainability concepts to enhance their practical impact on tourism-related behaviour.

However, according to the results, respondents were generally familiar with the concept of sustainable tourism, but factors such as eco-certificates and support for the local economy and local products did not appear as significant factors influencing their choice of destination. The study by Fonseca et al. (2025) highlights that campaigns have a positive impact on consumer perceptions and purchasing decisions. Sustainable marketing campaigns play a significant role in raising awareness of environmental issues and contribute to more conscious consumption decisions, reflecting an increasingly evident trend in environmental concern. In line with the present study, Liu-Lastres et al. (2025) investigated both Generation Z and Generation Y in the context of sustainable travel behaviour. The results also indicated that although both generations express strong intentions to engage in sustainable travel, putting these intentions into practice remains challenging. Key barriers identified include limited resources, higher costs, and insufficient knowledge. These findings highlight the gap between awareness and actual behaviour, emphasising the need for targeted policies and practical solutions to overcome these obstacles and encourage more consistent adoption of sustainable travel practices among younger generations.

Conclusion

This study examined the travel behaviour of Generation Z in Slovakia, with a specific focus on their destination choices, accommodation preferences, and factors influencing their selection of transport modes. The results suggest that Generation Z travellers in Slovakia value authentic experiences, affordability, and recommendations when choosing a destination, while environmental certifications and social trends have a minor impact on their decisions. Regarding transport preferences, practical factors such as the availability of connections, travel time, and environmental impact were prioritised, whereas safety was generally taken for granted and rated as less important.

These findings suggest that although the surveyed Generation Z demonstrates a considerable level of awareness about sustainable tourism, this awareness does not yet fully translate into decisive action when planning trips. Practicality and personal benefits remain dominant drivers of travel behaviour.

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Case Study of Marketing Tools and Strategies in DMOs in Slovakia: Current Status and Practice

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Abstract

Research background: Marketing and online marketing are key tools for effective management of tourism destinations. Their use and practice in Slovak destination management organisations (DMOs) are not sufficiently explored.
Purpose of the article: The aim of the article is to analyse the current state, approaches and tools of marketing and online marketing used in regional tourism organisations (DMOs) in Slovakia, with an emphasis on marketing strategies, their creation, market research and implementation.
Methods: The primary data source was a structured questionnaire distributed to DMOs. The obtained data were quantitatively processed and analysed to identify trends and preferences in the marketing practice of destination management in Slovakia based on selected examples and subsequently compared with a similar study conducted in 2019.
Findings & Value added: The results of the case study show that Slovak DMOs are increasingly aware of the need to set their direction through developed marketing strategies, and at the same time, currently leave the creation of marketing and online strategies to external institutions. The limit is the lower representativeness of the sample, which does not allow generalising the results to all DMOs. The article provides an overview of the current state of marketing activities in DMOs in Slovakia, thereby contributing to a better understanding of their marketing effectiveness and offering recommendations for enhancing marketing practices in the field of destination management.

Keywords: Destination management organisation, Marketing strategy, Online Marketing, Slovakia

JEL classification: M31, L83, Z32

1. Introduction

The tourism landscape is a dynamic and multifaceted realm, where the coordinated efforts of various entities are paramount to success. In recent decades, the concepts of destination management and destination marketing have emerged as distinct yet highly interrelated fields, crucial for navigating the complexities of attracting and satisfying visitors. While often used interchangeably, destination management encompasses a broader scope, with destination marketing serving as one of its integral functions. This evolution has led to the professionalisation of destination management, necessitating individuals with specialised skills and experiences, and recognising destination managers as a new, increasingly vital breed within society.

At the heart of this coordinated effort are Destination Management Organisations (DMOs). These specialised organisations arose from the compelling need for a unified approach to planning, developing, and marketing tourism destinations. DMOs are essentially teams of tourism professionals tasked with leading and coordinating all tourism stakeholders within a given geographic area, working to achieve the destination's vision and tourism goals. Their roles are extensive and strategic, extending far beyond simple promotion. According to the UN World Tourism Organisation (UNWTO), DMOs are instrumental in leading and coordinating the appropriate use of all destination elements, including attractions, amenities, accessibility, human resources, image, and price. They drive marketing efforts to attract visitors, but also play a critical role in creating a suitable environment through planning, infrastructure development, human resource development, and the implementation of policies that promote sustainable tourism. Furthermore,

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DMOs are responsible for "delivering on the ground," ensuring that the experiences promised in marketing are genuinely provided to tourists, with the ultimate goal of exceeding visitor expectations upon arrival. This demonstrates a shift from early DMOs that were primarily promotional agencies to today's more professional and sophisticated organizations (UNWTO, 2007; Gowreesunkar et al. 2018).

In an increasingly competitive global tourism landscape, the effective marketing and management of destinations are paramount for fostering sustainable growth and attracting visitors. DMOs play a pivotal role in this endeavour, acting as orchestrators and facilitators of tourism development within their respective regions (Sotiriadis, 2021). Their mandate extends beyond mere promotion to encompass strategic planning, product development, stakeholder coordination, and the overall enhancement of the visitor experience. The dynamic nature of the tourism industry, coupled with rapid advancements in technology and shifting consumer behaviours, necessitates a continuous evolution of marketing tools and strategies employed by DMOs (Gretzel, 2022).

Internationally, academic discourse has extensively explored various facets of destination marketing. Key areas of focus include the intricate process of destination branding, where DMOs strive to create a unique and appealing identity for their locales (Escobar-Farfán et al., 2024). This involves not only traditional communication channels but also increasingly leverages digital technologies and co-creation with stakeholders to build a compelling narrative (Escobar-Farfán et al., 2024). The rise of User-Generated Content (UGC) on platforms like Instagram has significantly altered the marketing landscape, prompting DMOs to adapt their visual communication strategies and engage with visitor-created content to enhance authenticity and reach (Kop et al., 2024). Furthermore, contemporary research emphasises the need for DMOs to adopt digital transformation, moving towards the concept of a "Smart DMO" that integrates advanced technologies and fosters new partnerships for knowledge sharing and efficient destination management (Gretzel, 2022). This shift also underscores a broader evolution in destination management, emphasising the importance of factors beyond mere visitor numbers, such as destination resilience, community involvement, and collaborative governance (Reinhold et al., 2023).

While international literature provides a robust theoretical and empirical foundation for understanding destination marketing, there remains a need for localised studies that examine the practical application of these strategies within specific national contexts. This article aims to address this gap by presenting a case study of marketing tools and strategies employed by DMOs in Slovakia. By analysing the current status and practices within the Slovak tourism sector, this research seeks to contribute to a deeper understanding of the challenges and opportunities faced by DMOs in a specific Central European environment. The findings will not only offer insights into the practical realities of destination marketing in Slovakia but also provide valuable comparative data for international discussions on effective DMO operations.

Destination management organisations

Beyond these foundational roles, DMOs provide significant added value to a destination. They act as strategic leaders in destination development, driving and coordinating management activities within a coherent strategic framework. Their functions include fostering partnerships and team-building among government agencies and the private sector, actively engaging with local communities and residents, and managing visitor flows and impacts to protect resources and enhance visitor safety and satisfaction. DMOs also take the lead in planning and research, conducting essential studies to inform tourism development and marketing strategies, and spearheading product development initiatives that enhance the destination's offerings. Their importance is underscored by tangible benefits such as establishing a competitive edge, ensuring tourism sustainability, spreading economic benefits, improving tourism yield, and building a strong, vibrant brand identity for the destination. For visitors, DMOs serve as a valuable "one-stop shop" for information, saving time and energy by providing comprehensive details about services and facilities, often at no cost. In essence, DMOs are the advocates and champions of tourism in their respective areas, working to elevate their understanding and ensure their rightful share of resources, ultimately building community pride and enriching both visitor experiences and local livelihoods. (Gowreesunkar et al. 2018)

The **Act No. 91/2010 Coll. on the Support of Tourism** has significantly influenced the establishment of Destination Management Organisations (DMOs) within Slovakia. Following the enactment of this legislation, the formation of local DMOs commenced in 2012. Subsequently, and in adherence to the provisions of this legal framework, a total of **8 regional** and **39 local (micro-regional)** tourism organizations have been officially constituted across diverse tourist destinations, as indicated by contemporary data.

The legislative intent behind the creation of these DMOs is to foster and enable conditions conducive to tourism development. This translates into strategic activities designed to augment the influx of both domestic and international visitors, prolong their duration of stay within the Slovak Republic, and thereby enhance their overall economic contribution to the national economy. Furthermore, a core function of these DMOs is to safeguard the collective interests of their member entities.

The aforementioned Act permits the formation of two distinct categories of DMOs: regional and local (micro-regional). The local DMOs represent the foundational tier of tourism governance within the Slovak administrative structure. As per the Act's stipulations, a local DMO can be established through a collaborative effort involving a minimum of five municipalities and an unrestricted number of tourism-related businesses operating within the designated destination area, provided the area records a minimum of 150,000 overnight stays annually. This model inherently embodies a public-private partnership approach. Conversely, each of Slovakia's eight administrative self-governing regions is authorized to establish a single regional DMO. A regional DMO, representing a higher territorial management unit (corresponding to a local government region), is also mandated to have at least one local DMO operating within its geographical jurisdiction.

Marketing strategies in DMOs

Promotional and marketing efforts are pivotal in influencing the operational success of businesses. These endeavours encompass not only the strategic selection of their deployment location, temporal sequencing, and implementation methodologies but also involve evaluating their capacity to stimulate heightened demand for a specific destination (Bobier et al., 2019). Consequently, the deliberate formulation of promotional initiatives constitutes an essential element of a destination's comprehensive marketing strategy. Such activities necessitate meticulous planning and precise alignment with the destination's distinct objectives and strategic priorities. As articulated by Saif & Aimin (2016), a well-conceived marketing strategy is fundamental to corporate operations, as it directly impacts an organisation's performance outcomes and overall efficacy. Furthermore, it is expected that appealing destinations can foster increased tourist demand within their respective areas through judicious promotional undertakings. Promotional activities executed by Destination Marketing Organisations (DMOs) or other tourism industry associations can augment destination performance by driving an increase in visitor numbers (Quaye, 2025).

As stated by Matušíková et al. (2023) a lot of research has shown how digital technologies create a huge potential for product and service innovation that is difficult to control and predict. Therefore, firms need dynamic tools to support themselves in managing the new types of digital innovation processes that emerge. The nature of these processes forces firms to challenge prior assumptions about their product and service portfolio, their digital environment, and ways of organizing innovation work. According to Beták et al. (2023) marketing tools and trends are changing, and various new forms of presentation and promotion of tourism products are being developed. Recently, it has become apparent that digital technologies are having a significant impact on tourism. Technically “savvy” prospective customers are embracing the use of digital technologies when deciding whether to use a given service, visit a destination or purchase a desired product.

The efficacy of a web marketing strategy for Destination Marketing Organisations (DMOs) is contingent upon, among other factors, the integrated implementation and harmonious coordination of three interconnected components: the optimal utilization of an appropriate combination of web technologies, the development of an effective marketing strategy specifically for the website, and the deployment of a robust promotional strategy for the website itself. Given their disparate technical capabilities, varied financial capacities, and diverse marketing objectives, DMOs apply web-based technologies through distinct approaches and with varying degrees of intensity (Wang & Fesenmaier, 2003).

2. Methods

The aim of the article is to analyse the current state, approaches and tools of marketing and online marketing used in regional tourism organisations (DMOs) in Slovakia, with an emphasis on marketing strategies, their creation, market research and implementation.

The primary data source was a structured questionnaire distributed to DMOs. The obtained data were quantitatively processed and analysed to identify trends and preferences in the marketing practice of destination management in Slovakia based on selected examples and subsequently compared with a similar study conducted in 2019. (Palenčíková & Mazúchová, 2019)

Our research gathered primary data through a sociological inquiry method, specifically a field survey utilising questionnaires. The survey, conducted between February and May 2025, aimed to evaluate the marketing activities of Destination Management Organisations (DMOs) over time from the perspective of their managers. The basic sample consisted of 39 local DMOs and 8 regional DMOs, and we received answers from 21 of them, which represents a 45 % return on questionnaires. The obtained data were processed and evaluated using MS Office Excel. In the survey, we seek answers to the following research questions: Q1: To what extent do DMOs have comprehensive marketing strategies in place, and how are these strategies developed? Q2: Which marketing tools are most commonly used in DMO practice? Q3: How do DMOs conduct market research?

3. Results

In accordance with prevailing legislation, the core functions of Destination Management Organisations (DMOs) predominantly encompass destination marketing management. These responsibilities involve strategic planning, comprehensive market research, and the development and execution of the marketing mix. Market research is critically important for the successful evolution of a tourism destination, forming the empirical basis for effective and strategic marketing decisions. It is essential for generating objective and reliable data that informs the selection of optimal marketing channels (e.g., digital platforms, print media, etc.), quantifies visitor awareness and perceptions of the destination, identifies primary competitors, and elucidates visitor decision-making processes. As visitor expectations continuously evolve, robust market research equips DMOs with the requisite insights to strategically position their destination and sustain competitive advantage. (Act No. 91/2010; Gowreesunkar et al. 2018).

The survey revealed that most DMOs conduct market research through surveys. Almost 86% of respondents use market research to gain a better understanding of their market and visitors. Fourteen percent of respondents do not conduct market research at all. Most respondents who use surveys for better functioning focus on identifying and segmenting destination visitors. None of the respondents in the surveys focus on determining the attitudes of local residents towards tourism development in the destination (Table 1). Neglecting to survey local residents' attitudes towards tourism development is detrimental for DMOs engaged in sustainable destination management, as it risks eroding community support, leading to negative socio-cultural and environmental impacts, and ultimately undermining the long-term viability and authenticity of the destination. This oversight can foster resentment, strain local resources, and result in misguided tourism strategies that prioritize visitor numbers over resident well-being and the destination's overall sustainability. (GSTC, 2025)

Table 1. Types of Market Research in Slovak DMOs

Answer	Number	Expressed in %
on visitors (who, when, where, how, etc. arrive at the destination)	18	86
on visitor satisfaction	2	10
on service providers in the destination	3	14
on determining the attitudes of local residents towards tourism development	0	0
we do not conduct surveys ourselves or through an external company	3	14

Source: Own elaboration, 2025

In cases where DMOs utilise surveys for more efficient functioning and better destination development, less than half of the respondents (44.4%) conduct the surveys themselves, 33.3% of respondents use a third party in the form of companies specialising in survey research, and 22.2% of respondents use universities. The use of universities that focus on tourism can be beneficial for both parties, as university students perform real tasks related to tourism and at the same time ensure the connection between academia and practice. (Petrovič et al., 2025)

A core responsibility within a DMO's planning and development duties is the **f**ormulation and execution of a robust marketing strategy. This strategy serves as the foundational blueprint, articulating a

shared vision for the destination and defining the DMO's overarching mission (Palenčíková, 2018). In 2025, only 44.4% of respondents have a marketing strategy for destination development and the same percentage of respondents are currently preparing a strategy. One respondent does not have a marketing strategy and is not currently preparing one.

Many Slovakian DMOs struggle with insufficient financial resources and chronic understaffing, averaging only two employees per organisation, primarily due to political issues. Consequently, a mere 33% of these DMOs manage to produce this document in-house, while a significant 56% rely on external outsourcing in cooperation with other organisations.

In Slovakia, DMOs primarily focus their legally mandated activities on developing and executing the marketing mix. This encompasses product design and delivery (promotion included), pricing strategies, distribution, and promoting the destination across both domestic and international tourism markets. A crucial initial step for the marketing strategy, which serves as an organisational framework guiding annual marketing efforts, involves identifying all key destination products. A positive finding is that nowadays most of the DMOs have identified their product lines or are currently working on them, and only one respondent has not identified product lines and is also not working on them (Figure 1).

Our survey assessed the marketing orientation of DMOs by examining destination managers' perspectives on various marketing activities. DMO employees were asked to rate the importance and emphasis they placed on specific marketing activities. Among the marketing activities that DMO managers could choose from were, for example, product or pricing policy, selection of distribution channels, promotion, public relations, online marketing, or personal sales. Reflecting the general need for online marketing tools in almost every industry, the results for DMOs were not surprising either. Almost 89% of respondents cited online marketing as the most important marketing activities, followed by promotion (67%) and the same number of responses were recorded for the marketing activities: creation of product policy, public relations and creation of product packaging (33%). Currently, DMO managers do not consider the selection of distribution channels and personal selling to be the most important marketing tools for their work.

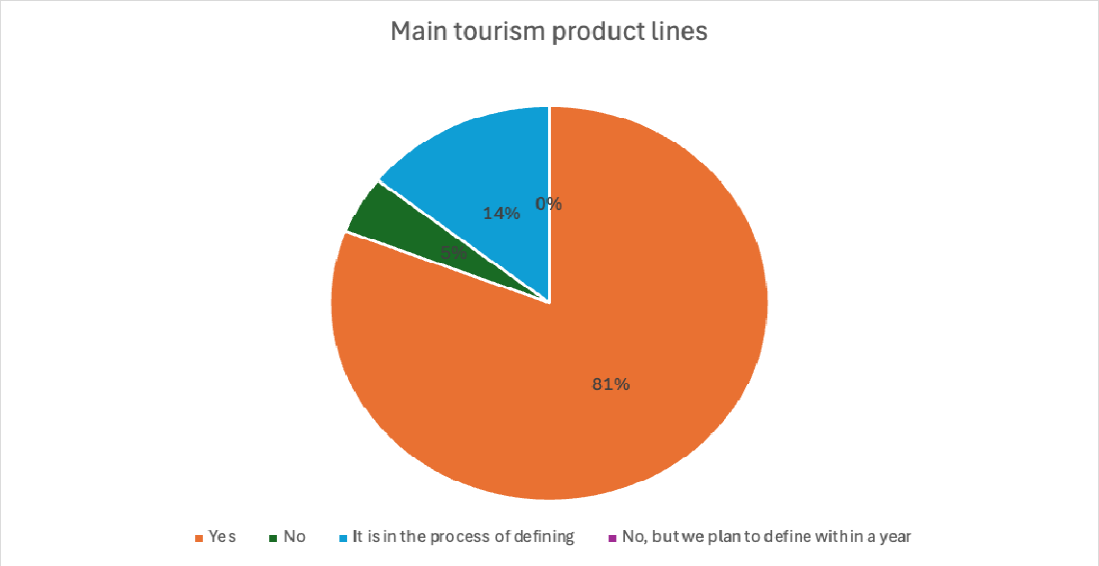

Figure 1. Defining the key tourism products of the destination in the marketing strategy document
Source: own processing (2025)

DMO employees in Slovakia evaluated the effectiveness of various marketing tools on a scale of 1 to 5, where 5 represented maximum efficiency (Figure 2). The findings indicate a clear preference for online strategies, with promotional videos rated as the most effective tool at 4.4, closely followed by the DMO's own website at 4.3, perceived as a critical virtual gateway to the destination. Other highly impactful online instruments included Instagram, scoring 4.1, online announcements and advertising banners at 3.7, and newsletters with a rating of 3.6. Conversely, traditional and less integrated digital tools were deemed least effective; flyers and brochures received a low score of 1.7, common websites shared with other organizations or self-government bodies scored 1.4 and 1.0 respectively, miscellaneous notices were rated 0.9, and the official DMO profile on Pinterest was considered the least effective at 0.8, likely due to its limited penetration among the local Slovakian population.

Following the proven effectiveness of online marketing tools, we were interested in whether DMOs have developed separate online marketing strategies. The results show that 43% of respondents do not have an online marketing strategy, 36% do, and the remaining 21% are working on creating one.

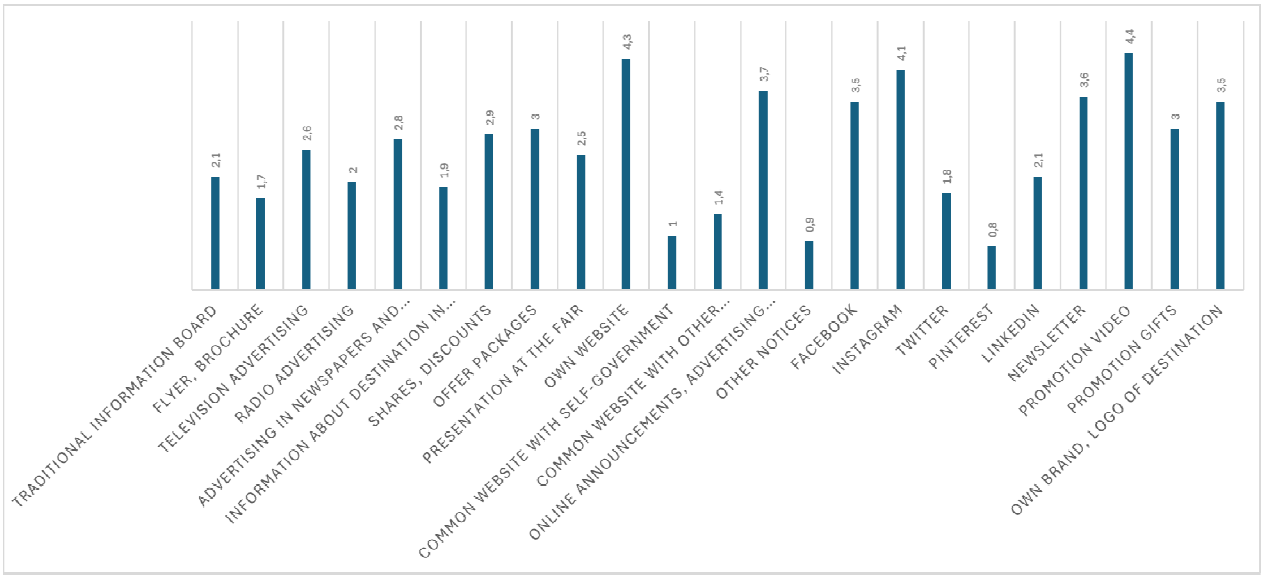

Figure 2. The effectiveness of the marketing tools of tourism organisations in Slovakia
Source: own processing (2025)

Recognising the pronounced reliance on online marketing tools among Slovak DMOs, with their own websites and social media platforms leading adoption, a critical insight emerges when cross-referencing this with reported effectiveness (Figure 3). While promotional videos (4.4) and Instagram (4.1) are highly rated for efficiency, their utilisation rates for content and influencer marketing remain comparatively lower (both at 9 DMOs). This disconnect suggests a potential strategic void: DMOs are clearly aware of the power of visual and engaging online content but may not be fully integrating these insights into comprehensive strategies or leveraging the full spectrum of available digital tools. Compounding this, a significant proportion of DMOs either lack a formal online marketing strategy (43%) or are still developing one (21%). This strategic deficit, likely exacerbated by limited financial resources and chronic understaffing, points to an opportunity for professional development and targeted support. Bridging this gap between perceived tool effectiveness and the formalisation of online marketing strategies could significantly enhance their capacity to convert digital presence into tangible tourism growth and ensure more sustainable destination development.

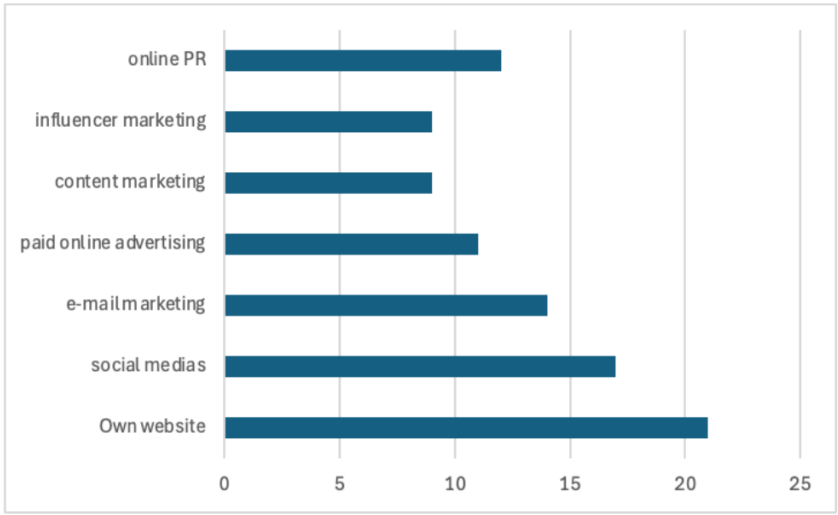

Figure 3. The Use of Online Marketing Tools in Slovak DMOs.
Source: own processing (2025)

4. Discussion

The results of the case study show a significant shift in the approach of the DMOs to marketing activities since the last research by Palenčíková and Mazúchová (2019). While in 2018, only 37% of organisations had a marketing strategy, by 2025, this share had already reached 44.4%, with the same number of organisations stating that they were currently working on a strategic document. This trend confirms the growing awareness of DMOs of the need for a more systematic and strategic approach to marketing.

The answer to the first research question, which focused on the status and form of marketing strategies in DMOs, indicates the continued dominance of outsourcing. The share of DMOs that prepare their strategy internally has increased only slightly (from 26% to 33%), with 56% still using external entities. This phenomenon is a consequence of the low capacity of organisations—the average number of employees per DMO remains at two, similar to the previous study.

In the second research task, which analysed the practical application of the marketing mix, we noted a high preference for online tools, with promotional videos (4.4), their website (4.3), and Instagram (4.1) among the most effective. These findings confirm a change from 2018, when traditional offline promotion was dominant (4.5). Importantly, however, despite the high effectiveness of online tools, up to 43% of DMOs do not have a separate online marketing strategy, and only 36% have already developed one.

The third research question, which examined the method of conducting marketing surveys, revealed a slight improvement: 44.4% of respondents conduct surveys independently. In comparison, one-third collaborate with research companies and 22.2% use universities. Compared to 2019, when as many as 63% of DMOs conducted surveys exclusively in-house, this is a positive shift towards a more professional approach.

A comparison with the previous study thus reveals several continuities, as well as progress. In both studies, the marketing mix and online marketing dominate as key tools. In 2019, however, DMOs rated their website as the most effective tool (4.1), whereas in 2025, more dynamic visual forms, such as videos (4.4) and Instagram (4.1), were preferred. In terms of the importance of marketing activities, promotion continues to be perceived as the most dominant by the public (2025: 67%, 2019: 4.5 out of 5), but at the same time, the importance of strategic planning and online tools is also growing.

In terms of future implications, DMOs should:

- Intensify cooperation with the academic sector for research and evaluation of the impact of tourism (e.g. through university partnerships),
- Strengthen strategic management by creating separate strategies for online marketing.
- Systematically improve the qualifications of their employees in the field of digital marketing.

Based on these findings, we can conclude that Slovak DMOs have undergone significant development in the area of marketing thinking over the past six years; however, their activities remain limited in terms of capacity, finances, and personnel. This situation is also confirmed by a profile survey of managers in Slovak DMOs, which identified that these employees often combine several functions and rarely have professional training in digital marketing or strategic planning, with managerial skills acquired "on the job" rather than through systematic education being dominant (Bíziková & Žitný, 2025). Without addressing these challenges, their ability to achieve competitiveness and sustainable growth will be significantly limited.

Conclusion

The primary aim of this study was to examine the current state and application of marketing tools and strategies within Destination Management Organisations (DMOs) in Slovakia, with an emphasis on strategic planning, market research, and the implementation of both general and online marketing practices. Using a structured questionnaire distributed among regional and local DMOs, we captured empirical insights that allow for a critical reflection on the progress made since 2019 and offer guidance for future development.

The research addressed three fundamental questions: (1) the existence and nature of marketing strategies within DMOs, (2) the practical application of marketing activities and tools, and (3) the implementation of market research. The findings indicate gradual progress in all areas. A larger share of DMOs now either possess or are developing formal marketing strategies (44.4%), and there is a marked transition towards online marketing practices, with tools such as promotional videos and social media platforms like Instagram being rated the most effective. However, the absence of dedicated online

marketing strategies in 43% of the organisations highlights a significant gap between perceived tool efficacy and formalised strategic planning.

A novel contribution of this study is the identification of a structural disconnect between the growing strategic awareness among DMOs and their actual operational capacity. The continued reliance on outsourcing (56%) for strategy creation, combined with staffing limitations — an average of only two employees per DMO — reflects institutional vulnerabilities. These findings align with recent analyses of managerial profiles in Slovak DMOs, which reveal a lack of formal training in strategic and digital marketing, thereby further compounding the challenges of in-house strategy development (Bíziková & Žitný, 2025).

From a broader perspective, this study demonstrates that Slovak DMOs are on a trajectory of digital transition; however, they lack the systemic support, resources, and strategic coherence necessary to leverage their digital marketing potential fully. The reliance on visual online media is promising but underutilised in a strategic context.

Several limitations must be acknowledged. Firstly, the response rate (45%) restricts the generalisability of the results, though the sample remains representative across Slovakia's regions. Secondly, the study does not evaluate the effectiveness of individual strategies in terms of tourism outcomes (e.g., visitor numbers, satisfaction, or economic impact), which would require longitudinal or mixed-method designs.

Future research should focus on three main areas: (1) evaluating the effectiveness of marketing strategies concerning tourism performance metrics, (2) exploring the role of resident perceptions in shaping strategic priorities for sustainable tourism, and (3) identifying scalable models for capacity building within DMOs, particularly in digital competencies and strategic planning. In addition, comparative international studies could provide valuable benchmarking data and further contextualise the Slovak experience within broader European destination governance trends.

In conclusion, while Slovak DMOs have demonstrated a gradual shift toward more structured and digitalised marketing practices, their progress remains constrained by structural and resource limitations. Bridging the gap between awareness and action—particularly through professional development, community engagement, and strategic alignment—will be crucial in ensuring the long-term effectiveness and sustainability of destination marketing in Slovakia.

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Efforts to Implement Environmental Principles in Tourism Enterprises in Slovakia

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Abstract

Research background: Environmental principles in tourism enterprises are a core component of sustainable development. Their adoption is influenced by legislative incentives, financial support, and consumer demand. Countries with long-term state sponsorship of ecological innovations tend to achieve higher levels of environmental policy implementation. Understanding these factors is crucial for designing effective policies and business strategies that ensure sustainability in tourism.
Purpose of the article: This study analyzes the adoption of environmental principles in Slovak tourism enterprises and examines key determinants influencing their implementation. It investigates whether legislative incentives and subsidies encourage businesses to adopt sustainable practices and assesses how rising consumer demand for green services shapes business strategies.
Methods: The research employed a mixed-method approach on a sample of 178 tourism enterprises, incorporating questionnaire surveys, statistical tests, and qualitative interviews. Pearson's correlation test was used to examine the relationship between legislative support and environmental strategy adoption. Comparative analysis with international studies provided insights into Slovakia's position relative to countries with stronger ecological policies.
Findings & Value added: The results confirm that legislative support and financial subsidies significantly impact sustainability decisions, with 55% of businesses utilizing available funding. Additionally, 74% reported increased consumer demand for eco-friendly services, which influenced their strategic planning. Pearson's correlation test ($r = 0.74$) revealed a strong positive relationship between legislative incentives and environmental actions. The study highlights the need for stronger policy frameworks to further enhance sustainability in Slovakia's tourism sector.

Keywords: Consumer behavior, Ecological innovations, Environmental sustainability, Legislative incentives, Tourism

JEL classification: O31, Q56, L83

1. Introduction

Sustainability has become one of the key priorities in the tourism sector, as businesses face growing pressure to adopt environmentally responsible practices. Governments, international organizations, and consumers are increasingly emphasizing the need for ecological sustainability, which has led to the development of various policy instruments and incentive programs. However, the actual implementation of environmental strategies varies across countries and industries, depending on regulatory frameworks, financial support mechanisms, and business motivations.

This study aims to analyze the adoption of environmental principles in tourism enterprises in Slovakia, with a particular focus on the role of legislative incentives, financial subsidies, and consumer demand. While prior research suggests that economic and regulatory incentives can drive sustainability (Mihalič, 2020; Gössling & Higham, 2022), their effectiveness in the Slovak tourism sector remains underexplored. Theoretical foundations for this research are based on environmental sustainability models, legislative frameworks in the European context, and consumer behavior trends, which are discussed in the following section.

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1.1 Environmental Sustainability in Tourism

Sustainability in tourism involves balancing economic growth, environmental protection, and social responsibility (Mowforth & Munt, 2016). It has become a key concern in the face of climate change and increasing demand for eco-friendly practices (Hall et al., 2015). Buckley (2012) defines environmental sustainability in tourism as the conservation of natural resources, waste reduction, and minimizing the carbon footprint of tourism activities.

Several theoretical models describe sustainable tourism development. Ecotourism (Weaver, 2018) focuses on environmentally responsible travel to natural attractions, aiming to protect the environment while benefiting local communities. Regenerative tourism (Dredge & Jamal, 2021) goes beyond sustainability by not only minimizing negative impacts but actively restoring ecosystems. Other approaches include slow tourism (Dickinson & Lumsdon, 2010), which promotes low-impact travel, and carbon-neutral tourism (Scott, Gössling & Hall, 2016), which seeks to offset emissions through environmental initiatives.

Mihalič (2020) emphasizes that implementing environmental policies effectively requires governmental support and investment in eco-innovation. In Slovakia, environmental policies in tourism are primarily driven by legislative provisions and funding programs, often supported by European Union initiatives (Sharpley, 2021). However, the application of these incentives varies, with some businesses perceiving administrative barriers and financial costs as obstacles (Gössling & Higham, 2022).

1.2 Legislative Instruments and Economic Incentives

Government policies play a crucial role in promoting sustainability in tourism enterprises. Legislative instruments, such as environmental regulations, certification programs, and tax incentives, can drive businesses to adopt greener practices (Bramwell, 2013). The European Green Deal (European Commission, 2023) represents a significant policy initiative aimed at transitioning industries, including tourism, toward a low-carbon economy.

Mihalič (2020) argues that countries with robust ecological policies demonstrate higher sustainability in tourism. Scandinavian countries, for example, enforce stricter environmental regulations compared to Southern European nations, leading to greater business involvement in green initiatives. In contrast, Slovakia faces challenges in effectively utilizing European funds to support ecological innovations in tourism (Sharpley, 2021).

Economic incentives such as subsidies, grants, and tax relief programs encourage businesses to implement sustainable measures. Mihalič and Peeters (2022) observe that direct financial rewards are among the strongest motivators for entrepreneurs to adopt eco-friendly solutions. Comparative studies highlight that Austria and Slovenia offer more accessible funding programs, which contribute to a higher adoption rate of environmental strategies in tourism enterprises (Schmidt & Weigert, 2023).

1.3 Consumer Behavior and Demand for Ecological Products

Consumer demand is a major factor influencing business decisions regarding environmental sustainability. Research by Kotler and Keller (2021) confirms that tourists are increasingly seeking eco-certified products and services. According to Poon (2023), destinations that actively demonstrate their commitment to sustainability gain a competitive market advantage.

Gössling and Higham (2022) report that consumer environmental awareness has grown significantly due to education and promotional campaigns. Their study found that 72% of respondents in Western Europe consider corporate environmental responsibility an important factor when choosing a travel destination. Additionally, recent surveys indicate that 68% of European travelers are willing to pay a premium for sustainable accommodations (Smith et al., 2024). In Asia, demand for eco-friendly hotels is rising, particularly in regions affected by high air pollution levels (Chan et al., 2023).

This shift in consumer preferences suggests that tourism businesses integrating sustainability into their operations can benefit not only from legislative incentives but also from increased customer loyalty and market differentiation. Understanding consumer behavior in this context is essential for businesses aiming to align their strategies with sustainability trends.

The theoretical background of environmental sustainability in tourism highlights three key drivers of sustainable practices: governmental regulations, economic incentives, and consumer behavior. While legislative frameworks and financial support mechanisms play a crucial role, consumer awareness and demand for eco-friendly services are becoming increasingly influential in shaping business strategies.

Previous research suggests that countries with well-structured financial incentives and clear regulatory policies tend to achieve better environmental outcomes in tourism (Schmidt & Weigert, 2023). Slovakia, despite having access to European funding mechanisms, has not yet reached the adoption rates observed in more environmentally proactive nations like Austria and Germany.

This study builds upon these theoretical foundations by examining how Slovak tourism enterprises respond to legislative incentives and evolving consumer preferences. The following sections will present the research methodology, findings, and a comparative discussion of these factors in an international context.

2. Methods

Ecotourism remains at the center of increasing academic and political discussion regarding environmental sustainability in tourism. Adoption of ecological strategies in tourism business may be significantly influenced by effective legislative frameworks, economic incentives, and changes in consumer attitudes as various studies hypothesize. Studies throughout this area continue to be crucial not just for environmental ends but also in ensuring the competitiveness and viability of the sector in the future. In order to test the hypothesis in an empirical way, the experimental approach was adopted. Research included data collection using structured questionnaires, in-depth interviews, and statistical testing. The research presented in this work discussed the effect of legislative stimuli and consumer demand on the take-up of environmental initiatives by tourism enterprises. The experimental system entailed several significant factors. Independent variables were government incentives, e.g., subsidies and tax reliefs, and consumer demand for green tourism services. The dependent variable was the intensity of environmental practices followed by firms, and it was measured by a Likert scale survey. Control variables were company size, geographic location, and the type of tourism service provided. A mixed-method design was applied, with quantitative analysis of survey data complemented by qualitative data gained from interviews of business managers. The primary objective was to determine whether enterprises that are offered financial and legislative incentives would be inclined to embrace sustainable practices more than enterprises without such incentives. To analyze relationships between variables and test statistical significance, Pearson correlation and regression analysis were employed.

To guide the research, the following questions were formulated, directly related to the tested hypotheses:

RQ1 *How do legislative incentives influence the adoption of environmental measures in tourism enterprises?*

R2 *What role does consumer demand for sustainable tourism play in shaping business strategies?*

These research questions align closely with the formulated hypotheses, ensuring consistency between the theoretical framework and empirical research. Answering these questions provides a comprehensive understanding of the factors influencing environmental sustainability in Slovak tourism enterprises and offers valuable policy recommendations to enhance the effectiveness of legislative incentives and business adaptation strategies.

Based on previous research in environmental economics and sustainable tourism, we formulated the following hypotheses:

H1: *The implementation of environmental principles in tourism enterprises in Slovakia is influenced by legislative incentives and financial subsidies.*

H2: *Consumers in Slovakia are showing an increasing interest in environmentally responsible products, which influences the strategies of tourism enterprises.*

The research was conducted on a sample of 178 tourism enterprises in Slovakia, including hotels, restaurants, and travel agencies. The selection of businesses was carried out using a stratified sampling method to ensure the representativeness of individual sectors:

- Hotels and guesthouses (42% of the sample)
- Restaurants (33% of the sample)
- Travel agencies (25% of the sample)

Data were collected through an online questionnaire survey and in-depth semi-structured interviews conducted from February to April 2025. The questionnaire consisted of 20 questions, asking respondents about:

- The degree of implementation of environmental measures (e.g., recycling, energy efficiency, emission reductions)
- Utilization of legislative incentives (subsidies, tax relief, environmental certifications)
- Perceptions of consumer demand for ecological products
- Barriers and obstacles to implementing ecological innovations

Respondents' answers were recorded using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), enabling quantification of the perceived benefits and obstacles of sustainable strategies.

Data were analyzed using SPSS 29 and Excel 2024. Statistical methods included descriptive statistics, Pearson correlation, regression analysis, and Friedman's test with semantic differential to compare business segments.

3. Results

The following section presents an analysis of environmental practices among enterprises based on the conducted survey. It provides insights into the proportion of enterprises implementing environmental measures, their usage and effectiveness ratings of legislative incentives, as well as their perception of consumer demand and importance of ecological products. The findings are contextualized by comparing them with results from recent international studies.

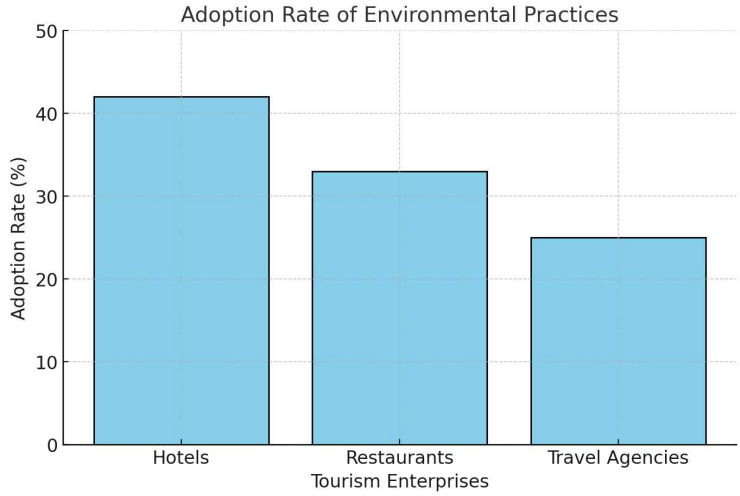

Figure 1. Adoption Rate of Environmental Practices
Source: own processing (2025)

Figure 1 illustrates the distribution of environmental practice adoption among Slovak tourism enterprises. The highest adoption rate is observed in the hotel sector (42%), followed by restaurants (33%) and travel agencies (25%). These figures suggest that accommodation providers are at the forefront of sustainability efforts, likely due to stronger regulatory pressure and consumer expectations for eco-friendly lodging.

Number of enterprises implementing environmental measures:

$$P_env = (62 / 100) \times 178 = 110\, enterprises$$

Out of 178 surveyed enterprises, 110 (62%) reported implementing at least some form of environmental measures.

Number of enterprises utilizing legislative incentives:

$$P_stim = (55 / 100) \times 178 = 97\, enterprises$$

This means that 97 enterprises actively use subsidies or other legislative tools to support ecological initiatives.

Average rating of the effectiveness of legislative incentives (scale 1-5):

$$X = (\Sigma X_i) / N = 3.55$$

On a 1–5 Likert scale, respondents rated the effectiveness of legislative incentives at 3.55, suggesting a moderate level of satisfaction but also room for improvement.

Number of enterprises perceiving demand for ecological products:

$$P_demand = (74 / 100) \times 178 = 131\ enterprises$$

131 enterprises reported increased customer interest in ecological products. A Pearson correlation of 0.68 between consumer demand and business strategies confirms that companies actively adjust their sustainability efforts based on customer preferences. The statistical significance of this correlation was also confirmed ($p < 0.05$).

Average rating of the importance of ecological products:

$$X_eco = 4.3$$

The result shows that environmental products are perceived as highly important by consumers. Pearson correlation coefficient between legislative incentives and implementation of measures:

$$r = 0.74$$

A value of 0.74 indicates a strong positive correlation between legislative incentives and the adoption of ecological measures by enterprises. This suggests that companies with access to subsidies are more likely to implement environmental strategies. The statistical significance of this correlation was tested using a t-test, confirming that the relationship is highly significant ($p < 0.05$). This means that the probability of this correlation occurring by chance is extremely low.

Figure 2 presents Pearson's correlation results, highlighting a strong relationship between legislative support and sustainability adoption ($r = 0.74$). This confirms that financial subsidies and government incentives significantly influence business decisions regarding environmental practices. Additionally, the positive correlation ($r = 0.68$) between consumer demand and business strategies suggests that increasing preference for eco-friendly services is prompting companies to integrate sustainable solutions into their operations.

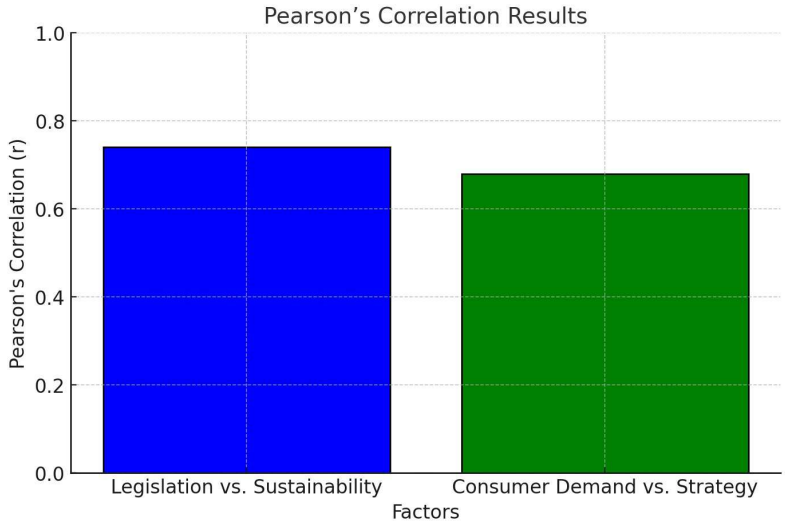

Figure 2. Pearson's correlation results
Source: own processing (2025)

Table 1. Results of hypothesis testing regarding the impact of legislative incentives and consumer demand on the implementation of environmental measures

Pair of variables	p-value	Pearson correlation coefficient	Relationship between variables	Effect size according to Cohen (1988)
Legislative incentives and implementation of measures	0.0003 < 0.05	0.74	exists	strong
Consumer demand and business strategies	0.0012 < 0.05	0.68	exists	strong

Source: own processing (2025)

This research verified the validity of two hypotheses, formulated as follows:

H1 was confirmed: *The implementation of environmental principles in tourism enterprises in Slovakia is influenced by legislative incentives and financial subsidies, demonstrated by 55% of enterprises utilizing these incentives. A strong positive correlation (0.74) between subsidy availability and the adoption of environmental measures supports this finding.*

H2 was confirmed: *Consumers in Slovakia show growing interest in environmentally responsible products, demonstrated by the fact that 74% of enterprises reported increased consumer demand for ecological products. This trend significantly influences the strategies of Slovak enterprises.*

Statistical analysis confirmed a strong positive correlation between legislative incentives and the adoption of environmental measures ($r = 0.74$, $p = 0.0003$) and between consumer demand and business strategies ($r = 0.68$, $p = 0.0012$). These p-values indicate a very low probability that the observed relationships occurred by chance. Both correlations were statistically significant, with p-values of 0.0003 and 0.0012, respectively, indicating a very low probability that these results occurred by chance.

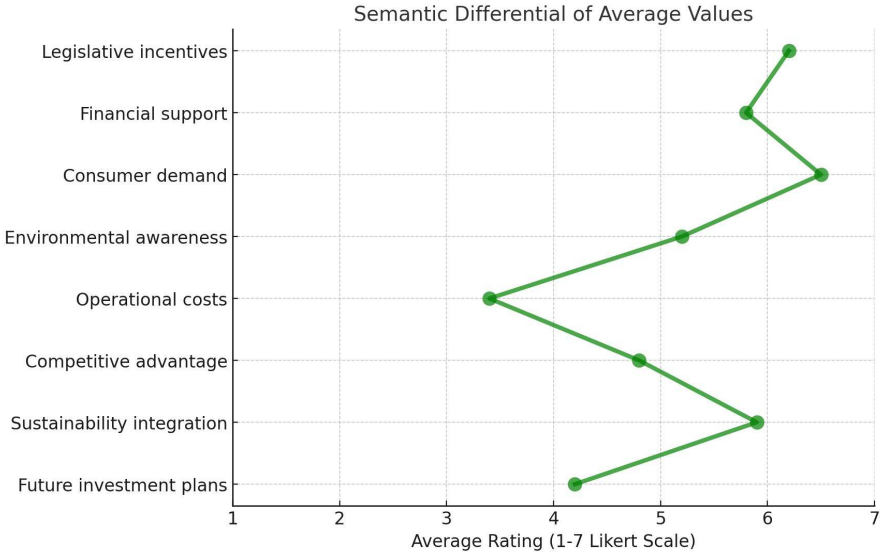

Figure 3. Evaluation of key environmental factors in tourism enterprises
Source: own processing (2025)

The chart presents the average ratings of key factors evaluated by enterprises on a Likert scale (1–7), with axes adjusted for clarity. The highest-rated factors are "Consumer demand" (6.5) and "Legislative incentives" (6.2), indicating that enterprises perceive legislative incentives and increasing consumer demand as crucial drivers of environmental strategies. Additionally, "Operational costs" (3.4) and "Future investment plans" (4.2) received lower average ratings, suggesting enterprises still do not fully prioritize ecological innovations in their business planning.

These findings highlight the crucial role of both policy and market-driven factors in shaping sustainability adoption. The next section compares these results with international trends and explores potential policy recommendations for Slovakia.

4. Discussion

The findings of this study confirm that both legislative incentives and consumer demand significantly influence the adoption of environmental strategies in Slovak tourism enterprises. Businesses benefiting from financial support mechanisms are more likely to implement sustainability measures, while increasing consumer interest in eco-friendly services is driving strategic adjustments in the sector. However, despite the availability of funding, administrative complexity and limited awareness remain significant barriers to broader adoption.

The strong positive correlation between legislative support and environmental strategy adoption indicates that government incentives play a crucial role in shaping sustainable business practices. Similarly, the relationship between consumer demand and sustainability strategies confirms that enterprises are adapting to evolving market expectations. These findings align with the Porter Hypothesis (Porter & van der Linde, 1995), which argues that well-designed environmental regulations can stimulate innovation and enhance business competitiveness.

Despite these positive trends, Slovakia still lags behind Western European countries in terms of sustainability adoption. Countries such as Germany (75%) and Sweden (80%) demonstrate higher implementation rates of environmental measures, largely due to structured financial support, tax reliefs, and mandatory sustainability requirements (Schmidt & Weigert, 2023). In Austria and Slovenia, where 67% and 70% of enterprises benefit from sustainability incentives, simplified grant application processes and better financial accessibility contribute to higher participation rates (Mihalič, 2023). These findings suggest that Slovakia's administrative barriers and lack of streamlined financial mechanisms hinder businesses from fully utilizing available sustainability programs.

Figure 4 provides a comparative analysis of incentive utilization for environmental innovations in Slovakia, Austria, and Germany. While Slovakia reports a moderate 55% incentive usage rate, Austria (75%) and Germany (80%) show significantly higher adoption levels. This suggests that stronger governmental support in Western European countries leads to a more widespread implementation of sustainability practices, underlining the need for enhanced policy frameworks in Slovakia.

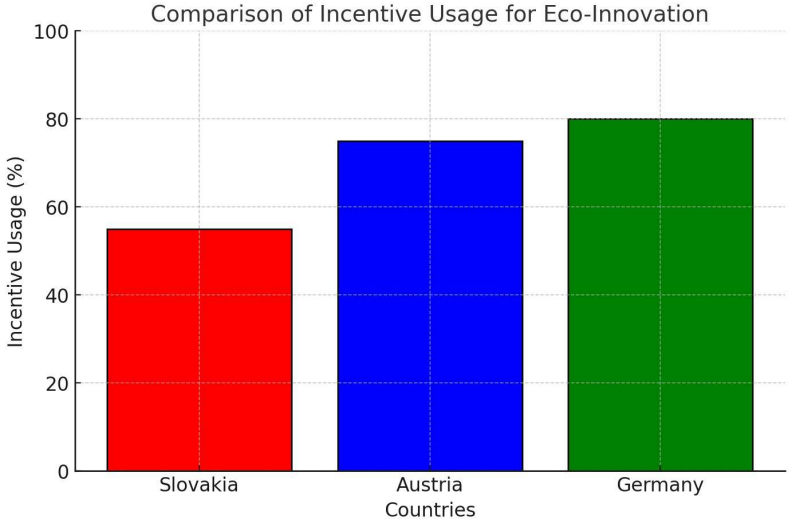

Figure 4. Comparative analysis of incentive utilization for environmental innovations in Slovakia, Austria, and Germany
Source: own processing (2025)

Consumer behavior also plays a key role in shaping sustainable business strategies. Research by Kotler & Keller (2021) found that in Western Europe, 80% of tourists are willing to pay a premium for eco-certified services, making sustainability a competitive advantage in those markets. In contrast, price sensitivity remains a challenge in Slovakia, where businesses acknowledge growing consumer interest in sustainability but struggle to leverage it as a market differentiator. Gössling & Higham (2022) emphasize that education and promotional campaigns significantly influence consumer awareness of sustainability,

suggesting that Slovak tourism enterprises could benefit from stronger marketing efforts to highlight their eco-friendly initiatives.

The results of this study indicate several policy and business implications. From a regulatory perspective, simplifying the process for accessing financial support could encourage greater participation in sustainability initiatives. Mihalič & Peeters (2022) emphasize that economic rewards such as taxation relief and grants are strong motivators for businesses to implement sustainable strategies, yet many Slovak enterprises remain unaware of these opportunities. In addition, Sharpley (2021) highlights that simplifying subsidy application processes could enhance participation rates, particularly among small and medium-sized tourism businesses. Introducing mandatory environmental certifications could further strengthen sustainability adoption, as observed in Austria and Germany.

For businesses, increasing awareness about available funding opportunities is essential. Many tourism enterprises remain unaware of sustainability support programs, limiting their ability to implement green practices. Mihalič (2020) stresses that proactive engagement from policymakers is necessary to ensure that financial incentives reach their intended beneficiaries. Additionally, leveraging consumer demand through stronger eco-marketing strategies could help businesses differentiate themselves in a competitive market. Strengthening public-private partnerships could also play a key role in sharing best practices and improving sustainability implementation across the tourism industry.

While this study provides valuable insights, some limitations should be acknowledged. The sample size, while representative, does not fully capture the diversity of the Slovak tourism sector. Future research should expand the dataset and include a more detailed segmentation of enterprises. Additionally, this study focused on short-term impacts of legislative incentives; a longitudinal analysis would provide deeper insights into their effectiveness over time. Another limitation is the lack of direct measurement of consumer willingness to pay for sustainable tourism services—future studies could explore this factor to determine the true market potential for eco-tourism in Slovakia.

Despite these limitations, this study contributes to the ongoing discourse on sustainable tourism by identifying key factors influencing environmental strategy adoption in Slovak enterprises. Compared to leading European markets, Slovakia faces challenges in policy efficiency and consumer engagement, but targeted improvements in financial accessibility, regulatory frameworks, and consumer education could significantly enhance sustainability adoption in the sector. By implementing better financial incentives, strengthening sustainability regulations, and increasing consumer awareness, Slovakia has the potential to establish itself as a competitive and responsible player in the global sustainable tourism market.

Conclusion

This study examined the adoption of environmental principles in Slovak tourism enterprises, focusing on the influence of legislative incentives and consumer demand. The findings confirm that both regulatory frameworks and market forces significantly impact sustainability adoption. Businesses with access to financial support are more likely to implement environmental strategies, while increasing consumer demand for eco-friendly services is driving further sustainability initiatives. However, administrative complexity and limited awareness continue to hinder the full potential of available sustainability programs.

In comparison with Western European countries, Slovakia still faces challenges in policy efficiency and business engagement in sustainability. While financial incentives exist, their accessibility remains lower than in countries such as Germany, Austria, and Slovenia, where simplified funding mechanisms and mandatory sustainability certifications encourage broader adoption. Additionally, while consumer demand for sustainable tourism is rising in Slovakia, it has yet to reach the levels observed in Western European markets, where eco-certified services are a recognized competitive advantage.

Based on these findings, several key recommendations emerge. First, simplifying the administrative process for obtaining financial support could encourage more businesses to participate in sustainability initiatives. Second, expanding financial incentives such as tax reliefs and targeted subsidies could enhance sustainability adoption, particularly among small and medium-sized enterprises. Third, raising awareness among businesses about available incentives and best practices through targeted outreach campaigns is essential. Lastly, investing in consumer education and stronger eco-marketing strategies could help businesses capitalize on the growing demand for sustainable tourism services.

While this study provides valuable insights, further research is needed to assess the long-term impacts of legislative incentives and to explore consumer willingness to pay for eco-tourism services. A broader dataset and longitudinal analysis could offer a more comprehensive understanding of how sustainability strategies evolve over time.

Slovakia has the opportunity to strengthen its position as a sustainable tourism destination by improving financial accessibility, enhancing regulatory frameworks, and fostering greater collaboration between businesses and policymakers. By addressing existing barriers and embracing new opportunities in policy and consumer education, Slovakia can position itself as a leader in sustainable tourism, balancing economic growth with environmental responsibility.

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Marketing Strategies for the Valorisation of Cultural Heritage in Slovakia

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Abstract

Research background: In recent years, digital technologies have become increasingly influential in how cultural institutions communicate with the public. As traditional methods of promotion are gradually complemented or replaced by online strategies, understanding public perception of digital marketing tools has become essential. Cultural heritage marketing in particular requires sensitivity to audience diversity, as engagement may vary based on demographic factors such as age and gender.
Purpose of the article: The aim of this study is to analyse the impact of selected forms of digital communication and advertising on public perceptions in the context of cultural heritage marketing in Slovakia. The research focuses specifically on identifying whether differences in age and gender influence attitudes toward and engagement with digital promotional strategies used by cultural institutions.
Methods: The research was conducted using an online questionnaire distributed across Slovakia, supplemented by printed versions to ensure inclusion of less digitally active respondents. The final sample included 168 participants. Statistical analysis was carried out using STATISTICA 12 software, applying one-way ANOVA, the Student's t-test, and the Mann–Whitney U test to evaluate differences in perceptions and behaviour across demographic groups.
Findings & Value added: The results show that age and gender significantly influence both perceptions of and interactions with digital marketing tools in the cultural heritage sector. Younger respondents expressed stronger engagement with interactive and technology-based formats, while older individuals preferred simpler or hybrid communication channels. Gender differences were also observed, with women responding more positively to visual online advertising formats such as banners. These findings highlight the importance of audience segmentation and the development of tailored, data-informed digital strategies. By aligning promotional content with specific audience characteristics, cultural institutions can enhance outreach, foster inclusion, and increase public participation in cultural heritage activities.

Keywords: Digital marketing, Cultural heritage, Audience segmentation, Online advertising, Slovakia

JEL classification: M31, Z11

1. Introduction

In today's dynamic digital age, cultural institutions are facing both new challenges and promising opportunities. Traditional forms of promotion—such as printed brochures, posters, or word-of-mouth recommendations—are increasingly being supplemented or replaced by digital strategies that offer broader reach, greater interactivity, and the ability to personalize content. Marketing cultural heritage within this digital context represents a specific field that demands not only cultural expertise but also a sensitive approach to engaging diverse audiences.

In recent years, cultural heritage has become more accessible online, particularly as a result of physical restrictions and anti-epidemic measures that limited traditional venues such as museums, exhibitions, and live events. In response, the European Commission has supported numerous initiatives aimed at making both tangible and intangible cultural heritage more accessible through digital means, including for people with disabilities. Intangible heritage—often referred to as "living heritage"—connects

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the past with the present and continues into the future. It encompasses people, generations, continuity, shared memories, experiences, and living traditions, such as crafts, songs, rituals, and oral storytelling. For this heritage to be sustainable, it must be documented, preserved, widely shared, and continuously practiced in everyday life (Todorova-Ekmekci, 2021; Wang, 2023).

However, public engagement with digital communication tools is not uniform. Age, gender, and digital literacy significantly influence how individuals perceive and interact with digital content. Understanding these differences is essential for designing marketing strategies that not only generate interest in cultural heritage but also foster inclusivity across a wide range of population groups.

Technological advancements play a pivotal role in driving the growth of tourism (Mora et al., 2023). Innovations such as artificial intelligence, virtual reality, and augmented reality have significantly contributed to the emergence and development of virtual tourism (Radicchi, 2013; Lee et al., 2020). Moreover, researchers highlight that the perceived experience and authenticity of online tourist destinations are key factors influencing the expansion and success of virtual tourism.

This article explores public perceptions of digital marketing in the context of cultural heritage in Slovakia, with particular attention to age and gender differences. The findings provide valuable insights that can inform the creation of more inclusive, targeted, and effective digital campaigns within the cultural sector.

1.1 Digital marketing in Cultural Heritage

Digital marketing generally refers to the process of promoting any product or service using the Internet or other electronic media. In this research, the "product" being promoted is cultural heritage, with the aim of bringing it closer to the public. Compared to traditional marketing channels, digital marketing is cost-effective and allows marketers to plan promotional campaigns precisely and manage their budgets in advance (Ibrahim, 2022; Pramuková, Štrba, 2025).

Today, social media plays a central role in both our personal and cultural lives, becoming inseparable from the online world. Its influence has expanded significantly into the heritage sector, emerging as a vital tool for marketing cultural heritage. Especially among younger audiences, social media has driven the branding and growth of many cultural industries, making it essential for cultural institutions to recognize its unique potential (Carignani et al., 2023). As a low-cost, rapidly evolving marketing channel, social media offers exceptional opportunities for outreach and engagement.

For heritage institutions in Slovakia aiming to enhance the valorisation of cultural heritage, adapting to this digital shift is crucial. Traditional marketing strategies must be reconsidered to harness the power of social media, enabling cultural organisations to effectively reach broader and more diverse audiences. Embracing this new era of digital marketing is key to revitalizing cultural heritage promotion and ensuring its relevance in today's fast-changing environment (Ibrahim, 2022; Flaviánet al., 2019; Krogmann et al., 2021).

The digital landscape is governed by a set of emerging regulations and guidelines that shape the practice of e-marketing, including within the field of cultural heritage marketing. Although these rules have been established relatively recently, they have already demonstrated their relevance and effectiveness in this evolving discipline (Smith, 2011; Berkenbosch, Groote & Stoffelen, 2022). However, the success of digital marketing initiatives depends heavily on audience acceptance, as not all users appreciate direct, one-on-one interactions with heritage sites. Such personalized engagement can sometimes lead to challenges, especially when multiple heritage institutions attempt to cultivate exclusive, individualized relationships with their audiences simultaneously.

Furthermore, marketers must be mindful of user experience concerns. Intrusive online elements—such as forced pop-up advertisements, mandatory downloads, or flashing visuals—are generally unwelcome by users and can undermine engagement efforts. Therefore, digital marketing strategies for cultural heritage assets should avoid such practices to ensure positive audience reception and foster sustainable connections with the public.

A digital marketing strategy is needed to increase foreign tourist visits to do heritage tourism virtually. Virtual tourism can use multimedia elements, one of which is virtual reality which can be enjoyed directly through their respective gadgets (Yung, Khoo-Lattimore & Potter, 2021; Mateoniu-Micu, 2024). Global digital transformation has created opportunities for various industries to develop, including improving the travelexperience (Cerquetti & Ferrara, 2018). Virtual tourism can be a means to foster visiting interest for potential international tourists (Putra et al., 2021; Rumangkit & Hadi, 2023; Iswanto, Istiqlal, & Irsyad, 2024).

1.2 Audience Segmentation and Demographic Influences on Digital Marketing in Cultural Heritage

A fundamental element of effective marketing strategies for the valorisation of cultural heritage lies in understanding the diversity of the audience. Engagement with digital marketing tools is far from uniform, as demographic factors such as age and gender significantly influence how different groups perceive and interact with digital content (Beel, Wallace, 2020).

Age plays a pivotal role in shaping preferences and the effectiveness of various digital channels. Younger audiences typically gravitate towards highly interactive, technology-driven formats, including social media platforms, virtual reality experiences, and mobile applications (Evangelou, 2023). Their advanced digital literacy and comfort with emerging technologies enable deeper engagement with immersive content. In contrast, older generations often prefer simpler, more user-friendly formats and may appreciate a blend of traditional and digital communication methods to ensure accessibility and ease of use.

Gender also contributes notably to how audiences respond to digital marketing. Studies suggest that women are generally more receptive to visually rich and emotionally engaging content, such as images, videos, and storytelling approaches. Men, conversely, may be more drawn to content emphasizing informational or functional aspects (Flavián et al., 2019).

By acknowledging these demographic differences, cultural institutions in Slovakia can craft more refined and targeted digital marketing campaigns. Audience segmentation allows for the customization of promotional content, ensuring it aligns with the specific preferences and behaviors of diverse groups. This tailored strategy enhances the overall impact of digital marketing efforts, fostering greater public participation, inclusivity, and ultimately contributing to a more meaningful valorisation of Slovakia's cultural heritage.

Through the application of statistical analysis to understand audience behavior and preferences, cultural marketers are better equipped to optimize their strategies and maximize engagement across varied demographic segments.

2. Methods

The aim of the research was to analyse the impact of selected forms of digital communication and advertising on public perceptions in the context of cultural heritage marketing, while also examining whether different population segments (based on age and gender) exhibit variations in these perceptions.

The research focused on respondents from the general population of the Slovak Republic, with the research sample selected through random sampling. Data collection was conducted via an online questionnaire distributed among respondents across Slovakia. The collected data were processed using the statistical software STATISTICA 12. Given the characteristics of the data, the Mann–Whitney U test was used where appropriate due to non-parametric distributions, while one-way ANOVA and Student's t-test were used for other hypotheses to examine significant differences and relationships among groups.

To address the research objective, the following hypotheses were formulated:

H1: There is a statistically significant relationship between the respondent's age and the perception of digital marketing strategies promoting cultural heritage.

H2: There are statistically significant differences in the frequency of online interaction with cultural institutions based on age.

H3: There is a statistically significant relationship between gender and the likelihood of reacting to visual online advertisements promoting heritage sites.

3. Results

The research sample comprised 168 respondents, selected through a combination of random sampling and practical availability. Data collection was conducted primarily via an electronic questionnaire distributed online; however, a small number of responses were obtained using printed versions to reach individuals with limited digital access. This approach was chosen to promote demographic diversity and ensure the meaningful interpretation of results in the context of public perceptions of marketing strategies related to cultural heritage.

In terms of gender distribution, the sample included 103 women (61.3%) and 65 men (38.7%). Although the proportion of female respondents was notably higher, this disparity is not expected to significantly affect the findings, as the nature of voluntary participation in surveys often leads to greater engagement from certain demographic groups.

Respondents were asked to indicate their age group by selecting from three predefined categories: up to 26 years, 27–45 years, and over 45 years. These categories were designed to reflect distinct life stages. The youngest group, consisting of students and young adults, accounted for 71 respondents (42.3%). The middle group—comprising economically active individuals—represented 72 respondents (42.9%). The oldest category, representing adults over 45, included 25 respondents (14.9%) and was the least represented, likely due to the online format of the survey. Notably, most responses from this age group were obtained via the printed version of the questionnaire.

Educational attainment was also assessed to explore how background knowledge and media literacy might influence perceptions of digital communication and advertising. Respondents selected from five education levels. The largest proportion—81 individuals (48.2%)—had completed secondary education. Additionally, 46 participants (27.4%) reported holding a second-level university degree, while 31 (18.5%) had completed a first-level university degree. A smaller portion—eight respondents (4.8%)—had attained only primary education, and two individuals (1.2%) reported holding a doctoral degree. These results suggest the sample was relatively well-educated, which is advantageous when analysing perceptions of more complex or digitally mediated marketing strategies.

Finally, respondents were asked to indicate whether they reside in a rural or urban environment, with the aim of identifying potential differences in access to and perception of certain marketing forms—such as LED billboards, which are more common in urban areas. Of the 168 participants, 101 (60.1%) lived in rural areas and 67 (39.9%) in urban settings. While an even distribution was sought, the higher rural representation may reflect the relevance of the research topic to local identity and the preservation of regional cultural heritage.

Perception of Online Advertising

Digital platforms have become the dominant channels through which consumers encounter marketing content, including the promotion of cultural heritage. This study aimed to explore how internet users perceive online advertisements related to cultural events, heritage sites, or digital campaigns. Specifically, the research examined whether such advertisements are seen as annoying, useful, or evoke indifference.

The findings reveal a varied set of attitudes. A combined 51.14% of respondents stated that online advertisements “definitely” (20.24%) or “rather” (30.9%) inform and do not bother them. In contrast, 22.02% reported that they “rather” bother them, while 5.36% stated that they “definitely” bother them. Additionally, 15.48% chose the neutral option “I don’t know,” which may reflect ambivalence or limited recall of such advertising.

Overall, the results suggest that while online advertising in the cultural heritage sector has the potential to reach and engage more than half of the audience positively, a significant portion perceives it as bothersome or unmemorable. These insights highlight the importance of ensuring high-quality content, relevance to the target audience, and the use of non-intrusive ad formats when designing digital campaigns in this domain.

Banner Advertisement Click Behavior

A central question for cultural institutions employing digital marketing tools is whether audiences actively engage with promotional content—specifically, clickable banner advertisements. To explore this, respondents were asked whether they had ever clicked on such ads.

The findings show that only 30.36% of participants reported a likelihood to click on banner ads—4.82% selected “definitely yes” and 25.54% “rather yes.” However, the predominant response indicated limited engagement: 41.67% answered “rather no” and 20.83% “definitely no.” An additional 7.14% chose the “I don’t know” option, which may reflect either a lack of awareness or passive interaction with banner content.

These results suggest that banner advertising, when used in isolation, may have limited impact in the context of cultural heritage promotion. To improve audience engagement, cultural institutions might consider complementing or replacing banners with more integrated approaches, such as native advertising, social media content, or collaborations with digital influencers.

Preference for LED vs. Classic Billboards

Visual communication in public spaces continues to serve as a key promotional tool, particularly in the context of local and regional cultural marketing. To assess public preferences between traditional print

billboards and modern digital LED formats, respondents were asked which form they found more appealing.

The results indicate a clear preference for LED billboards: 20.24% of respondents selected “definitely yes” and 36.9% “rather yes,” for a combined 57.14%. This suggests that contemporary audiences—especially younger individuals—tend to be more receptive to dynamic and illuminated media formats. On the other hand, 22.02% expressed mild disapproval (“rather no”) and 5.36% a strong negative opinion (“definitely no”), which may reflect concerns related to light pollution, digital overload, or personal aesthetic preferences. Additionally, 15.48% chose the neutral “I don’t know” response, possibly indicating limited exposure to one or both billboard types.

These findings support the increasing relevance of modern LED formats in cultural advertising, particularly in urban areas where visibility and novelty can enhance message impact and audience engagement. Nonetheless, careful consideration of context, setting, and visual harmony remains essential when implementing such media.

Based on the results obtained in the descriptive phase of the research, we proceeded to test the predefined research hypotheses. The objective was to examine whether demographic factors—namely age and gender—affect individuals’ perceptions of and engagement with digital marketing strategies aimed at promoting cultural heritage. The following section outlines the findings related to hypotheses H1, H2, and H3.

The objective of research **hypothesis H1** was to determine whether there are statistically significant differences in how respondents from different age groups perceive digital marketing strategies related to cultural heritage. As digital formats increasingly shape cultural communication, age may influence individuals' familiarity with and openness to tools such as social media, banners, and interactive platforms. A one-way ANOVA was conducted to compare the mean perception scores across three age categories. The results revealed a statistically significant difference ($p = 0.02497$). Younger respondents (up to 26 years) reported the most favorable attitudes toward digital marketing ($M = 3.60$), followed by the middle-aged group (27–45 years; $M = 3.10$). Respondents over the age of 45 showed the lowest level of agreement with digital marketing strategies ($M = 2.50$). Therefore, research **hypothesis H1 was accepted.**

The objective of research **hypothesis H2** was to investigate whether age influences the frequency of online engagement with cultural institutions. This included activities such as browsing cultural heritage websites, following museums on social media, or subscribing to newsletters. A one-way ANOVA revealed a statistically highly significant difference between age groups ($p = 0.000208$). The youngest respondents (up to 26 years) reported the highest frequency of online interaction ($M = 5.0$), while the oldest group (over 45 years) showed the lowest levels of engagement ($M = 2.0$). These findings confirm substantial variation in digital engagement across age categories. Therefore, research **hypothesis H2 was accepted.**

The objective of research **hypothesis H3** was to examine whether gender influences responsiveness to visual digital advertising—specifically, banner ads promoting cultural events or destinations. To evaluate this, the Mann–Whitney U test was used to compare responses between male and female participants. The analysis revealed a statistically significant difference ($U = 1765.0$, $p = 0.022$). Female respondents rated such advertisements more positively ($Mdn = 3.00$) compared to male respondents ($Mdn = 2.40$), indicating a measurable difference in ad responsiveness by gender. Therefore, research **hypothesis H3 was accepted.**

4. Discussion

The analytical part of the research confirmed that demographic factors—specifically age and gender—play a statistically significant role in shaping how individuals perceive and respond to digital marketing strategies aimed at promoting cultural heritage. Each of the tested hypotheses was supported by the data, providing a solid empirical basis for segment-specific communication recommendations.

Hypothesis H1 focused on age-related differences in the perception of digital marketing strategies related to cultural heritage. The results of the ANOVA test indicated a statistically significant difference between age groups, with younger respondents (up to 26 years) expressing the most favorable views of tools such as social media campaigns, digital banners, and interactive online content. The middle-aged group (27–45 years) reported moderately positive attitudes, while respondents over the age of 45 exhibited noticeably lower levels of agreement. These findings suggest that younger populations are not only more digitally literate but also more receptive to the integration of technology into cultural promotion. Therefore, marketing strategies that leverage dynamic and engaging formats may be more effective among this age segment, whereas traditional communication methods may remain more suitable for older audiences.

Hypothesis H2 further explored age-related dynamics, this time focusing on the frequency of online interaction with cultural institutions. These interactions included actions such as visiting cultural websites, subscribing to digital newsletters, or following institutions on social media platforms. The results showed a highly significant difference between age groups, with younger respondents once again demonstrating the highest engagement levels. This trend confirms that digital engagement in the cultural sector is strongly influenced by age, and supports the need for institutions to diversify their communication channels. While younger users respond well to interactive and social media-based content, older audiences may require simplified access, direct messaging, or even hybrid forms that combine online and offline components.

Hypothesis H3 examined the relationship between gender and responsiveness to visual digital advertisements—namely, banner ads promoting cultural events and sites. The Mann–Whitney U test revealed a statistically significant difference between male and female respondents, with women being more likely to react positively to such advertising. This outcome is consistent with broader marketing findings that suggest women are often more attentive to visual detail and emotionally driven promotional content. It also indicates that gender-specific preferences should be considered when designing digital campaigns in the cultural domain. For instance, more personalized, narrative-driven visual content may resonate better with female audiences, while men may respond to more informative, concise formats.

In summary, the results of the hypothesis testing emphasize the need for cultural institutions and marketers to adopt a nuanced approach to digital communication. Age and gender significantly influence both perception and engagement, and therefore, segmentation should be a core element of any strategic plan. Effective cultural heritage marketing should not adopt a one-size-fits-all approach but rather be built on adaptive, inclusive, and diversified tactics that reflect the diverse needs and behaviors of different demographic groups. These findings provide valuable insights for the design of future campaigns aiming to strengthen public awareness, appreciation, and participation in cultural heritage activities through digital means.

Conclusion

This study aimed to examine how selected forms of digital communication and advertising influence public perceptions within the context of cultural heritage marketing, with particular attention to demographic differences based on age and gender. The results clearly indicate that these demographic factors significantly affect both attitudes toward digital marketing and patterns of user engagement.

The findings underscore the importance of developing more targeted and differentiated communication strategies. Cultural institutions and marketers should move beyond generic messaging and tailor their campaigns to reflect the specific preferences and behaviors of distinct audience segments. For example, younger respondents demonstrated greater receptiveness to digital tools and interactive formats, suggesting a stronger affinity for technology-driven communication. In contrast, older individuals reported lower levels of digital engagement, highlighting the need for more accessible interfaces or hybrid approaches that combine digital and traditional media.

Gender-based differences were also evident, particularly in response to visual advertising. Female respondents evaluated banner advertisements for cultural events and sites more positively, indicating the potential effectiveness of emotionally resonant or narrative-rich content in appealing to this demographic. Overall, the results reveal that digital marketing in the cultural heritage sector cannot follow a one-size-fits-all model. A more nuanced, data-driven approach is essential—one that takes demographic diversity into account and adapts communication strategies accordingly. Such an approach can enhance the effectiveness of outreach efforts and foster broader, more inclusive public engagement with cultural heritage in the digital era.

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Possibilities and Limitations of Innovative Marketing Communication in the Context of Slovak Towns and Municipalities

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Abstract

Research background: Marketing communication plays a key role in enhancing the competitiveness of towns and municipalities and supporting their sustainable development. In the context of increasing pressure on local governments to differentiate themselves and engage residents, the adoption of innovative communication tools is becoming increasingly important.
Purpose of the article: The aim of this article is to present the results of research focused on innovative forms of marketing communication used by Slovak towns and municipalities. The study seeks to explore current practices and assess how these are perceived by local residents.
Methods: The research was conducted using a combination of quantitative and qualitative methods, including a survey of residents and a comparative analysis of communication tools used by selected municipalities. Attention was paid to the frequency and perception of modern communication approaches, including digital platforms and emerging technologies.
Findings & Value added: The analysis revealed significant differences in the use of innovative communication tools depending on the size and geographical location of municipalities. Furthermore, the study highlighted a general underutilisation of digital and interactive platforms and pointed to the need for a more systematic integration of modern tools into local communication strategies. The results serve as a basis for designing a methodological framework for the implementation of innovative communication strategies aimed at improving the effectiveness of local promotion with regard to the eco-environment within regions in Slovakia. The article contributes to the academic discourse on regional marketing innovation and opens avenues for further empirical research in this field with a focus on eco-innovation.

Keywords: Innovative approaches to promotion, Perception of residents, Regional development, Towns and municipalities

JEL classification: R58, O35, M31

1. Introduction

In order to better understand the possibilities and limitations of innovative marketing communication at the local level, it is necessary to first define the broader context in which such communication takes place. This includes the characteristics of individual regions, the specifics of regional marketing communication, and the role of innovation and ecological values in local promotion. The following subchapters provide a theoretical framework for analysing current communication strategies of Slovak towns and municipalities, while also highlighting key trends relevant to the development of modern, sustainable and resident-oriented marketing.

1.1 Region – specification

Regions play an important role in local development because they create space for economic and social interaction, thereby promoting more efficient use of local resources and capacities (Rejman & Fedan, 2019). Their importance also lies in their ability to influence political and economic processes at the national and supra-regional levels (Buček et al., 2011). Regions have different resources and potentials, such as labour, natural resources and infrastructure, which serve as the basis for creating competitive advantages and

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sustainable development (Hanuláková et al., 2004). It follows from the above that regions are complex spatial units inextricably linked to economic and social development. It is therefore essential to pay sufficient attention to their specific characteristics and possibilities when planning development strategies in order to fully exploit their potential. There are a total of 25 regions in Slovakia.

When examining regions, it is necessary to divide them based on specific characteristics. Typologies of regions take into account geographical, demographic and economic factors. For example, Borisová (2020) proposes a classification of regions into urban, rural and transitional. Urban regions are characterised by high population density and intense economic activity, while rural regions are typically characterised by lower population density and dependence on sectors such as agriculture. Transitional regions combine the characteristics of both, which brings specific challenges and opportunities for their development.

Regions play a crucial role in achieving national goals, as they are the space where national priorities meet the demands of local communities. In our view, one of the key strategies for reconciling these interests is decentralisation, which transfers powers and responsibilities from the central level to lower territorial units (Horváthová, 2010). This process enables regions to better respond to the specific needs of the local population and also to support development that takes into account their socio-economic environment.

Regional disparity is generally understood as differences in economic and social development between regions, manifested in unequal living conditions, access to jobs, infrastructure and public services. These differences are the result of various factors, such as geographical location, availability of natural resources, level of education and professional skills of the workforce, as well as the presence of investment and technological innovation (Kollár&Matúšová, 2022). In this context, we would add that these disparities are further exacerbated by historical, economic and political conditions that affect the ability of regions to adapt to change and effectively use their own resources for development. It is therefore essential to accurately identify the causes of regional disparities in order to understand them. Only then is it possible to propose effective solutions that take into account the complex nature of these differences. It is clear that addressing regional disparities requires a multidisciplinary approach that takes into account both economic and social aspects (Kollár & Matúšová, 2022).

Uneven regional development has a direct impact on the ability of regions to present and promote their strengths. More developed regions are better able to use marketing activities to increase their attractiveness, attract investors and promote tourism, while less developed areas face problems related to image and inadequate infrastructure (Harasimová, 2009).

1.2 Specifics of regional marketing communication

Marketing communication specifically focused on regions, cities and municipalities bears the distinct imprint of the social, cultural and economic conditions of the given environment. According to Jobczyk (2018), one of the main goals of regional marketing is to highlight local values, traditions and characteristics that serve to shape a favourable image of the locality. This process, also known as local branding, involves a thorough analysis of the local market and the adaptation of strategies to the specific needs and expectations of target groups (Stepanenko et al., 2022).

One of the key objectives of marketing communication for cities and municipalities is to create a positive image of the region, which plays an important role in attracting tourists, new residents, investors and entrepreneurs (Wróblewski, 2016). Successfully building this image requires consistent and authentic messages that emphasise the unique values of the region, such as cultural traditions, natural beauty and local crafts. Authenticity is an essential pillar of a region's image.

Marketing communication for cities and municipalities should focus on raising awareness of the unique characteristics, products and services that the region offers. This includes promoting cultural and natural attractions, local products and services that give the region a competitive advantage in the market (Mišúnová, 2015). At the same time, it is important to tailor communication messages to diverse target groups so that they are effective in both the domestic and international markets.

Tourism is often considered one of the key tools for promoting regional development. Its strategic management can contribute to economic growth, increased employment and improved infrastructure, which benefits not only visitors but also local residents. This also improves the overall quality of life in the area. Long-term research confirms that investments in tourism can bring broad benefits if they are implemented as part of comprehensive regional development strategies. Effective promotion of cities and municipalities requires diversified marketing strategies that can appeal to different target groups. Local events such as festivals, craft markets or sporting events are a proven tool for promoting interest in the region and creating long-term links between visitors and the place (Praude&Voznuka, 2008). However,

digital platforms that allow authentic stories, experiences and photos to be presented also play an important role today. These tools can not only be cost-effective, but also encourage more intensive involvement of tourists and create space for direct interaction.

1.3 Innovation of marketing activities in regional marketing in an ecological environment

The growing importance of digital technologies has brought new opportunities to regional marketing communications. Social media such as Facebook, Instagram, and TikTok enable regions not only to effectively reach target groups but also to build their loyalty through real-time interactions (Rojíková & Lisková, 2022). Technologies such as virtual reality (VR) and augmented reality (AR) are becoming increasingly popular in presenting cities and their cultural and natural monuments. These technologies offer immersive experiences that allow visitors to interact with cultural artefacts and monuments in an engaging way (Ergen, 2020). AR and VR applications in the field of cultural heritage serve multiple purposes, including protecting cultural values, enriching tourist experiences, increasing visitor numbers and improving promotional activities.

Content personalisation and data-driven marketing are modern approaches that help regions better reach their target groups. These personalised strategies enable regions to increase their attractiveness by tailoring their offerings to the specific needs and expectations of visitors (Raja, 2024). In the context of regional marketing, this is a key tool for increasing tourist satisfaction and effectively highlighting local characteristics.

In the current debate on the development of cities and municipalities, values associated with environmental sustainability and responsible consumer behaviour are increasingly being emphasised. This brings to the fore a group of so-called eco-consumers – individuals who take the impact on the environment into account in their decisions. These residents can be an important target group for the marketing communication of cities and municipalities, especially if it is conducted in an innovative way and emphasises values with which residents can identify (Koszembar-Wiklik, 2022). In addition to providing information about local government activities, such communication can also contribute to promoting an environmentally conscious attitude and greater participation in local events.

2. Methods

The main focus of the study was on Slovak towns and municipalities located in all eight regions of Slovakia, from which our 165 questionnaire survey respondents originate. For the purposes of this paper, we divided the towns and municipalities into small, medium-sized and large according to the following population figures: small towns and municipalities have up to 20,000 inhabitants (most Slovak towns) (SODBTN, 2024); medium-sized towns and municipalities have between 20,001 and 50,000 inhabitants, and large towns have more than 50,000 inhabitants. Our survey covered 67.8% of small towns and municipalities, 17.6% of medium-sized towns and municipalities, and 14.6% of large towns.

When formulating the characteristics of the research problem, we based our findings on the answers to the questions in the questionnaire survey. The three questions described below are the most important questions whose answers can shape the future direction of further research in this area.

- How often do you record information about the marketing activities of your town/village?
- Which of the following marketing activities/tools of your city/municipality are you familiar with?
- Does your city/municipality use any of the following innovative forms of marketing communication?

A total of 165 respondents from Generation Z participated in the questionnaire survey. The questions were focused on obtaining relevant information about the use of marketing tools and innovative forms of marketing and marketing communication by cities and municipalities from which the respondents originate or in which they currently live. The questionnaire was distributed online. The research sample in the pilot survey was the aforementioned Generation Z, i.e. teenagers and young adults aged 14 to 27. There were 165 respondents in total, and as many as 40 of them identified themselves as entrepreneurs, which means that they currently own a brand that necessarily involves marketing activities and that they also try to promote the town or municipality in which they live as part of their brand promotion. In this way, they contribute to increasing the effectiveness of promoting these towns and municipalities. Respondents were selected at random from all regions of Slovakia. We chose Generation Z for the survey mainly because it is currently the most connected to the marketing activities of various entities, as well as to innovations in marketing. This is the first generation to grow up exclusively in the digital age with access to the internet, which is why Gen Z members are sometimes referred to as digital nomads (Barhate & Dirani, 2021).

Our research material consisted of questionnaire responses. Each respondent answered five basic demographic questions and 15 questions concerning:

- awareness of marketing activities in the city or municipality in which they live;
- perception and understanding of marketing strategies and communication in the city or municipality in which they live;
- satisfaction with individual communication channels of the city or municipality in which they live; preferences in the way of obtaining information about the city or municipality in which they live;
- credibility and transparency of information about the city or municipality in which they live.

In the section for entrepreneurs, six research questions were answered concerning the marketing tools that respondents use to promote their business activities as part of increasing the effectiveness of promoting the town or municipality in which they live.

The research units in the pilot survey were individual towns and municipalities throughout Slovakia. The towns and municipalities were divided according to population and region. The most numerous category is towns and municipalities in the Trnava region, with 30 in total.

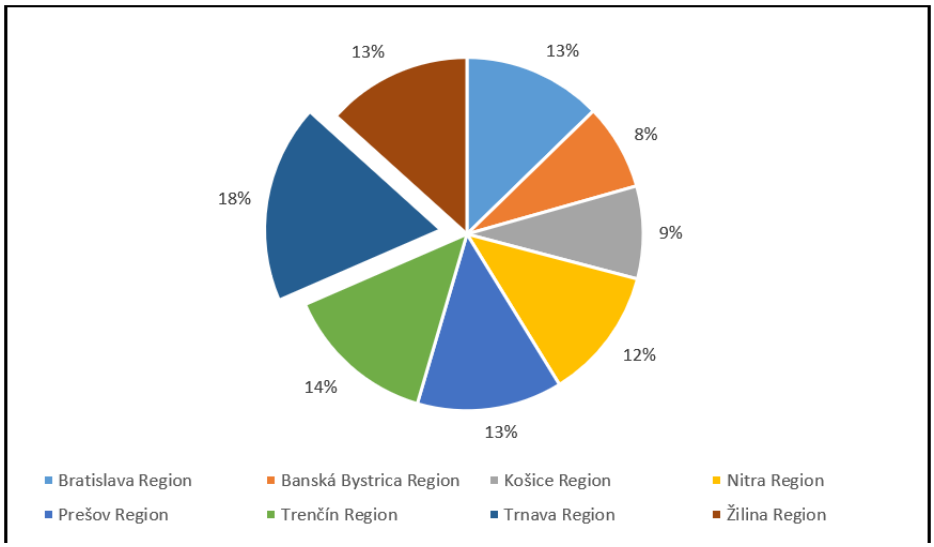

Figure 2. Distribution of towns and municipalities by regions in Slovakia
Source: own processing (2025)

In terms of population, we have three categories with the highest numbers: small towns and villages with 2,000 to 4,999 inhabitants, small towns and villages with 10,000 to 19,999 inhabitants, and medium-sized towns with 20,000 to 49,999 inhabitants. Despite these figures, however, all eight Slovak regions and all size categories according to population are sufficiently represented.

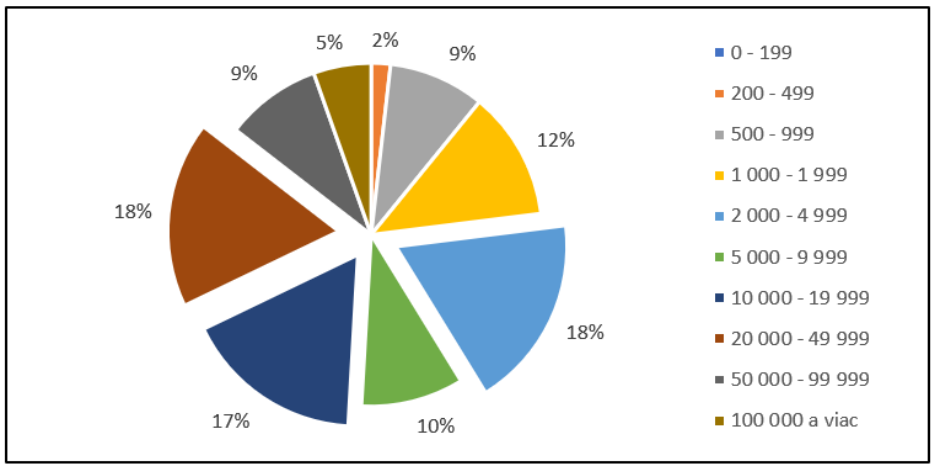

Figure 3. Classification of towns and municipalities by population size
Source: own processing (2025)

Despite the fact that respondents were mainly approached at one institution (St. Cyril and Methodius University in Trnava), and there was therefore a certain risk of similar responses, we managed to obtain respondents from as many as 125 different towns and municipalities throughout Slovakia.

3. Results

As we have already mentioned, when preparing this article, we mainly drew on the answers to three main questions in the questionnaire survey.

In the first question, we asked how often respondents notice information about marketing activities in their city or municipality. The two most common answers were a few times a year (30%) and a few times a month (31%). Upon closer examination, we concluded that the answer 'a few times a year' was chosen mainly by respondents from towns and municipalities with up to 20,000 inhabitants (76%). The answer 'a few times a month' was also chosen mainly by respondents from towns and municipalities with up to 20,000 inhabitants (67%). An interesting, but perhaps alarming, finding was that up to 14% of respondents who record information about the marketing activities of their town or village a few times a month come from large towns or villages, i.e. those with more than 50,000 inhabitants. Therefore, we have an opportunity to focus our attention in our main marketing research and in the creation of a suitable communication model not only on small towns and municipalities, but also on large, more developed ones.

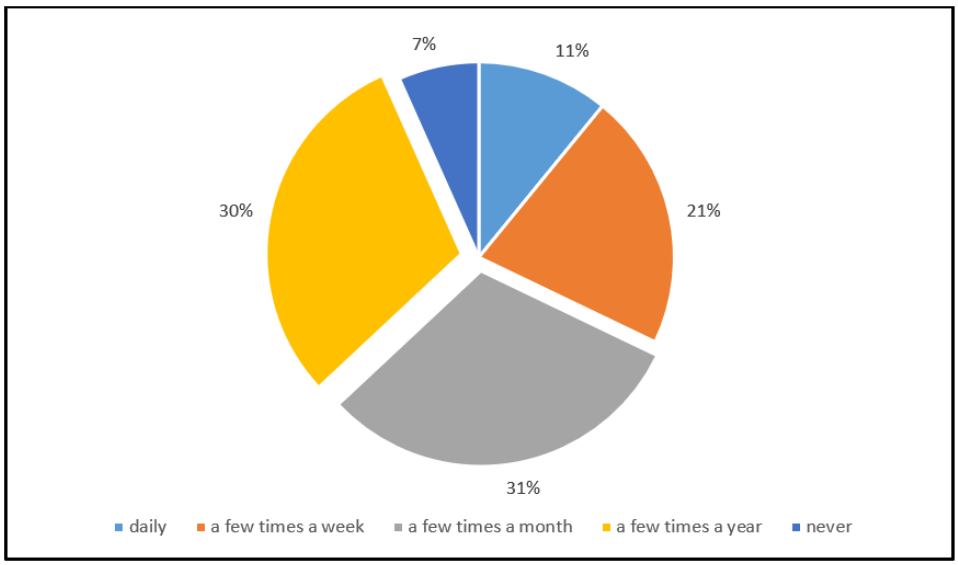

Figure 4. How often do respondents encounter information about the marketing activities of their town or municipality?
Source: own processing (2025)

In the second question, we asked which marketing activities/tools respondents were familiar with in their town/municipality, and we can therefore say with certainty that their town/municipality uses them. As many as 75% clicked on the option 'official website', 68% of respondents clicked on the option 'information boards', 63% of respondents clicked on the option 'cultural events' and the fourth most clicked option was 'social media' (59% of respondents). We can conclude that these are the four most commonly used marketing tools/activities of cities/municipalities. However, the important direction of our work will be determined mainly by question number 4.

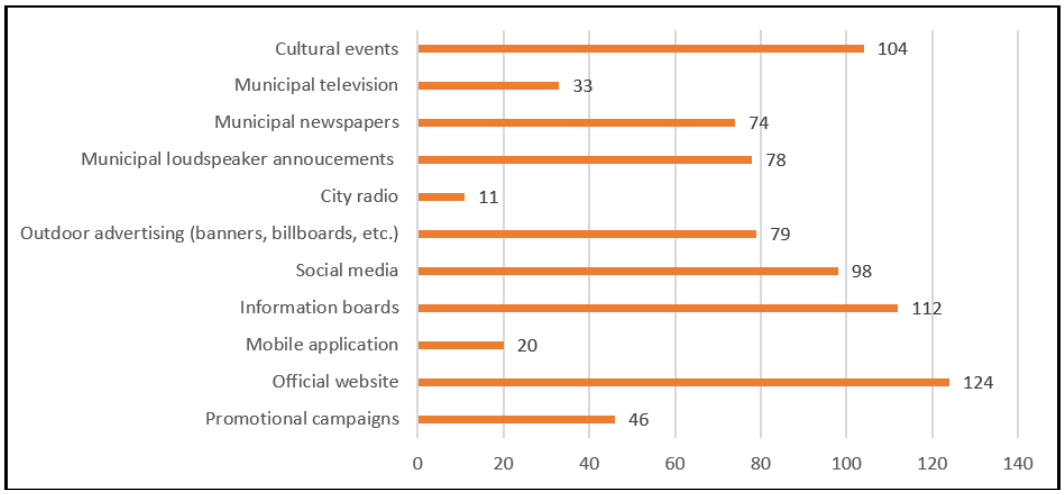

Figure 5. Which of the following marketing activities/tools implemented by their town or municipality are respondents familiar with?
Source: own processing (2025)

In question number 4, we asked whether the respondents' city or municipality uses any of the innovative forms of marketing communication mentioned. The two most common answers were Thematic festivals, with up to 43% of respondents, and Smart City technologies (interactive information boards, free Wi-Fi zones, air quality monitoring sensors, etc.), with 32% of respondents. The answer that creates space for our further research and the creation of specific proposals is None of the above. This option was chosen by 39% of respondents.

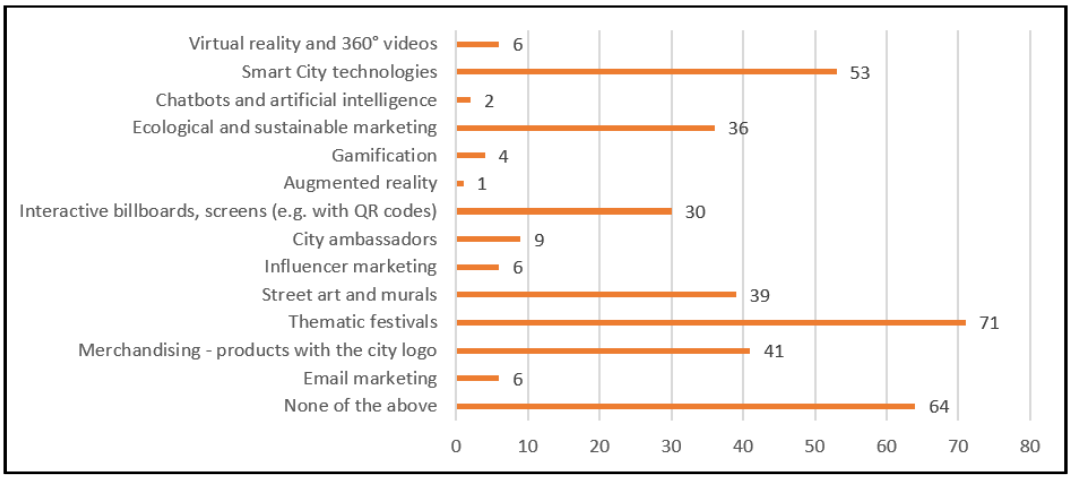

Figure 6. Which of the listed innovative forms of marketing communication are used by the town or municipality where the respondent lives or comes from?
Source: own processing (2025)

The findings point to the continuing dominance of traditional marketing communication tools, with innovative forms remaining rather marginal. Significant differences were noted not only between individual municipalities, but also in the level of awareness among respondents themselves. It appears that the implementation of modern tools is often unsystematic and limited by several factors. These findings form the basis for a discussion on ways to increase the effectiveness and relevance of communication between towns and municipalities and their residents.

4. Discussion

The results of the research show a significant imbalance in the use and knowledge of marketing tools by Slovak cities and municipalities. While traditional forms of communication – such as official websites, notice boards and the organisation of cultural events – still dominate, innovative approaches, including digital interactivity and Smart City technologies, remain rather exceptional. An interesting finding is that a significant proportion of respondents stated that their municipality or town does not use any of the above-

mentioned innovative forms, which points to a relatively significant gap between current communication possibilities and their practical use in the territory.

The data also showed that even larger cities, which should have better capacity and financial resources, do not automatically use innovative forms of communication. This fact calls into question the assumption that development in the field of marketing communication is directly related to the size or economic strength of the local government. Rather, it appears that strategic thinking, awareness of the importance of communication and an active approach by city or municipality leaders play a key role. In many cases, the problem may also be a lack of human resources, weaker professional preparedness or the low priority that the local government attaches to this area.

A specific aspect of this research is the target group of respondents – young people from Generation Z, who are digitally savvy and have natural expectations of modern forms of communication. The fact that they often do not perceive the presence of innovative tools in their community or city points to a potential mismatch between expectations and reality. This may be due to the fact that communication outputs are not sufficiently tailored to the younger generation, which prefers more dynamic, interactive and visually attractive forms of presentation.

At the same time, however, it is young people who represent a promising target group whose loyalty, interest in public affairs and identification with the place can have long-term significance for community development. If local governments are able to reflect the needs of this audience and actively involve them in content creation – for example, through participatory platforms or community campaigns – they can strengthen not only their communication, but also trust and solidarity among residents.

Innovative marketing communication by cities and municipalities should also emphasise environmental issues and communicate them effectively to residents, especially the younger generation. At the same time, it is necessary to develop strategies that encourage residents to actively participate in environmental initiatives, which can strengthen their attachment to the city and promote environmentally conscious behaviour.

The topic of innovation in local government marketing communication thus remains open, and it is clear that it is not just about technical tools, but above all about the ability to use them correctly and connect them with specific target groups. The results point to the need for deeper reflection in this area and the importance of a strategic approach that also includes values such as authenticity, transparency and inclusiveness.

Conclusion

Research has confirmed that marketing communication at the municipal and local level in Slovakia still relies mainly on traditional forms, which are stable and long-established, but often fail to reach all target groups – especially the younger generation. Innovative approaches, such as digital technologies, interactive online tools and Smart City elements, are still used only marginally, even though their potential for effective and dynamic communication is undeniable. The findings also show that openness to new forms of communication does not depend solely on the size or economic strength of the local government, but on the willingness of city and municipal leaders to think innovatively, strategically and long-term. Therefore, the key factor appears to be not only technical readiness, but also the ability to understand the current communication needs of residents and adapt the content and form of city marketing to them. From the perspective of the target group, which consisted of young people from Generation Z, there appears to be significant room for improvement, particularly in terms of visual appeal, interactivity and public involvement in communication processes.

In line with the title of the article, several opportunities and limitations can be identified in relation to the use of innovative marketing communication in Slovak cities and municipalities. The opportunities include, in particular, the ability to reach younger residents more effectively, build trust through interactive and value-oriented content, and strengthen the identity of the territory through modern forms of presentation. On the other hand, the most significant limitations include insufficient funding, weak strategic planning, and a lack of knowledge about tools that could significantly improve communication with the general public.

Cities and municipalities should therefore perceive marketing communication not only as a promotional tool, but also as a way of building relationships with the community, strengthening the identity of the area and supporting sustainable development. The results of this paper can serve as inspiration for further research and for the practical creation of methodological recommendations. In the future, it will be important to focus not only on identifying the most effective tools, but also on how to

implement them in line with the real needs and expectations of residents. Only then can innovative communication become a natural and functional part of life in cities and municipalities.

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A Comparison of Hilton Hotel Reviews on Booking and Google in the V4 Countries

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Abstract

Research background: In the era of digital travel technologies and increasing globalization, tourism has become one of the most dynamic and rapidly growing industries. Customer reviews play a key role in this process by influencing decisions and shaping the reputation of accommodation providers, while also providing potential guests with valuable information about the services and amenities offered by each establishment.
Purpose of the Article: The article aims to analyze customer reviews of the Hilton hotel chain on the Booking.com and Google.com platforms to evaluate differences in customer satisfaction and perceptions across these platforms, and to understand how online reviews impact the tourism industry.
Methods: This study focuses on analyzing customer reviews from Booking.com and Google.com. Descriptive statistics were used to systematically process and interpret the data obtained from the reviews. To assess whether differences in customer ratings between the two platforms were statistically significant, a paired Student's t-test and a Wilcoxon test were employes. These methods enable a thorough comparison of review ratings, revealing platform-specific differences in customer satisfaction and perceptions.
Findings & Value added: The results demonstrate that targeted analysis of customer reviews from both platforms is an effective way to evaluate service quality in the accommodation sector. The study identified significant differences in customer ratings, reflecting different evaluation criteria across platforms. These findings enhance understanding of the impact of online reviews on tourism dynamics and rpvide hoteliers with practical advice on optimizing their online reputation, improving service delivery, and gaining a competitive advantage in an increasingly digitalized market. The insights help businesses navigate the evolving tourism landscape more effectively.

Keywords: Distribution, Customer rating, Booking.com, Hilton Hotels & Resorts

JEL classification: F21, C32, C50

1. Introduction

In the digital and globalized era, tourism has become one of the fastest-growing sectors. Online platforms such as Booking.com and Google have transformed the way travelers select accommodation. Customer reviews play a pivotal role in this process, offering potential guests' valuable insights into the quality of services and amenities provided by each establishment. (Aakash et al., 2021)

The development of the internet and digital platforms is fundamentally changing information flows and travelers' decision-making, with online customer reviews becoming a key accommodation selection factor and essential hotel reputation element. (Akgunduz et al., 2018)

Booking.com and Google reviews are the primary sources of information, significantly influencing travelers' decisions due to their perceived authenticity. (Leung et al., 2020)

The accommodation industry has undergone a digital transformation, with numerous platforms now connecting providers with potential guests.
These platforms offer a wide range of options, including hotel bookings and rentals of apartments and entire houses. Booking.com is one of the world's largest and most well-known online accommodation

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booking platforms. It offers a wide range of accommodation, from luxury hotels to cozy apartments and hostels, to meet every customer's expectation. (Hyun-Jeong & Hak-Seon, 2019)

Booking's portfolio includes accommodation (a huge selection of hotels, apartments, villas, hostels and guesthouses around the world), flights (flight price comparison and easy booking), car rental (a wide range of car rental companies in different locations), transport (taxi, bus and other transport booking) and activities (holiday activities and experiences, from trips and excursions to adrenaline sports). (Booking, 2025)

Another important online platform is Google, which serves not only as a search engine but also as an effective travel planning tool. (Yang et al., 2021; Zyrianov & Zyrianova, 2021)

One useful feature is the ability to compare reviews of accommodation establishments. The platform uses the following tools to compare reviews:

- Centralized reviews: Google collects reviews from various sources, such as Google Maps, Booking.com and TripAdvisor. This means that all reviews are in one place.
- Quick and easy search: simply enter the name of the hotel or other accommodation in the search box, followed by the name of the city. The results show ratings, photos, and reviews from customers who have stayed at the accommodation.

We can filter reviews by different criteria, such as length of stay, date of stay or review topic. This way, we can access more relevant information.

- Map with location: Google Maps shows the exact location of the accommodation and allows us to compare it with others in the area.
- Rating: Google provides an overall rating of the accommodation based on all reviews. This rating gives us a quick idea of how satisfied customers are. (Yang et al., 2021; Shin & Perdue, 2023)

Customer reviews are written ratings that customers leave about products or services they have purchased. They provide valuable feedback that can influence other potential customers' decisions to purchase a service or product. Reviews can be brief or extensive, positive or negative, and provide valuable information about quality, functionality and overall customer satisfaction. (Filieri & Mariani, 2021; Ru-xin et al., 2020)

Customer reviews are an integral part of the customer experience for accommodation establishments. They provide invaluable information on how customers perceive the establishment's services, enabling it to target improvements to its offerings and marketing strategies. Reviews of accommodation establishments usually consist of two main parts: a written review from the customer and a rating of various categories that the customer has filled in. (Liburd & Hjalager, 2010; Liu, 2017)

The rating score is clearer and easier for potential customers to understand when making a booking decision than reviews. Current business practice usually relies on unidimensional and multidimensional systems for hotel booking platforms. The multidimensional rating system enables consumers to rate different services offered by accommodation establishments independently, thereby improving the conveyance of comprehensive information about products and services. This approach facilitates the verification and comparison of information on aspects such as service, location and cleanliness. (Rosario et al., 2020; Yae-Ji & Hak-Seon., 2022)

Tourists usually try to find out as much as possible about a given accommodation in order to make the best choice. Traditional word of mouth from friends can help to reduce the risk of making the wrong choice. However, due to continuous technological development, this traditional method of evaluation has largely been replaced by online reviews.

These reviews can be accessed by all potential customers on the websites of specific establishments or via various other platforms. This method is becoming increasingly trustworthy when it comes to booking accommodation, as customers who have already used a facility's services can share their experiences in terms of satisfaction or dissatisfaction. (Ecwid, 2025; Pinhal et al., 2025)

2. Methods

This study aims to compare the average overall ratings of Hilton hotels in the V4 countries, based on ratings from Booking.com and Google.com.

Based on this, our research question is as follows: Is there a statistically significant difference in the average overall ratings of Hilton hotels in the V4 countries when ratings from Booking.com and Google.com are compared? The following research hypotheses have been formulated for this question:

- H0: There is no statistically significant difference in the average overall ratings of Hilton hotels in the V4 countries between the two platforms.
- H1: There is a statistically significant difference in the average overall ratings of Hilton hotels in the V4 countries between the two platforms.

To determine the relationship between the selected indicators, we worked with secondary data: specifically, publicly available customer reviews of the Hilton hotel chain in the V4 countries in 2024. The research sample consisted of reviews for selected Hilton hotels in each V4 country: DoubleTree by Hilton Košice and DoubleTree by Hilton Bratislava; for the Czech Republic: Hilton Prague and Hilton Prague Old Town; for Hungary: Hilton Budapest and Hilton Garden Inn Budapest City Centre; and for Poland: Hilton Warsaw City Hotel and Hilton Gdansk.

Data were collected directly from Booking.com and Google.com for each of the eight hotels in question. Descriptive statistics were used to analyze the data, and a paired Student's t-test and a Wilcoxon test were used to compare the means across the different platforms. Statistical analyses were performed using the JASP software package.

For each platform and country, the basic descriptive characteristics of the overall ratings were calculated, including the mean, standard deviation, median, Q1, Q3, minimum and maximum. These statistics provide an overview of the ratings' distribution and central tendency and are summarized clearly in a table.

3. Results

To test for statistical significance, we will use a Student's t-test for two dependent samples, which is appropriate for comparing two related samples. In this case, we will compare the same hotels on two different platforms. To verify the results, we will also perform a Wilcoxon test for dependent samples, which is a non-parametric alternative to Student's t-test. Prior to applying the tests, the normality of the differences between the pairwise ratings were verified using the Shapiro–Wilk test. These tests will provide formal statistical evidence as to whether the differences in ratings between the platforms are significant or merely random.

Table 1. Descriptive statistics of the overall ratings of Hilton hotels in Slovakia, as found on Booking.com and Google.com

	Booking.com	**Google.com**
Number of hotels	2	2
Average	8,800	9,100
Median	8,800	9,100
Standard deviation	0,141	0,141
Minimum	8,700	9,000
Maximum	8,900	9,200
Q1	8,750	9,050
Q3	8,850	9,150

Source: own processing (2025)

Table 1 shows the descriptive statistics for the overall ratings of the DoubleTree by Hilton hotels in Košice and Bratislava, as found on Booking.com and Google.com in Slovakia. Initial analysis indicates differences in ratings for these hotels on the two platforms. Comparing the averages and medians revealed that Hilton hotels in Slovakia achieved higher ratings on Google.com than on Booking.com. A similar trend is evident in the minimum and maximum ratings recorded, which are consistently higher on Google.com. While Q1 (the lowest 25 %) is higher for Google.com than for Booking.com, Q3 (the lowest 75 %) is the same for both platforms. Interestingly, the standard deviation is the same for both platforms, indicating a similar level of review dispersion despite the higher averages on Google.com.

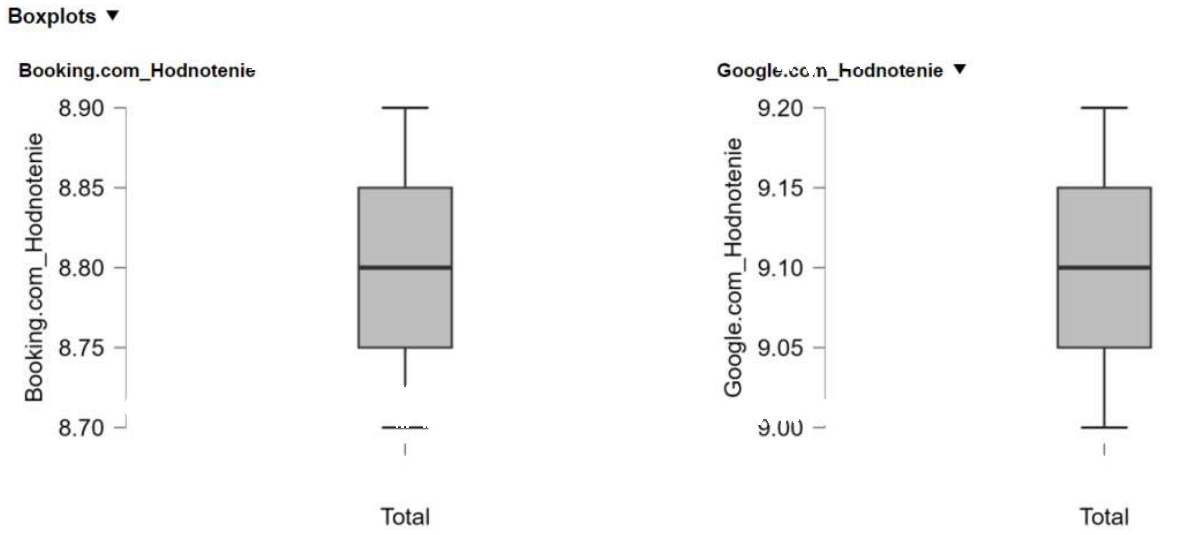

Figure 1. Distribution of overall ratings of Hilton hotels in Slovakia, as shown on Booking.com and Google.com.
Source: own processing (2025)

Figure 1 shows box plots comparing the distribution of overall ratings for Hilton hotels in Slovakia on the Booking.com and Google.com platforms. A visual comparison reveals that ratings on Google.com tend to be skewed towards higher values, as evidenced by the higher median ranking. The dispersion of ratings is similar on both platforms, and there is no evidence of significant outliers in the box plots.

Table 2. Descriptive statistics of the overall ratings of Hilton hotels in Czech Republic, as found on Booking.com and Google.com

	Booking.com	**Google.com**
Number of hotels	2	2
Average	8,350	8,900
Median	8,350	8,900
Standard deviation	0,212	0,141
Minimum	8.200	8,800
Maximum	8,500	9,000
Q1	8,275	8,850
Q3	8,425	8,950

Source: own processing (2025)

Table 2 shows the descriptive statistics for the overall ratings of the Hilton Prague and Hilton Prague Old Town hotels on Booking.com and Google.com in the Czech Republic. Initial analysis indicates differences in the ratings of these hotels on the two platforms. Comparing the averages and medians revealed that the Hilton hotels in the Czech Republic achieved higher ratings on Google.com than on Booking.com. A similar trend is evident in the minimum and maximum ratings recorded, which are also higher on Google.com. While Q1 is higher for Google.com than for Booking.com, Q3 is the same. Interestingly, the standard deviation is lower for Google.com, indicating a more consistent level of review dispersion despite the higher averages.

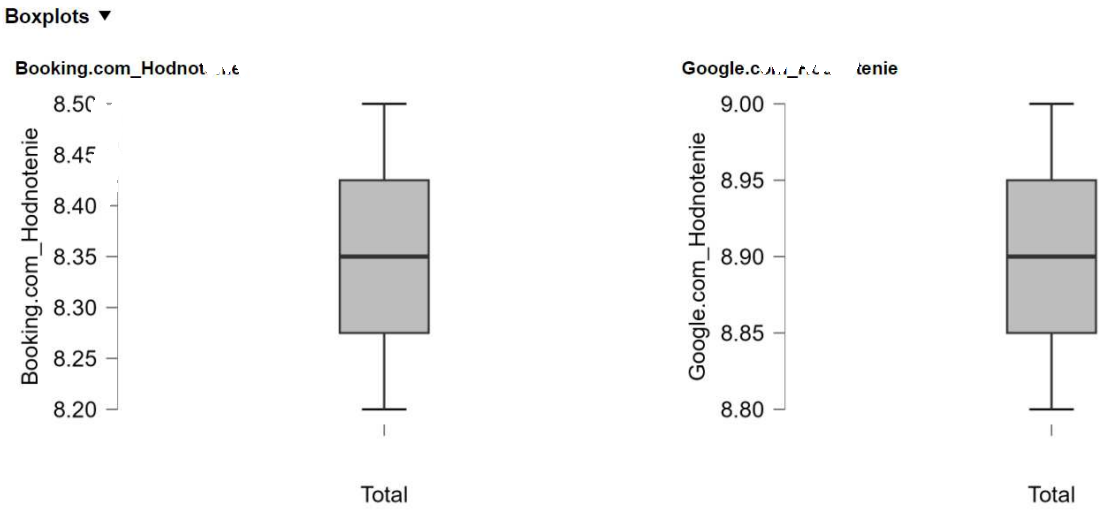

Figure 2. Distribution of overall ratings of Hilton hotels in Czech Republic, as shown on Booking.com and Google.com.
Source: own processing (2025)

Figure 2 uses box plots to compare the distribution of overall ratings for Hilton hotels in the Czech Republic on the Booking.com and Google.com platforms. The visual comparison shows that the mean value is consistently higher on the Google platform. The range of ratings in the middle 50 % is comparable on both platforms, but the overall range of ratings is slightly wider on Booking.com. There is no indication of significant outliers in the data for either platform.

Table 3. Descriptive statistics of the overall ratings of Hilton hotels in Hungary, as found on Booking.com and Google.com

	Booking.com	**Google.com**
Number of hotels	2	2
Average	8,850	9,000
Median	8,850	9,000
Standard deviation	0,071	0,283
Minimum	8,800	8,800
Maximum	8,900	9,200
Q1	8,825	8,900
Q3	8,875	9,100

Source: own processing (2025)

Table 3 shows the descriptive statistics for the overall ratings of the Hilton Budapest and Hilton Garden Inn Budapest City Centre hotels on Booking.com and Google.com in Hungary. Initial analysis indicates slight differences in the ratings of these hotels on the two platforms. When the means and medians were compared, it was found that Hilton hotels in Hungary achieved slightly higher ratings on Google.com than on Booking.com. A similar trend is evident for the maximum rating recorded, which is higher on Google.com. While Q1 (the lowest 25% of ratings) is higher for Google.com than for Booking.com, so too is Q3 (the lowest 75%). Interestingly, the standard deviation is significantly higher for Google.com, indicating a significantly greater degree of rating dispersion, even though the averages are only slightly higher on Google.com compared to the more consistent ratings on Booking.com. The minimum rating is the same for both platforms.

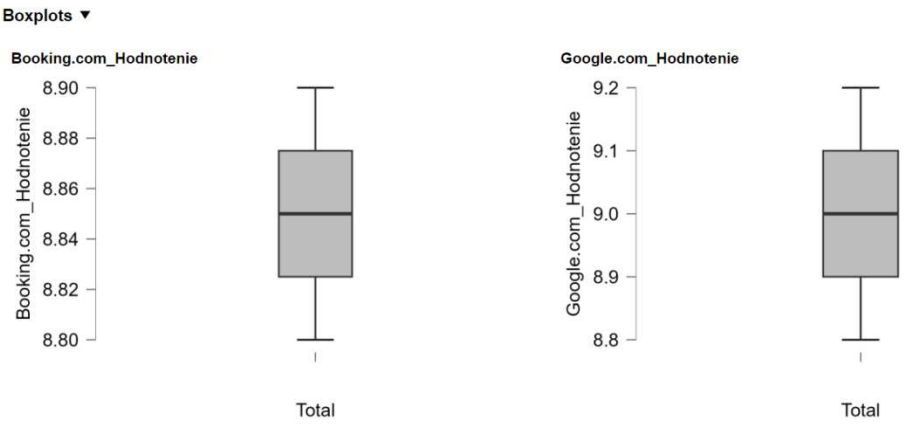

Figure 3. Distribution of overall ratings of Hilton hotels in Hungary, as shown on Booking.com and Google.com.
Source: own processing (2025)

Figure 3 shows box plots comparing the distribution of overall ratings for Hilton hotels in Hungary on the Booking.com and Google.com platforms. A visual comparison shows that the mean rating level is slightly higher on the Google.com platform. The variance in ratings is similar on both platforms, and there is no indication of significant outliers in the box plots.

Table 4. Descriptive statistics of the overall ratings of Hilton hotels in Poland, as found on Booking.com and Google.com

	Booking.com	**Google.com**
Number of hotels	2	2
Average	8,550	9,100
Median	8,550	9,100
Standard deviation	0,212	0,141
Minimum	8,400	9,000
Maximum	8,700	9,200
Q1	8,475	9,050
Q3	8,625	9,150

Source: own processing (2025)

Table 4 shows the descriptive statistics for the overall ratings of the Hilton Warsaw City Hotel and the Hilton Gdansk, as found on Booking.com and Google.com in Poland. Initial analysis indicates differences in the ratings of these hotels on the two platforms. Comparing the means and medians revealed that Hilton hotels in Poland achieved higher average and median ratings on Google.com than on Booking.com. A similar trend is evident in the minimum and maximum ratings recorded, which are higher and in a narrower range on Google.com. While Q1 (the lowest 25% of reviews) is higher for Google.com than for Booking.com, Q3 (the lowest 75%) is the same for both platforms. Interestingly, the standard deviation is lower for Google.com, indicating greater agreement and less dispersion of ratings, despite the higher averages

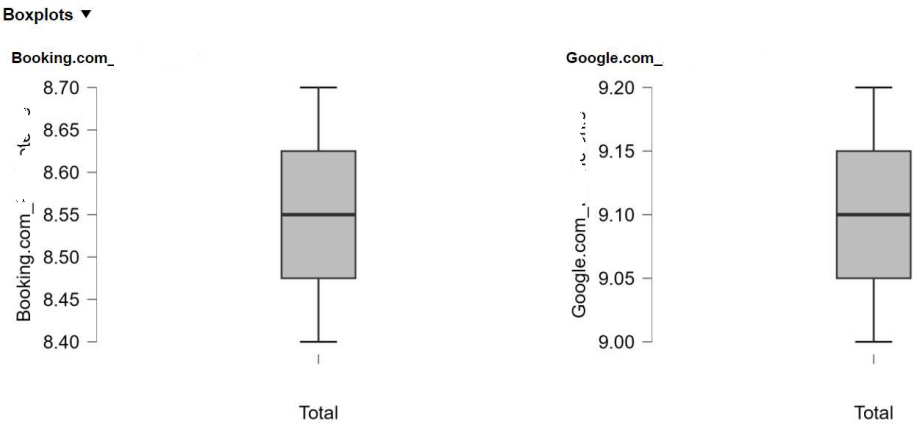

Figure 4. Distribution of overall ratings of Hilton hotels in Poland, as shown on Booking.com and Google.com.
Source: own processing (2025)

Figure 4 shows box plots of the overall ratings of Hilton hotels in Poland on Booking.com and Google.com. The median rating is clearly higher on Google. The variance in ratings is similar on both platforms, and there are no significant outliers in the box plots.

To test for statistical significance, we will use a Student's t-test for two dependent samples, which is appropriate for comparing two related samples — in this case, the same hotels on two different platforms. To verify the results, we will also perform a Wilcoxon test for dependent samples, which is a non-parametric alternative to Student's t-test. Prior to applying the tests, the normality of the differences between the pairwise ratings were verified using the Shapiro–Wilk test. These tests will provide formal statistical evidence as to whether the differences in ratings between the platforms are significant or merely random.

Table 5. Results of Shapiro-Wilk normality test

Statistics	**Value**	**Degree of magnitude**	**p-value**
w-statistics	0,848	8	0,090

Source: own processing (2025)

As can be seen in Table 5, the value of the W-statistic reached 0.848, with an associated p-value of 0.090. Using a standard significance level of $\alpha = 0.05$, the p-value exceeds this threshold. Therefore, *we cannot reject the null hypothesis of the Shapiro–Wilk test*, which states that the data come from a normal distribution. Based on this result, we can conclude that *the distribution of differences in scores does not exhibit any statistically significant deviations from normality.*

Table 6. Results of Student‘s t-test for 2 dependent samples

Statistics	**Value**	**Degree of magnitude**	**p-value**
t-statistics	-4,775	7	0,002
Average difference	-0,387		
SE difference	0,081		

Source: own processing (2025)

Table 7. Wilcoxon test results for dependent

Statistics	**Value**	**p-value**
z-scores	-2,380	0,0021
Hodges-Lehmannov estimate	-0,425	

Source: own processing (2025)

Tables 6 and 7 show the results of the Student's t-test and the Wilcoxon test. These tests consistently showed a statistically significant difference in the average overall rating of Hilton hotels on the Booking.com and Google.com platforms. The average ratings were higher on Google.com. Therefore, we reject the null hypothesis (H0), which hypothesized that there was no statistically significant difference,

and confirm the alternative hypothesis (H1), which hypothesized the existence of a statistically significant difference. On average, customers rate Hilton hotels in V4 countries more favorably on Google.com, which has implications for the hotels' online strategy.

4. Discussion

In this study, we analyzed reviews of Hilton hotels in Slovakia, the Czech Republic, Hungary and Poland from two major platforms: Booking.com and Google.com. Our aim was to verify whether there are statistically significant differences in reviews between these platforms, and if so, whether these differences have practical implications for hotels and potential customers.

Firstly, it is worth emphasising that descriptive statistics show reviews on Google.com tend to be higher than on Booking.com in all countries studied. The most striking differences were the higher mean and median values on Google.com. However, the variance of reviews (as measured by standard deviation) was often similar or even lower, suggesting greater consistency in reviews on Google.

Visual comparisons using box plots confirm that the distributions of reviews are similarly dispersed on both platforms, but the average review score is significantly higher on Google.com. This may reflect different user behavior on these platforms or different review criteria. The results of the statistical tests (Student's t-test and Wilcoxon test) clearly confirmed that the differences in average ratings were statistically significant in all the countries studied. This means that the higher ratings on Google.com are not random but reflect a real trend in consumer ratings.

Methodologically, it is positive that the normality of the differences was verified using the Shapiro–Wilk test before applying the statistical tests. The fact that the distribution of differences does not show statistically significant deviations from normality means that parametric tests such as the Student's t-test can be used reliably. Similarly, the consistent results of the non-parametric Wilcoxon test confirm the robustness of the findings.

These findings have multiple practical implications. For example, for hotels, it means that customers tend to rate them more positively on Google.com than on Booking.com, which can affect their online image and reputation. From a marketing perspective, it is important to consider these differences when devising communication strategies and optimizing the online presence. However, it should be noted that these differences may reflect different user groups and their expectations, or how ratings are conducted on individual platforms.

However, the limitations of the study must also be considered. The hotel samples in individual countries were relatively small (two hotels each), which may affect the representativeness of the findings. Likewise, differences in the scope of ratings, the demographic composition of users, and cultural differences may affect the results. Therefore, future research should expand the hotel samples and consider other factors, such as reviews, hotel types and customer segments.

In conclusion, based on the obtained data, it can be stated that there is a clear and statistically significant difference in Hilton hotel ratings between the Booking.com and Google.com platforms. This insight is important for hotels, which should consider how to influence their reviews on various platforms and which strategies to adopt to improve their reputation. Users and potential customers should be aware that reviews on Google may be more positive, which could influence their decision-making when choosing accommodation.

Conclusion

In conclusion, the analysis of Hilton hotel reviews from the V4 countries on the Booking.com and Google.com platforms confirmed that customers rate Hilton hotels significantly more positively on Google.com than on Booking.com. Statistical tests, including Student's t-test and the Wilcoxon test, clearly showed that these differences were statistically significant. Higher ratings on Google were likely to reflect different user behavior or rating criteria on these platforms.

These findings could be beneficial for the hotel sector by enabling more effective marketing and reputation strategies to be developed based on knowledge of differences in ratings on different platforms. Hotels can use this knowledge to manage their online presence more effectively, focusing on increasing customer satisfaction on platforms with higher ratings or optimizing communication with users to influence their decision-making more effectively. Additionally, hotels can use statistics and review analysis to identify weaknesses in their services and implement targeted improvements, potentially enhancing their overall reputation and competitive advantage.

From a research perspective, these findings have several advantages. It would be beneficial to expand the sample size to include more hotels and a wider geographical area to make the findings more generalizable.

Research could also examine which specific factors (e.g. hotel type, target group, rating method or cultural differences) influence differences in reviews between platforms. Furthermore, it would be possible to analyze how different marketing strategies or activities affect changes in reviews on individual platforms. Furthermore, the research could be extended to other accommodation service segments or reviews from different time periods to track trends and their causes.

Overall, this knowledge offers valuable insights that will help both hotels and academia to better understand the impact of online reviews on business and performance in the digital era. It will also help them to use available data more effectively to increase their competitiveness and customer satisfaction.

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Differences in the Perception of Sustainable Tourism from the Perspective of Generations X, Y and Z

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Abstract

Research background: Tourism sustainability research has its origins in the 1980s. Today, tourism sustainability is being researched in several directions, with generational differentiation being no exception. Against this background, our research focused on assessing differences in perceptions of sustainable tourism from the perspective of three selected generations.
Purpose of the article: The aim of the paper was to analyse the differences in the perception of sustainable tourism from the perspective of Generation X, Y and Z. These differences were assessed on a research sample of 166 respondents from the respective generations, through five research questions and their associated research hypotheses.
Methods: A questionnaire survey was used for data collection to find out the main attitudes of respondents from the generations under study towards sustainable tourism. The established research hypotheses were tested through Student's T-test at $\alpha = 0.05$ level of significance in R statistical software.
Findings & Value added: In particular, the finding of statistically significant differences in holiday booking patterns between Generation X and Generation Y respondents as well as between Generation X and Generation Z respondents can be considered as a sub-conclusion of the paper. It was also found that Generation X and Generation Z respondents perceive the importance of sustainability pillars differently. These results thus point to the need for a generationally differentiated approach in tourism, especially in the communication and design of tourism products that take into account not only technological habits but also attitudes towards sustainability, as generational differences play a significant role in consumer behaviour in tourism, which we consider to be the greatest added value of our research.

Keywords: Sustainable Tourism, Generation X, Generation Y, Generation Z, Differences

JEL classification: M21, Z32

1. Introduction

Sustainable tourism takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, industry, the environment and host communities. Sustainable tourism should make optimum use of environmental resources, which are a key element of tourism development, preserve essential ecological processes and help to protect natural heritage and biodiversity; respect the socio-cultural authenticity of host communities, protect their built and living cultural heritage and traditional values, and contribute to intercultural understanding and tolerance; Ensure viable, long-term economic operations, providing socio-economic benefits to all stakeholders that are equitably shared, including stable employment and earning opportunities and social services for host communities and contributing to poverty alleviation (GSTC, 2022).

The concept of sustainability began to take shape in particular in the 1980s, when the World Commission on Environment and Development published a report entitled ‘Our Common Future’, but today this document is also known as the ‘Brundtland Report’. The Brundtland Report stated that critical global environmental problems were primarily the result of extreme poverty in the South and unsustainable patterns of consumption and production in the North. Further, this report pointed to the need for a strategy that would unite development and the environment, which we now know described by the well-established term ‘sustainable development’ (United Nations, 1987).

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At the same time, the perception of sustainable tourism is conditioned in terms of age (and especially in terms of) belonging to a generation (Chang et al., 2024). In the research literature, we often encounter several studies focusing on the issue of generational differences in the perception of sustainable tourism (e.g., Graton & Mailliez, 2019; Kim & Yoon, 2020; Bahja & Hancer, 2021; Riva et al., 2022), which confirm the rationale for exploring this issue. It is also for this reason that our research focuses on the perception of sustainable tourism from the perspective of the three generations that currently make up the bulk of tourism customers - X, Y and Z.

1.1 Generation X and sustainable tourism

Generation X people are now aged 45-60, as the literature puts their birth dates between the second half of the 1970s and the end of the 1980s. Having grown up during the advent of computers and the introduction of mobile phones, they are more competent and comfortable with computer-mediated communication, but they tend to ignore advertising aimed at them and reject any form of segmentation and marketing techniques. They generally like to communicate via mobile phones, use online forums, Facebook, etc. (Eger et al., 2021).

Hysa et al. (2021) in their research examined the use of social media by different generations in destination marketing from a sustainable tourism perspective, the frequency of social media use by different generations and the extent of social media use in trip planning. Generation X does not use blogs and microblogs frequently, with 42% of respondents not using them at all and 43% using them occasionally. However, they use social media more frequently, with 40% of respondents using it several times a day. In addition, 18% of Generation X respondents use content communities such as YouTube, Vimeo and Pinterest several times a day and 14% use them once a day.

Up to 71% of this generation likes to discover new places off the beaten track and look for local recommendations, while 70% visit museums, historical sites, as well as art and culture. Therefore, they often visit their favourite cities where they can find interesting sights or rich history. When choosing to travel abroad, they usually look for quiet, recreational places or interesting cultural sites. Despite the fact that people from this generation were born in analogue times, they have fit perfectly into the modern digital world and modern technology, and therefore they readily use the Internet when planning and booking their tourist trips (Hysa et al., 2021).

1.2 Generation Y and sustainable tourism

Generation Y, also referred to as ‘Millennials’, are well-informed, investigative and loyal, and are heavily influenced by their peers. This generation wants to build relationships with the brands they buy so companies have to create brands that are cool, real, unique, inspire happiness and allow for identification between the customer and the brand. When it comes to technology use, people from this generation witnessed the extensive growth of the internet when they were teenagers and young adults (Bravo et al. 2019).

Generation Y members use social networks several times a day, content communities once a day and co-working networks once a week, and occasionally use blogs and microblogs, review sites and travel forums. Generation Y is more critical of negative comments on social media compared to Generation Z. Hysa et al. (2021) in their research ‘Social Media Use by Different Generations as a Sustainable Tourism Marketing Tool in an Idea 5.0 Society’ suggests that Gen Y women are more likely to check social media reviews of places they want to visit and are more likely to be influenced by positive comments and comments in general when deciding to take a trip.

This generation is visiting and exploring more destinations, spending more while travelling and is hungry for interesting experiences and information. As a group, however, they do not prefer any particular type of vacation. In fact, millennials want variety. Some like adventurous and unique experiences, others want to relax on the beach and sample the local cuisine. They also look for all-inclusive, relaxing and romantic trips. However, they keep an eye on their travel budget (Hysa et al., 2021) and are the most active travelers of all generations (Huang & Lu, 2017). They reject mass tourism and instead show social and environmental awareness, interest in environmentally oriented activities, locally produced goods and services. Positive attitudes towards diversity, flexibility and social issues, such as a growing interest in the impacts of travel and a strong desire to experience local culture, are reflected, for example, in the interest of Generation Y travellers in volunteer tourism (Pompurová et al., 2018). Millennials are the first generation to place an emphasis on the environment and sustainability. They are growing up at a time

when climate change and environmental issues are receiving increasing attention in the media and public awareness (Szalaiová, 2023).

UNWTO and WYSE Travel Confederation (2012) highlights the fact that compared to the past, this segment includes a wider range of the population: people aged 15-30+ rather than 18-24. In terms of behaviour, it underlines the fact that young travellers and students want to discover and experience different cultures and be able to interact with the local population. These factors open up the opportunity to encourage behaviour that is more responsible and aware of different aspects of sustainability through this segment of tourism demand. Data from UNTWO and WYSE Travel Confederation (2012) support these findings and describe youth and student travellers as 'paving the way for responsible tourism' (Buffa, 2015). They have a positive attitude towards sustainable consumption in an approach of reducing the waste of natural resources (Mammadli, 2023).

1.3 Generation Z and sustainable tourism

Representatives of this generation, also called GenZ, Post-Millennials or iGeneration (Georgiev, 2023), were born around 1995-2010 and are currently aged between 15 and 30. They are more committed to helping others and the environment, and are more inclined to group action because they are aware of their role in the world and their responsibility to help improve it. Perhaps the most defining characteristic of this generation is their ubiquitous use of technology. However, this use of technology has also created an efficient but impatient generation that wants everything quickly. Therefore, they prefer shopping in brick-and-mortar stores that provide them with a comprehensive experience of trying on clothes and buying them immediately, rather than waiting 3-5 business days for a package to arrive (Szalaiová, 2023). Generation Z members are not afraid of constant change and lack a sense of commitment (Bravo et al., 2019). However, they tend to consume sustainably to reduce pollution and protect the environment.

They share similar views with millennials, who share the same views on the political situation and are aware of the social problems that need to be addressed. They are becoming more politically engaged and are looking to spend their money on companies that reflect their values and promote change on social issues. They believe that their individual skills can make a difference, but they also ask businesses and governments to contribute to building a better future. They have grown up in an era where climate change is a constant backdrop to their lives. They are often described as the most environmentally conscious generation and have a heightened awareness of the impact of human activity on the planet, promoting environmental activism and incorporating sustainable practices into their personal and professional lives. In its report, First Insight saw that 73% of customers from this generation will pay 10% more for a product that is sustainable. They are familiar with marketing tricks and can recognize insincere advertising, so it is very difficult to fool them (Szalaiová, 2023).

Analysis by Expedia Group Media Solutions (2018) also shows that more than 50% of Generation Z use platforms such as Twitter, Snapchat, Facebook, Instagram and YouTube when planning and during travel. In addition, 84% of Generation Z believe that social media plays an important role in travel (Hysa et al., 2021). Deyan Georgiev (2023) reports in his study that up to 45% of Generation Z travellers choose environmentally and socially responsible brands while on holiday.

2. Methods

Based on the above information on the attitudes of different generations towards sustainable tourism, it is clear that there are some differences between the perceptions of sustainable tourism. Therefore, the aim of this paper is to analyse the differences in the perception of sustainable tourism from the perspective of Generation X, Y and Z.

For the purpose of our research on the differences of the selected generations in the perception of sustainable tourism, we consider the distribution of generations according to Mammadli (2023) and Bravo et al. (2019):

- Generation X (born between 1965-1980),
- Generation Y (born between 1981-1994),
- Generation Z (birth between 1995-2010).

We sought to meet the main objective of the paper by setting the following five research questions (RQ) and their associated research hypotheses:

RQ 1: ***Are there statistically significant differences in how Generation X, Y and Z book their holidays?***

- H_0: We assume that there are no statistically significant differences in the way holidays are booked from the perspective of Generation X, Y and Z.
- H_1: We hypothesise that there are statistically significant differences in the way holidays are booked from the perspective of Generation X, Y and Z.

RQ 2: ***Are there statistically significant differences in the consideration of the environmental impacts of holidays from the perspective of Generation X, Y and Z?***

- H_0: We assume that there are no statistically significant differences in the consideration of the environmental impacts of holidays from the perspectives of Generation X, Y and Z.
- H_1: We assume that there are statistically significant differences in the consideration of the environmental impacts of holidays from the perspective of Generation X, Y and Z.

RQ 3: ***Are there statistically significant differences in the consideration of the economic impact of leave from the perspective of Generation X, Y and Z?***

- H_0: We assume that there are no statistically significant differences in the consideration of the economic impact of leave from the perspective of Generation X, Y and Z.
- H_1: We assume that there are statistically significant differences in the consideration of the economic impacts of leave from the perspectives of Generation X, Y and Z.

RQ 4: ***Are there statistically significant differences in the consideration of the social impact of leave from the perspective of Generation X, Y and Z?***

- H_0: We assume that there are no statistically significant differences in the consideration of the social impacts of leave from the perspective of Generation X, Y and Z.
- H_1: We assume that there are statistically significant differences in the consideration of the social impact of leave from the perspective of Generation X, Y and Z.

RQ 5: ***Are there statistically significant differences in the perceived importance of the pillars of sustainability from the perspectives of Generation X, Y and Z?***

- H_0: We assume that there are no statistically significant differences in the perceived importance of sustainability pillars from Generation X, Y and Z perspectives.
- H_1: We assume that there are statistically significant differences in the perceived importance of the pillars of sustainability from the perspective of Generation X, Y and Z.

The main research method used to collect data on the differences in perceptions of sustainable tourism from the perspective of the generations studied was a non-standardized 17-item questionnaire survey. A total of 166 respondents participated in the questionnaire survey, which constituted our research sample. Of this number of respondents, 98 females (59%) and 68 males (41%) comprised the research sample. Regarding the distribution of the research sample according to the generations studied, the largest group was Generation Z (59 respondents, 36%), followed by Generation Y (56 respondents, 34%) and Generation X (51 respondents, 30%). The selection of respondents was done by random sampling.

The research hypotheses were tested by Student's T-test at $\alpha = 0.05$ level of significance using R statistical software.

3. Results

In this section of the paper, we present only the most important findings from the survey, which provide the basis for further analyses of differences through T-tests.

We consider the most significant results of the survey to be that respondents from the generations studied mainly use social networks, the Internet and travel agencies when booking a holiday (Figure 1). Social media is mainly used by Generation Z (50 respondents), the internet is mainly used by Generation Y (42 respondents) and booking a holiday through a travel agency is mainly used by Generation X (33 respondents).

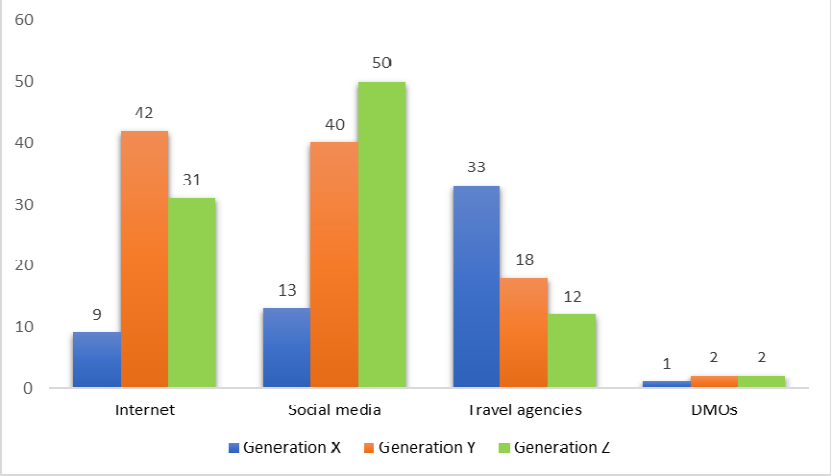

Figure 1. Holiday booking methods by the generations surveyed
Source: own processing (2025)

Given that respondents mainly use the internet and social media when booking holidays (Fig. 1), we were interested to see how often respondents consider environmental, economic and social impacts when booking a holiday. Regarding the environmental impacts of a holiday, these are only sometimes taken into account by respondents, regardless of the generation surveyed, when planning a holiday (Fig. 2).

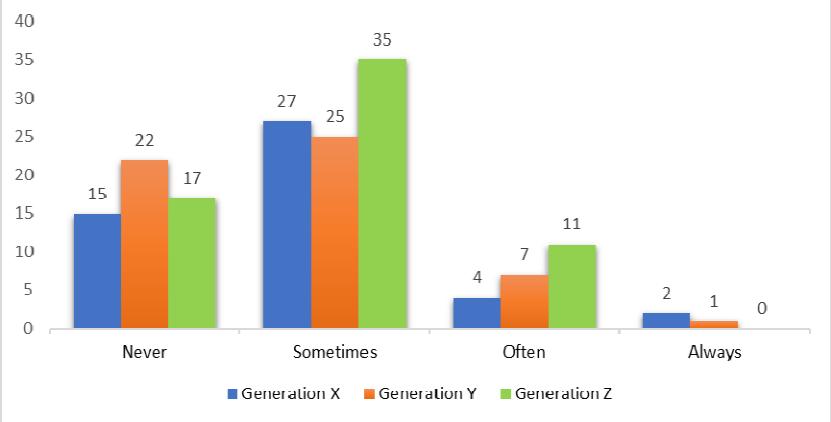

Figure 2. Frequency of consideration of the environmental impacts of holidays by the generations surveyed
Source: own processing (2025)

Similarly, when considering the economic impact of leave (Figure 3), which is only sometimes taken into account by respondents.

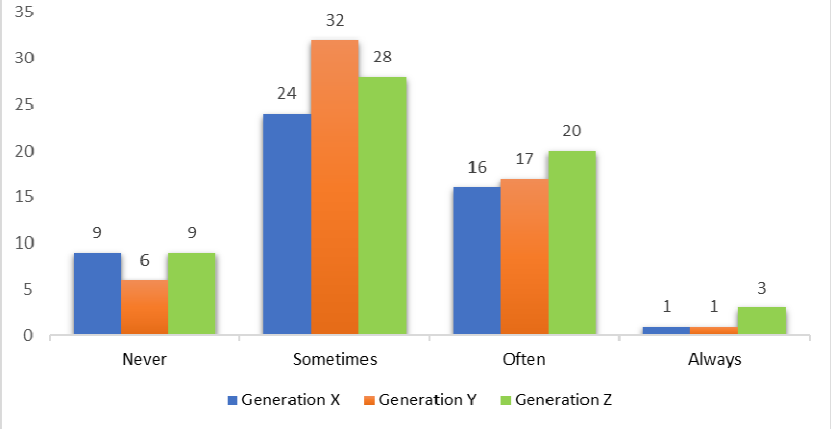

Figure 3. Frequency of taking into account the economic impact of holidays by the generations surveyed
Source: own processing (2025)

In the case of taking into account the social impacts of leave, these are also sometimes taken into account by respondents from the generations surveyed (Figure 4).

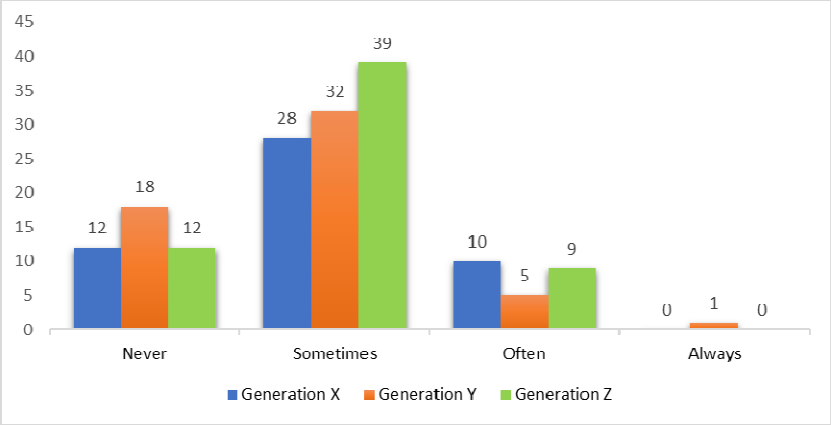

Figure 4. Frequency of consideration of the social impact of leave by the generations surveyed
Source: own processing (2025)

If we take a closer look at the previous Figures 2, 3 and 4, we can see several differences. In the case of environmental and social impacts of holidays, apart from respondents considering them sometimes, the second most common response was that respondents (regardless of the generation studied) never consider them (Figure 2 and Figure 4). In the case of taking into account the economic impact of leave, the second most common response was "often" (Figure 3). These findings only confirm the fact that respondents are aware of the importance of perceiving the sustainable pillars of their holiday activities, especially through their perception of the economic impacts of their holiday.

With regard to the perception of specific pillars of sustainability, we identified which of the pillars respondents from the generations surveyed considered most important. From Figure 5 we can observe that according to respondents from the generations studied, the most important is to protect and promote the local culture of the destination. Respondents consider nature protection as the second most important pillar of tourism sustainability, followed by supporting the local economy.

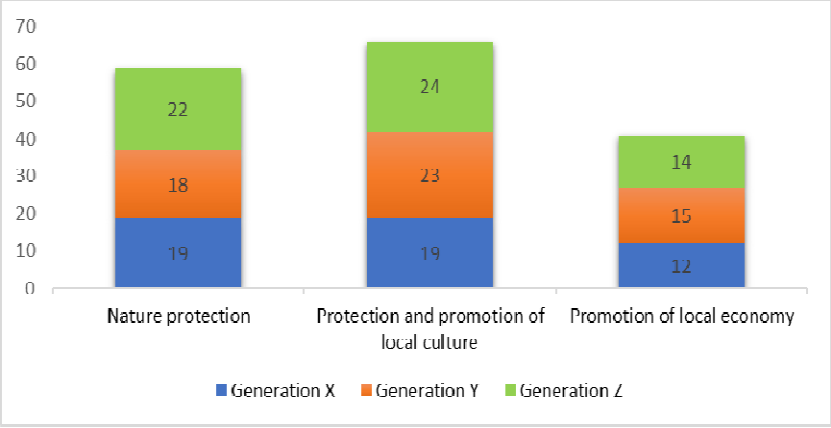

Figure 5. The most important pillar of sustainability according to the generations surveyed
Source: own processing (2025)

The last item in the survey was devoted to potential barriers to sustainable tourism for respondents. In this case, respondents perceived a lack of information about sustainable holiday options as the biggest barrier to sustainable tourism orientation (68 respondents from the generations surveyed). At the same time, we can also observe several differences in the perception of barriers to sustainable tourism from the point of view of the generations studied. Generation Z respondents also cited the lack of financial means to pay more for sustainable products or services as the second biggest barrier. Generation Y respondents cited the lack of facilities that offer sustainable services or products as the second biggest barrier. What is positive, however, is that a number of respondents from the generations surveyed (total 42) said that there was nothing stopping them from booking a holiday that included sustainable products or services.

In light of the above survey results, which demonstrate differences in perceptions of sustainable tourism from the perspective of the generations studied, it is warranted to verify the stated research hypotheses and answer the research questions, for the sake of determining statistically significant differences in perceptions of sustainable tourism from the perspective of the generations studied. In the following Table 1, we present the resulting p-values obtained by Student's T-test for each of the variables under study.

Table 1. Resulting p-values of Student's t-test and interpetation of results of verification of research hypotheses

Variable	P-value	Conclusion
RQ 1 – the way of book a holiday (Gen X-Gen Y)	**0.0364**	**H_0 is rejected. There are statistically significant differences between how Generation X and Generation Y book their holidays.**
RQ 1 – the way of book a holiday (Gen X-Gen Z)	**0.0469**	**H_0 is rejected. There are statistically significant differences between how Generation X and Generation Z book their holidays.**
RQ 1 – the way of book a holiday (Gen Y-Gen Z)	0.0906	H_0 is not rejected. There are no statistically significant differences between the method of booking holidays from the perspective of Generation Y and Z.
RQ 2 – considering the environmental impact of holiday (Gen X-Gen Y)	0.0838	H_0 is not rejected. There are no statistically significant differences between the consideration of the environmental impacts of holidays from the perspective of Generation X and Generation Y.
RQ 2 – considering the environmental impact of holiday (Gen X-Gen Z)	0.0701	H_0 is not rejected. There are no statistically significant differences between considering the environmental impacts of holidays from the perspective of Generation X and Z.
RQ 2 – considering the environmental impact of holiday (Gen Y-Gen Z)	0.0837	H_0 is not rejected. There are no statistically significant differences between considering the environmental impacts of holidays from the perspective of Generation Y and Z.
RQ 3 – considering the economic impact of holiday (Gen X-Gen Y)	0.0865	H_0 is not rejected. There are no statistically significant differences between taking into account the economic impact of leave from the perspective of Generation X and Generation Y.
RQ 3 – considering the economic impact of holiday (Gen X-Gen Z)	0.0748	H_0 is not rejected. There are no statistically significant differences between taking into account the economic impact of leave from the perspective of Generation X and Generation Z.
RQ 3 – considering the economic impact of holiday (Gen Y-Gen Z)	0.0914	H_0 is not rejected. There are no statistically significant differences between taking into account the economic impact of leave from the perspective of Generation Y and Generation Z.
RQ 4 – considering the social impact of holiday (Gen X-Gen Y)	0.0873	H_0 is not rejected. There are no statistically significant differences between taking into account the social impact of leave from the perspective of Generation X and Generation Y.
RQ 4 – considering the social impact of holiday (Gen X-Gen Z)	0.0778	H_0 is not rejected. There are no statistically significant differences between taking into account the social impact of leave from the perspective of Generation X and Z.
RQ 4 – considering the social impact of holiday (Gen Y-Gen Z)	0.0915	H_0 is not rejected. There are no statistically significant differences between taking into account the social impact of leave from the perspective of Generation Y and Generation Z.
RQ 5 – perception of the importance of the pillars of sustainability (Gen X-Gen Y)	0.0577	H_0 is not rejected. There are no statistically significant differences between Generation X and Generation Y perceptions of the importance of sustainability pillars.
RQ 5 – perception of the importance of the pillars of sustainability (Gen X-Gen Z)	**0.0435**	**H_0 is rejected. There are statistically significant differences between Generation X and Generation Z perceptions of the importance of sustainability pillars.**
RQ 5 – perception of the importance of the pillars of sustainability (Gen Y-Gen Z)	0.0746	H_0 is not rejected. There are no statistically significant differences between the perceived importance of the pillars of sustainability from Generation Y and Generation Z perspectives.

Source: own processing (2025)

Table 1 shows that the stated research questions were only partially confirmed based on the assessment of the p-value of Student's t-test. Only RQ 1 was confirmed, as statistically significant differences in the way of booking holidays exist between Generation X and Generation Y respondents as well as between Generation X and Generation Z respondents. RQ 5 was also partially confirmed, as Generation X and Z respondents perceive the importance of sustainability pillars differently. In the case of taking into account the environmental, economic and social impacts of the holiday, no statistically significant difference between respondents from the generations studied was confirmed.

4. Discussion

Based on the results of the mathematical and statistical verification of the stated hypotheses, which we interpret in Table 1, we can argue that the results of our research are closely related to the results of previous research focused on this issue. As an example, Szalai's (2023) study found that Generation Z is aware of sustainability aspects and the impacts of their travel activities on the environment, local culture and the destination's economy, and is willing to pay more for sustainable services or products, which at the same time significantly differentiates them from Generation X, which pays the least attention to sustainability issues. This divergence was confirmed in the case of the RQ 5 we have identified, with a statistically significant difference in the perception of the pillars of sustainability from the perspective of the two generations. This disparity may be due not only to the age range of these generations, as there is an age difference of up to 45 years between the oldest person from Generation X and the youngest person from Generation Z, but also to the access to information on sustainable tourism. While Generation Z uses various technologies as a source of information even several times a day, Generation X uses technology to obtain information only once a day (Hysa et al., 2021). At the same time, it should also be mentioned that Generation X pays the least attention to sustainability, precisely because the term sustainability was not used when members of this generation were born. It was not until the 1980s, when members of Generation Y were born, that the issue of sustainability and sustainable development began to emerge (United Nations, 1987). Members of Generation Z were ‘born’ into a society where the concept is clearly and precisely defined, research-based and communicated through various information channels. This fact, thus, only points to a significant gap and disparity between the perception of sustainability and its pillars from the perspective of Generation X and Z, which was also confirmed in the case of our research and testing of research hypotheses for RQ 5.

Another significant result of the research is the existence of a statistically significant difference in the way of booking holidays for Generation X, Y and Z, which was confirmed both in the analysis of the survey data itself (Figure 1) and later in the case of the validation of RQ 1 (Table 1). Thus, these results are again related to previous research that has been devoted to this. For example, Hysa et al. (2021) report that Generation X uses the internet most often to book holidays, Generation Y and Z social media. For Generation Y and Z, this difference is reflected in the use of other social media (e.g., Generation Y mainly uses Facebook and YouTube; Generation Z mainly uses Twitter and Snapchat) (Expedia Group Media Solutions, 2018). The reasons in this disparity can be seen mainly in the lifestyle of the generations studied, the boom and popularity of the selected social media.

Since no statistically significant difference between the perception of the environmental, economic and social aspects of the holiday between the generations studied was confirmed, we can assess, especially according to the survey results, that the respondents from the generations studied take them into account, but only sometimes. What is positive is that the generations surveyed take these aspects into account to the same extent.

Conclusion

In conclusion, the results of our research point to the need for a generationally differentiated approach in tourism, especially in communication and offer design that takes into account not only technological habits but also attitudes towards sustainability, as generational differences play a significant role in consumer behaviour in tourism.

It is essential to take into account the specificities of the different generations - in particular their technological habits, service preferences and attitudes towards sustainability - in the design of tourism products and in marketing communication. Generations Z and Y are generally more tech-savvy and more inclined towards online bookings or digital tools, while Generation X may prefer more traditional forms of communication. They also differ in their sensitivity to the environmental and social aspects of travel, which is important to consider when presenting sustainable products.

It follows from the above that a universal approach in communication and the offering of tourism services can be ineffective. Personalization of content, communication channels, and products according to the age structure of the target group can significantly contribute to higher client satisfaction and at the same time to more effective promotion of sustainability principles in tourism.

A universal approach in communication and the creation of tourism products appears to be ineffective because each generation approaches travel for different reasons. Generation Z often seeks authentic experiences, adventure, and sustainable forms of tourism. Generation Y may emphasize a balance between relaxation and personal development, viewing sustainability as a natural part of decision-making.

Generation X more frequently prefers comfort, reliability, and established destinations. It is important to reflect these differences in product creation and marketing messages. In an era of strong individualization and diverse consumer values, a generationally sensitive approach is essential for effective product creation, marketing communication, and fulfilling sustainability goals.

Generational consideration also allows for more precise market segmentation and tailoring the offering to specific needs – whether it is about the mode of communication, choice of destinations, service packages, or emphasis on experience, comfort, or sustainability. Such an approach increases not only customer satisfaction but also the competitive advantage of the provider.

Acknowledgements

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Financial Performance and Resilience of Slovak Spa Companies: A Comparative Analysis Before, During, and After the COVID-19 Pandemic

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Abstract

Research background: The spa sector, particularly small and medium-sized enterprises in Slovakia, is highly vulnerable to external shocks such as the COVID-19 pandemic. This crisis significantly affected the financial stability and operational performance of spa companies.
Purpose of the article: This paper aims to analyze the development of key financial indicators in Slovak spa companies from 2013 to 2023, with a focus on identifying differences across the pre-pandemic, pandemic, and post-pandemic periods.
Methods: A quantitative approach was applied, using non-parametric statistical tests (Friedman ANOVA and Wilcoxon paired tests with Holm-Bonferroni correction) to assess differences in indicators of profitability (Return on Assets, Return on Sales), costs (Personnel Cost Ratio, Cost-to-Sales Ratio, Return on Costs), liquidity (Net Working Capital, Current Ratio), and debt (Equity to Total Liabilities Ratio, Debt Ratio). Data from 20 spa companies were analyzed to capture sector-wide trends across three key periods: pre-pandemic (2013–2019), pandemic (2020–2021), and post-pandemic (2022–2023).
Findings & Value added: The study confirms the high sensitivity of the Slovak spa sector to external shocks, with statistically significant changes observed in most financial indicators during the pandemic. Early signs of recovery were identified in 2023. These exploratory findings offer valuable insights for industry stakeholders and form a foundation for further research—such as cross-country comparisons, qualitative studies of managerial responses, and broader analyses that incorporate sustainability dimensions.

Keywords: Spa sector, Spa companies, Financial performance, COVID-19 pandemic, Slovakia

JEL classification: L83, Z32, Z33

1. Introduction

Spas have traditionally been a significant segment of the tourism industry in the Slovak Republic, playing an important role in healthcare, regional development, and employment (Štefko et al., 2020). Over the past decade, Slovak spa companies have encountered several structural challenges, including the impacts of the COVID-19 pandemic, the energy crisis, and changes in government support (Derco & Pavlisinová, 2017). These factors have had a considerable influence on the financial performance of companies within the sector, particularly in the period following 2020. Key financial indicators—such as return on assets, return on sales, and asset turnover—serve as fundamental tools for tracking corporate performance and identifying potential risks (Kliestik et al., 2020).

The quality of spa services in Thailand has been examined in several studies, including those by Sivapitak and Sangpikul (2024) and Somkeatkun and Wongsurawat (2017). Thipbharos and Sangpikul (2023) analyzed the characteristics of spa service outcomes based on various sources such as previous research, online reviews, and customer interviews. A focused study on spa services in Bangkok was conducted by Sangpikul (2022). In Sweden, Lagrosen and Lagrosen (2015, 2016) investigated spa hotels using exploratory factor analysis and cluster analysis. The spa industry in Slovakia and the Czech

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Republic has been the subject of multiple studies, including those by Grenčíková et al. (2022), Dusek & Skorepa (2015), Vlcek (2013), Attl & Studnička (2012), Karas & Dodecký (2012), and Kraftová et al. (2011).

The financial condition and position of Slovak spa companies during the period 2007–2018 were assessed by Štefko et al. (2020) using methods such as quantifying the influence of key determining factors and multidimensional scaling. Their analysis revealed that total asset turnover and return on sales were the most significant contributors to changes in return on equity. The study identified Spa Bojnice (Kúpele Bojnice, a. s.) as having the strongest financial position, while Specialized Medical Institute Marína (Špecializovaný liečebný ústav Marína, s. o.) was found to have the weakest.

Jenčová et al. (2019) used multi-criteria evaluation methods to analyze the financial and economic situation of Slovak spa companies during the period 2013–2017. Based on selected financial indicators—return on assets, return on sales, the ratio of personnel costs to net turnover, and the ratio of added value to sales—the highest-performing spas included Spa Bojnice (Kúpele Bojnice, a. s.), Spa Lúčky (Kúpele Lúčky, a. s.), Spa Dudince (Kúpele Dudince, a. s.), Bardejov Spa (Bardejovské kúpele, a. s.), and Slovak Health Spa Piešťany (Slovenské liečebné kúpele Piešťany, a. s.). In contrast, the lowest-rated spas were Spa Štós (Kúpele Štós, a. s.), The Red Monastery Spa Smerdžonka (Kúpele Červený Kláštor Smerdžonka), PIENINY RESORT, s. r. o., Natural Iodine Spa Číž (Prírodné jódové kúpele Číž, a. s.), and Spa Brusno (Kúpele Brusno, a. s.).

Slovak spas were also evaluated by Jenčová and Vašaničová (2019) using a range of assessment methods. According to their evaluation, the top-performing spas included Slovak Heatlh Spa Rajecké Teplice (Kúpele Rajecké Teplice, a. s.), Spa Nimnica (Kúpele Nimnica, a. s.), Slovak Health Spa Turčianske Teplice (Slovenské liečebné kúpele Turčianske Teplice, a. s.), Spa Nový Smokovec (Kúpele Nový Smokovec, a. s.), Bardejov Spa (Bardejovské kúpele, a. s.), Spa Bojnice (Kúpele Bojnice, a. s.), and Spa Lúčky (Kúpele Lúčky, a. s.). The worst places in this rating were taken by Natural Iodine Spa Číž (Prírodné jódové kúpele Číž, a. s.), Spa Sliač (Kúpele Sliač, a. s.), and Spa Brusno (Kúpele Brusno, a. s.).

Previous research has primarily focused on analyzing spa enterprises as a whole or on inter-company comparisons. However, a systematic comparison of the development of individual financial indicators over time—particularly before and after the onset of the COVID-19 pandemic—is insufficiently addressed in the available literature. Novotná et al. (2024) assessed the performance of the Czech spa industry in the context of the COVID-19 pandemic. Their study examined the relationship between the level of tourist attractiveness and changes in revenue. They found that despite significant public funding allocations, the impact of subsidies on financial performance remained limited.

The aim of this paper is to analyze the development of financial indicators of Slovak spa companies over the period 2013–2023, with a particular focus on identifying differences across the pre-pandemic, pandemic, and post-pandemic periods. The findings of this analysis are intended to provide valuable insights for formulating effective policies and strategies to support the recovery and long-term sustainability of the spa sector in Slovakia.

2. Methods

The analysis of selected financial indicators of Slovak spa companies was conducted using a panel dataset spanning the period from 2013 to 2023. Although partial data for 2024 were available, they were excluded from the analysis due to their incompleteness at the time of processing (May 2025). The input data were sourced from publicly available financial statements registered in the Register of Financial Statements maintained by the Ministry of Finance of the Slovak Republic.

Currently, there are 21 spa towns in the Slovak Republic, hosting a total of 30 spa enterprises. The sample for this study comprised spa enterprises operating within the Slovak Republic that conduct their activities as joint-stock companies (a. s.), limited liability companies (s. r. o.), or state-owned enterprises (š. p.). Of the 30 active spa entities, only 20 with complete data available for the monitored period were included in the analysis. Enterprises lacking complete data, as well as those not operating as business entities (e.g., non-profit organizations or facilities under the Ministry of the Interior of the Slovak Republic), were excluded from the sample. The company Spa Brusno (Kúpele Brusno, a. s.) was excluded from the analysis due to ongoing restructuring and the absence of relevant data on assets or revenues for certain years. Consequently, the analysis included 20 spa entities: Bardejov Spa (Bardejovské kúpele, a. s.), Natural Iodine Spa Číž (Prírodné jódové kúpele Číž, a. s.), Spa Dudince (Kúpele Dudince, a. s.), Spa Kováčová (Kúpele Kováčová, s. r. o.), Spa Bojnice (Kúpele Bojnice, a. s.), Spa Horný Smokovec (Kúpele Horný Smokovec, s. r. o.), Spa Lúčivná (Kúpele Lučivná, a. s.), Spa Lúčky (Kúpele Lúčky, a. s.), Spa

Nový Smokovec (Kúpele Nový Smokovec, a. s.), Spa Vyšné Ružbachy (Kúpele Vyšné Ružbachy, a. s.), Specialized Medical Institute Marína (Špecializovaný liečebný ústav Marína, š. p.), Spa Nimnica (Kúpele Nimnica, a. s.), PIENINY RESORT, s. r. o., Slovak Health Spa Piešťany (Slovenské liečebné kúpele Piešťany, a. s.), Slovak Health Spa Rajecké Teplice (Slovenské liečebné kúpele Rajecké Teplice, a. s.), Spa Sliač (Kúpele Sliač, a. s.), Slovthermae Spa Diamant Dudince (Slovthermae kúpele Diamant Dudince, š. p.), Spa Štós (Kúpele Štós, a. s.), Spa Trenčianske Teplice (Kúpele Trenčianske Teplice, a. s.), Slovak Health Spa Turčianske Teplice (Slovenské liečebné kúpele Turčianske Teplice, a.s.).

The selection of financial indicators was designed to comprehensively cover the key aspects of corporate performance: profitability, efficiency, debt, liquidity, and cost. The chosen set of indicators includes:

- Return on Assets (ROA): This indicator measures a company's ability to generate profit from its total assets. A higher ROA signifies more efficient use of assets to produce earnings.
- Return on Sales (ROS): This ratio measures EBT (Earnings Before Taxes) as a proportion of total sales. It indicates the company's ability to generate operating profit from its revenues. A higher ROS suggests efficient cost management and strong operational performance.
- Assets Turnover (AT): This ratio measures how efficiently a company uses its assets to generate revenue by indicating how many times assets are "turned over" during an accounting period. A higher asset turnover ratio reflects greater efficiency in utilizing assets to drive sales.
- Equity to Total Liabilities Ratio (E/TL): This indicator reflects a company's financial structure by showing the proportion of financing from equity relative to total liabilities. A higher ratio indicates a healthier capital structure and lower reliance on debt. For companies in the tourism sector (including spas), a recommended value is ≥ 0.5, meaning that equity should cover at least half of the liabilities. A value below 0.3 may signal a risk of over-indebtedness and reduced financial stability.
- Net Working Capital (NWC): This indicator represents the difference between current assets and current liabilities. It indicates the company's liquidity reserve and its ability to meet short-term obligations using its own operational resources.
- Debt Ratio (DR–Total debt to total assets ratio): This ratio represents the proportion of total assets financed by liabilities and serves as an indicator of financial stability. A value above 60–70% may suggest a high reliance on external financing and increased vulnerability during periods of reduced revenue.
- Current Ratio (CR): This ratio measures a company’s ability to meet its short-term liabilities using its current assets. A value greater than 1 is generally considered a sign of good short-term financial health.
- Personnel Cost Ratio (PCR–Personnel costs to total costs): This indicator represents the share of personnel costs in total costs, reflecting the company’s labor intensity and the effectiveness of its human resource management.
- Cost-to-Sales Ratio (CSR): This ratio measures overall operating efficiency, with a higher value indicating lower profitability.
- Return on Costs (ROC): This ratio measures profitability relative to the costs incurred, indicating the company’s ability to generate profit from its expenses.

The aim of this paper is to analyze the development of financial indicators of Slovak spa companies over the period 2013–2023, with a particular focus on identifying differences across the pre-pandemic, pandemic, and post-pandemic periods. Rather than tracking trends or changes in indicator values themselves, the study tests whether company performance, as reflected by specific indicators, differed significantly across these distinct timeframes. The analysis does not examine performance development at the individual company level, as variations in size, ownership, and operating conditions among spa entities could distort the results of direct inter-company comparisons.

For the global comparison of an indicator’s development over multiple years, the Friedman test for repeated measures was used. When results were statistically significant, pairwise post-hoc comparisons were conducted using Wilcoxon tests, with the Holm-Bonferroni correction applied to control for multiple comparisons.

Given the nature of the data and the lack of normal distribution for most analyzed indicators (confirmed by the Shapiro-Wilk, Lilliefors, and Jarque-Bera tests), non-parametric methods were employed in the analysis. To test for differences between years, the Friedman test for repeated measures

(Friedman ANOVA with Kendall's Coefficient of Concordance) was used, as it assesses whether the distribution of a given indicator differs across multiple time points. When results were statistically significant, post-hoc Wilcoxon matched-pairs tests with Holm-Bonferroni correction were applied to control for type I errors in multiple comparisons. Data processing and statistical analyses were conducted using Gretl, Statistica, and Microsoft Excel.

3. Results

This section presents the findings of the analysis of financial performance indicators for Slovak spa companies over the period 2013 to 2023. First, the average values and trends of key financial indicators are described to provide an overview of sector performance over time. Following this, statistical tests are applied to determine whether there are significant differences in company performance across three key periods: before the pandemic (2013–2019), during the pandemic (2020–2021), and after the pandemic (2022–2023). The results offer insights into how the pandemic and subsequent recovery affected the financial stability and efficiency of the sector.

3.1 Descriptive Analysis of Financial Indicators Over Time

The following section presents the results of an analysis of the financial indicators of Slovak spa companies over the period 2013 to 2023. Table 1 presents descriptive statistics (mean, media, and standard deviation) of the financial indicators for each period. For greater clarity, Figure 1 illustrates the trends in the average values of individual financial indicators over time.

The development of profitability and efficiency indicators—ROA, ROS, and ROC—reveals significant differences across the periods before, during, and after the pandemic. ROA declined during the pandemic, dropping from a positive value of 0.0275 to –0.0446, reflecting the impact of income losses and rising costs on overall asset profitability. This decline was primarily caused by the complete shutdown of spa operations in the spring of 2020, followed by limited operations under the VTR (vaccinated, tested, recovered) and VR (vaccinated, recovered) regimes, as well as a reduced demand for medical stays due to fear of infection. In the post-pandemic period, ROA gradually recovered to 0.0558, exceeding its pre-pandemic level. This recovery was largely driven by the lifting of restrictions, the return of both domestic and international clientele, and increased demand for preventive healthcare services.

A similar, but even more pronounced trend was observed in the ROS indicator, which declined from 0.0495 in 2019 to –0.1104 in the first year of the pandemic. This sharp drop in ROS underscores the severe impact of restrictions and reduced demand, as many facilities were forced to operate below capacity. Negative ROS values persisted through 2021 and 2022, reflecting ongoing challenges from the pandemic's aftermath, compounded by rising operating costs. After the complete lifting of restrictions, ROS rebounded sharply to 0.7986, exceeding its pre-pandemic level—mirroring the recovery seen in ROA. This significant increase may be attributed to cost rationalization, a surge in deferred (catch-up) demand, and enhanced operational efficiency within spa facilities.

ROC also turned negative during the pandemic, falling from 0.0500 to –0.0793. This decline can be attributed to the high proportion of fixed costs—such as wages, overhead (operating) costs, and facility maintenance—that remained constant despite significantly reduced operations. In the post-pandemic period, the indicator recovered to 0.0718, reflecting improved performance driven by resumed operations and higher occupancy rates.

Asset utilization efficiency, as measured by AT, was highest in 2018 (0.6111), declined slightly during the pandemic (to 0.4922 in 2020 and 0.4611 in 2021), and then increased significantly post-pandemic, reaching 0.7986 in 2023. This trend indicates that, following the challenging pandemic period, spa facilities successfully adapted to new conditions by improving capacity utilization and using their assets more efficiently—likely supported by digitalization and more effective reservation management.

The financial structure, as reflected by the Equity to Total Liabilities Ratio, exhibited a distinct trend over the observed period. The ratio increased significantly in 2018—from 2.5830 to 4.5776—which may be attributed to partial debt repayment or the reinvestment of profits from prior years. A more notable decline occurred in 2023, when the ratio dropped to 2.9585, likely due to increased reliance on external financing to cover operating and investment costs (e.g., energy modernization). Nevertheless, the average value remained above 2 throughout the period, indicating a relatively low dependence on external funding and a generally stable financial position within the sector. These findings suggest improved financial stability following the pandemic, though the potential for high variability among individual companies—outside the scope of this analysis—should be acknowledged.

Table 1. Descriptive Statistics of Financial Indicators Over Time

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Return on Assets										
Mean	0.0289	0.0258	0.025	0.0173	0.0138	0.0139	0.0275	-0.0446	-0.015	-0.0128	0.0558
Median	0.0272	0.0283	0.026	0.0282	0.0195	0.0161	0.0267	-0.0231	-0.0057	0.0114	0.0767
Std. Dev.	0.072	0.0459	0.0412	0.0539	0.0613	0.0581	0.0616	0.0869	0.1039	0.1301	0.1076
	Return on Sales										
Mean	0.0576	0.0396	0.0487	0.0337	0.0301	0.0287	0.0495	–0.1104	–0.0805	–0.0463	0.0758
Median	0.0448	0.051	0.0446	0.0379	0.0425	0.0265	0.0417	–0.0411	–0.0297	0.0162	0.0941
Std. Dev.	0.1823	0.1096	0.0921	0.1153	0.1106	0.0977	0.1046	0.1969	0.2237	0.1814	0.1509
	Asset Turnover										
Mean	0.5368	0.5542	0.5146	0.557	0.5759	0.6111	0.6074	0.4922	0.4611	0.6192	0.7986
Median	0.4877	0.5342	0.5163	0.5801	0.5875	0.6243	0.6509	0.4616	0.4777	0.6039	0.7206
Std. Dev.	0.285	0.2545	0.1917	0.2073	0.2043	0.2298	0.2721	0.2334	0.2646	0.3265	0.3601
	Equity to Total Liabilities Ratio										
Mean	2.6185	2.5015	2.5771	2.596	2.583	4.5776	4.7421	4.8346	3.722	3.0849	2.9585
Median	2.1389	1.7391	2.2121	2.3613	2.4175	2.8317	3.2467	3.1282	3.092	2.5859	2.8931
Std. Dev.	2.0302	1.9919	1.7539	1.6703	1.5248	5.3509	4.7375	5.2093	3.367	2.9941	2.6732
	Net Working Capital										
Mean	–98,271.65	344,183.95	323,601.90	491,006.35	401,334.30	1,293,601.05	1,643,445.30	1,339,363.85	1,171,669.70	1,298,236.30	1,565,358.40
Median	85,920.00	82,142.50	–11,271.00	–79,048.50	–403,269.00	278,651.50	492,800.50	468,491.50	736,797.00	594,570.00	1,034,621.00
Std. Dev.	2,095,748.55	1,888,473.91	2,256,752.48	2,935,744.07	2,916,689.83	2,414,977.60	2,570,530.84	2,037,998.87	2,131,512.01	2,377,827.23	2,690,384.53
	Debt Ratio										
Mean	0.1792	0.1845	0.1673	0.1703	0.1868	0.0768	0.08	0.0885	0.0899	0.1198	0.1186
Median	0.116	0.1459	0.1394	0.1193	0.1092	0.0808	0.0755	0.0601	0.08	0.1002	0.0962
Std. Dev.	0.2207	0.2046	0.1613	0.2019	0.2714	0.0313	0.0376	0.0645	0.0707	0.0966	0.0833
	Current Ratio										
Mean	2.1174	2.0753	2.2803	2.2989	2.1631	2.8526	3.3157	3.0123	3.3369	2.9518	2.8129
Median	1.2568	1.0703	0.9649	0.9832	0.6728	1.5371	1.897	2.2204	2.2316	1.8771	2.4763
Std. Dev.	2.5261	2.5474	3.4128	3.4813	3.308	3.1497	3.1805	3.1906	3.9954	4.2086	2.9155
	Personnel Cost Ratio										
Mean	0.3507	0.3755	0.3915	0.3904	0.4066	0.4152	0.4341	0.4707	0.4597	0.4425	0.4321
Median	0.3414	0.3697	0.3754	0.3876	0.409	0.4029	0.4447	0.4697	0.4744	0.4384	0.4452
Std. Dev.	0.1077	0.0971	0.0964	0.1017	0.1014	0.1096	0.1476	0.1047	0.097	0.1092	0.1175
	Cost-to-Sales Ratio										
Mean	1.1471	1.0232	1.0165	1.0341	1.0357	1.0646	0.995	1.2628	1.3429	1.1672	0.9723
Median	0.9905	0.9888	1.0017	1.0083	0.9982	1.0674	0.9846	1.1877	1.2203	1.0877	0.9571
Std. Dev.	0.5652	0.1496	0.1398	0.1599	0.1571	0.1592	0.1743	0.2686	0.2977	0.2282	0.2947
	Return on Costs										
Mean	0.0305	0.0389	0.0437	0.0317	0.0291	0.0234	0.05	–0.0793	–0.0277	–0.0159	0.0718
Median	0.0352	0.0345	0.0192	0.0256	0.0275	0.0161	0.0286	–0.0444	–0.0243	0.0087	0.0979
Std. Dev.	0.1003	0.12	0.116	0.1398	0.1258	0.1136	0.1267	0.1294	0.1747	0.1584	0.1416

Source: own processing
Note: Std. Dev. denotes standard deviation.

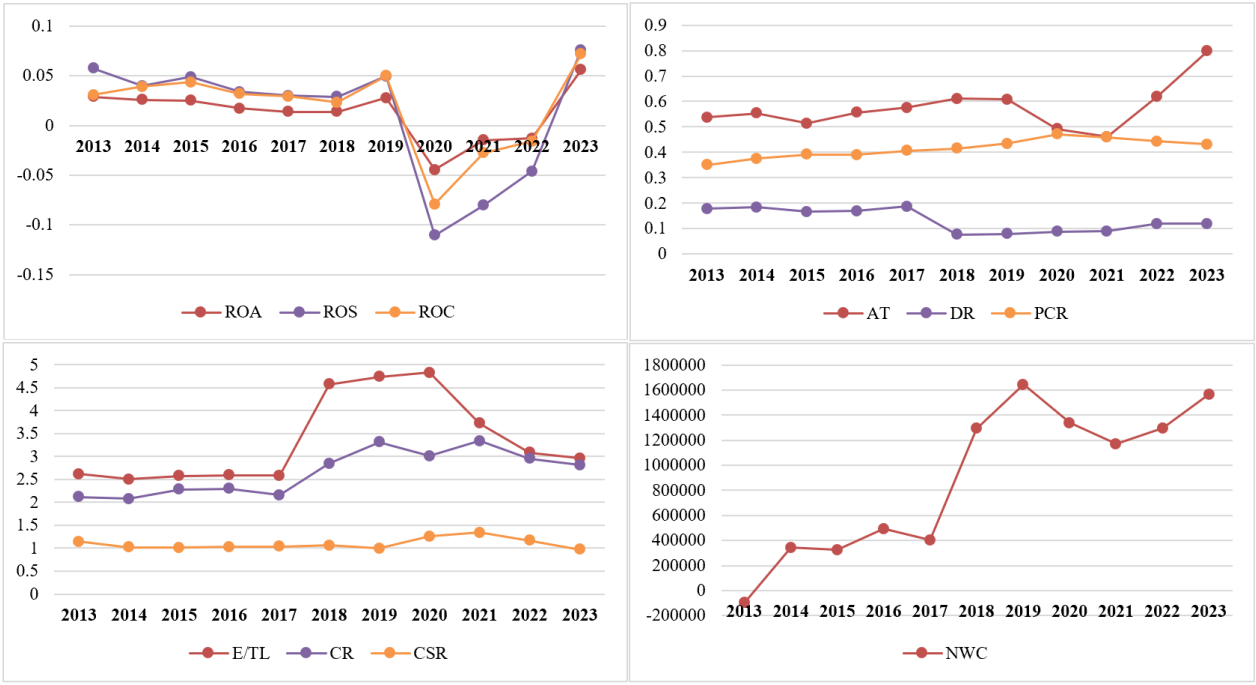

Figure 1. Trends in the Average Values of Financial Indicators Over Time
Source: own processing

The debt ratio gradually declined from 0.1792 in 2013 to 0.0768 in 2018, suggesting a gradual consolidation of corporate finances, loan repayments, or increased reliance on self-financing. However, since 2018, the ratio has steadily risen to 0.1186 in 2023, likely due to sudden energy costs, investments in energy-efficient technologies, and possible use of bridging finance.

Net working capital increased sharply in 2018, rising from €401,334.30 to €1,293,601.05 and then to €1,643,445.30. This growth likely resulted from a reduction in short-term liabilities combined with an accumulation of current assets. During the pandemic, net working capital decreased by over €300,000 to €1,339,363.85, reflecting lost sales, reduced receivables, and lower turnover. By 2023, it has nearly returned to its pre-pandemic level, indicating a recovery in operations and favorable turnover trends.

The assessment of the current ratio is noteworthy, as it rose to values above 3 during the pandemic and the period of stricter restrictions. This increase may paradoxically result from halted investment activities, slower turnover of current assets, and an accumulation of cash or receivables held by companies as a precautionary reserve.

The personnel cost ratio showed consistent growth until 2021, when it began to decline slightly. This change may be attributed to adjustments in personnel costs, the reduction of redundant staff, optimization of work shifts, or a shift in service offerings that require less labor.

The Cost-to-Sales Ratio increased from 0.9950 to 1.3429 in 2021 during the pandemic, resulting in reduced profit margins. This rise was driven not only by lower sales but also by higher energy costs, enhanced hygiene measures, and inefficiencies linked to reduced operating capacity. Following the pandemic and the energy crisis, the ratio declined to 0.9723 in 2023, reflecting improved cost management and successful adaptation to the evolving market conditions.

3.2 Testing for Significant Differences in Spa Sector Performance Across Periods

The primary objective was to determine whether there are statistically significant differences in company performance across three key periods: before the pandemic (2013–2019), during the pandemic (2020–2021), and after the pandemic (2022–2023). Given the non-parametric nature of most data, the Friedman ANOVA test for repeated measures was used to assess differences between periods. When the test indicated statistically significant differences, post-hoc Wilcoxon paired tests with Holm-Bonferroni correction were performed.

Table 2 presents the results of tests for statistically significant differences in selected financial indicators across the defined periods. The analysis revealed that a statistically significant difference was found for all indicators except the Equity-to-Liabilities Ratio, which reflects the company's financial structure (p = 0.2242). The average values of this ratio remained above 2 in each year, indicating that

equity substantially exceeds liabilities and that the capital structure of Slovak spa companies has remained stable overall. While individual spa companies may show significant variation in this indicator, this analysis focuses on differences at the sector level.

In contrast, the Friedman ANOVA test revealed statistically significant differences over the observed years for all other indicators ($p < 0.05$), indicating that the performance of spa enterprises during the analyzed period was influenced by external economic and epidemiological factors. The highest values of the coefficient of concordance were observed for the indicators AT, PCR, and CSR, reflecting a strong consistency in year-to-year changes across companies for these measures.

Table 2. Friedman ANOVA Test – Results of Testing

Financial Indicators	ANOVA χ^2	*p*-value	Coefficient of Concordance	Average rank *r*
Return on Assets	7.2636	**0.0000**	0.2363	0.1961
Return on Sales	41.5556	**0.0000**	0.2309	0.1856
Asset Turnover	84.6988	**0.0000**	0.4235	0.3932
Equity to Total Liabilities Ratio	12.9909	0.2242	0.0650	0.0157
Net Working Capital	34.4909	**0.0002**	0.1725	0.1289
Debt Ratio	53.4909	**0.0000**	0.2675	0.2289
Current Ratio	36.1455	**0.0001**	0.1807	0.1376
Personnel Cost Ratio	77.9426	**0.0000**	0.4102	0.3775
Cost-to-Sales Ratio	67.8990	**0.0000**	0.3772	0.3406
Return on Costs	45.1866	**0.0000**	0.2378	0.1955

Source: own processing

Post-hoc Wilcoxon paired tests with Holm-Bonferroni correction were conducted only for indicators where Friedman's ANOVA indicated statistically significant differences ($p < 0.05$). These tests identified specific periods during which the performance of spa enterprises experienced significant changes.

For the ROA indicator, significant differences were observed between the pre-pandemic period (2013–2019) and the pandemic years (2020–2021), reflecting a substantial decline in asset profitability due to revenue losses. Additionally, significant differences were found between the pandemic period and 2023, indicating a phase of stabilization following the lifting of most restrictions. The notable difference between 2022 and 2023 may also be attributed to the easing of the energy crisis, which primarily impacted costs in 2022.

Similarly, the ROS indicator exhibited significant differences between the pre-pandemic years and the periods affected by the pandemic and energy crisis. The reduced ROS from 2020 to 2022 reflects lower occupancy rates, increased costs, and operational restrictions. However, in 2023, ROS rose significantly, signaling not only a recovery in the sector but also the impact of cost-saving measures and partial reductions in operating expenses.

For the AT indicator, significant differences were observed across several years, with notable increases in efficiency during 2022–2023. This improvement, alongside changes seen during the pandemic period, may reflect investments in modernization and digitalization of services following the pandemic.

Significant differences in NWC were especially evident between the pre-pandemic years and the period from 2018 to 2023. The sharp increases during this time may be attributed to changes in the composition of receivables and inventories (e.g., influenced by state aid), as well as subsequent adjustments and cost increases driven by inflation and rising energy prices.

The DR fluctuated primarily between the pre-pandemic period and subsequent years. The slight increase in debt after 2019 may be attributed not only to the pandemic but also to the need for refinancing rising input costs during the energy crisis, particularly in 2022.

The CR increased during the pandemic, likely reflecting more cautious cash management and increased provisioning, partly supported by state aid. Furthermore, the significant differences observed between 2015–2019 and 2021 may be attributed to changes in the composition of short-term assets, driven by deferred investments and more conservative financial management.

The PCR (personnel costs to total costs) showed statistically significant differences across most of the years analyzed, indicating a long-term upward trend in personnel expenses. More pronounced changes were observed during the pandemic, with a decrease linked to operational shutdowns and short-time work

schemes. A renewed increase in 2022–2023 suggests a rebound in staffing costs, although this may have been moderated by workforce optimization efforts.

The CSR increased during the pandemic and energy crisis, as evidenced by the significant difference between 2019 and 2022. However, the decline observed in 2023 may indicate stabilizing energy prices and improved operational efficiency.

Finally, the ROC indicator proved to be the most sensitive to cost fluctuations. Statistically significant differences were observed between the pre-crisis period and 2020, as well as between the pandemic years and 2023. ROC remained negative from 2020 to 2022 but returned to positive values in 2023, likely due to cost-reduction measures and a decline in energy-related expenses.

In summary, statistically significant differences in the analyzed indicators were most frequently observed:

- between the pre-pandemic period (2013–2019) and the pandemic years (2020–2021),
- between the pandemic period and 2023, indicating a partial recovery of the sector,
- and, in some cases, between the pandemic years and the energy crisis period (2022), particularly for the indicators ROS, CSR, ROC, and NWC.

These differences highlight the multifaceted impact of the COVID-19 pandemic and the subsequent energy crisis, as well as the effects of management responses and state support. Spa businesses adapted by restructuring costs, adjusting liquidity, and modifying employment practices.

4. Discussion

The analysis of financial indicators for Slovak spa companies over the period 2013–2023 reveals the significant impact of the COVID-19 pandemic and the subsequent energy crisis on sector performance. These findings are consistent with existing literature, which emphasizes the high vulnerability of small and medium-sized enterprises in the tourism industry to external shocks. The pandemic triggered a sharp decline in revenues, rising costs, and operational restrictions, which—among the companies studied—were most evident in reduced profitability (as measured by ROA, ROS, and ROC) and shifts in both capital and cost structures (Kahveci, 2022; Mohammed, 2022).

In terms of resilience—understood as the ability of companies to adapt to and recover from crisis events—the findings align with the conclusions of Hall et al. (2022), who highlight the predominance of “engineering resilience” in the hospitality and spa sector, where recovery is defined as a return to pre-crisis performance levels. The notable increase in ROA and ROS in 2023 can be seen as evidence of the sector's recovery capacity, supported by government incentives and the easing of restrictions. However, as noted by Prayag and Dassanayake (2023), recovery is not solely determined by external factors, but also by internal organizational resilience—shaped, for example, by employee creativity and adaptive strategies.

The development of the cost-to-sales ratio is particularly noteworthy. It rose sharply during the pandemic and then declined during the energy crisis in 2022–2023. This trend can be attributed to a combination of reduced sales, rising energy prices, and persistent fixed costs—especially in older, seasonally operated facilities. These findings are consistent with Kahveci (2022), who noted that small and medium-sized enterprises in the tourism sector faced not only significant revenue losses during the crisis, but also increasing operational costs and mounting pressure to adapt or transform their business models.

The analysis of year-to-year differences reveals that statistically significant changes most frequently occurred between the pre-pandemic period (2013–2019) and the pandemic years (2020–2021), as well as between the pandemic and the post-pandemic period (2023). These findings align with studies examining entrepreneurial behavior in post-crisis contexts (Lin et al., 2025), which suggest that the decision of businesses to continue operating after a crisis is influenced not only by objective financial indicators but also by individual characteristics of business leaders—such as age, optimism, and the ability to navigate uncertainty.

Consistent with the findings of Mohammed (2022), it appears that maintaining long-term economic, social, and environmental balance in the spa industry will be more challenging in the post-crisis period—particularly for smaller enterprises with limited access to investment capital. These businesses face the dual pressure of ensuring short-term survival while pursuing long-term sustainability strategies. The increased variability in financial indicators across companies also suggests differing levels of adaptive capacity, which may be influenced not only by economic factors but also by the quality of managerial decision-making, the degree of digitalization, and engagement in regional support networks.

Despite the use of established statistical methods and a systematic approach to data analysis, several limitations of this research must be acknowledged. Financial indicators of Slovak spa companies were analyzed for the period from 2013 to 2024; however, the quality and completeness of the data varied across years. In some instances, companies underwent restructuring, reported zero values in accounting items, or had missing data for the final year, which may have impacted the overall reliability of the results. Due to the relatively small sample size (20 spa companies) and the heterogeneous nature of the companies, a conservative analytical approach was adopted to account for sample variability and minimize the risk of drawing incorrect conclusions. Consequently, non-parametric tests (Friedman ANOVA and Wilcoxon paired tests) were employed, as they do not require the assumption of normally distributed data. Additionally, post-hoc comparisons were adjusted using the Holm-Bonferroni correction to reduce the likelihood of false positive results arising from multiple testing.

Despite these precautions, the results should be interpreted with caution. Potential distortions may arise from high variability between companies and delayed accounting recognition of external crisis impacts—whether due to pandemic restrictions, state aid, or legislative changes. Moreover, some companies exhibited fluctuations driven by their own strategic decisions or asset developments, rather than solely by pandemic or macroeconomic factors. Therefore, this study is primarily exploratory in nature. It does not aim to draw definitive conclusions applicable to the entire spa sector but rather provides insights into the financial indicator trends during a period heavily influenced by external crises. The findings should be viewed as a foundation for further research rather than a conclusive evaluation of the sector's situation.

Conclusion

This paper aimed to analyze the development of financial indicators of Slovak spa companies over the period 2013–2023, with a particular focus on identifying differences across the pre-pandemic, pandemic, and post-pandemic periods. Using non-parametric statistical methods, the study identified statistically significant differences in several key financial indicators related to profitability, costs, liquidity, and debt. The most pronounced shifts were observed between the pre-pandemic years, the height of the COVID-19 crisis, and the gradual stabilization seen in 2023.

The findings confirm the high vulnerability of the spa sector—particularly small and medium-sized enterprises—to external shocks such as global health crises and energy price volatility. At the same time, early signs of recovery in 2023 suggest a degree of sectoral resilience, likely supported by a combination of state aid, internal adaptation strategies, and renewed demand for preventive healthcare services.

These results are primarily exploratory and should be interpreted with caution given limitations in data quality, sample size, and the heterogeneity of the spa companies analyzed. Nonetheless, the study contributes to a better understanding of crisis-related financial dynamics in the spa sector and highlights the need for strategic flexibility and resilience planning.

Future research could build on this work by conducting cross-country comparisons within the Visegrád Group (V4), integrating qualitative insights from managers and staff, or expanding the analysis to include environmental and social dimensions in line with sustainability goals. Such interdisciplinary approaches will be critical in shaping more robust and adaptive business models for the spa and wellness industry in a post-crisis world.

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Perceptions of City Image Among Millennials: The Case of Prague, Vienna, and Budapest

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Abstract

Research background: Destination image, i.e., a purposefully formed image of a destination, plays a crucial role in describing, promoting, and distributing a destination product. It influences tourists' decisions about which destination to visit and what emotions, ideas, and stereotypes they have associated with a certain place as a tourist destination.
Purpose of the article: The paper aims to evaluate the perception of the image of three European metropolises – Prague, Vienna, and Budapest – by Generation Y (millennials).
Methods: Quantitative data were collected through a structured questionnaire survey. Five sections were examined (Environmental Beauty & Convenience, City's Citizens, Local Culture & Cuisine, Shopping & Tourist Accommodation, and Place & Architectural Structure). Data collection took place from October 2020 to January 2021, and 200 respondents participated. ANOVA and Tukey HSD tests were used to evaluate the results.
Findings & Value added: The results show that the image of the surveyed cities was perceived positively by representatives of Generation Y. The participants found Prague, Vienna, and Budapest safe, progressive, and well-maintained cities. These mentioned cities must keep this positive image in the future – competition between destinations is increasing, and only a destination with a suitably formulated image can attract visitors. Cities attract visitors thanks to their positive image, but they should be aware that it is not only important to attract visitors, but it is much more important to retain them.

Keywords: Urban destination branding, Tourist attitudes, Youth travel behavior

JEL classification: L83, Z32

1. Introduction

Destination image is a complex construct comprising cognitive (cognitive), affective (emotional), and conative (behavioral) components that together influence tourists' decision-making processes. Research in recent years has focused on four main areas: the structure of destination image, its measurement and branding, the factors influencing its formation, and the impact of image on tourist behavior. Destination image influences tourists' perceptions and opinions of a place and plays a crucial role in their behavior and decision-making process related to travel and tour purchases. For example, the use of big data analytics from online reviews provides a deeper understanding of how tourists perceive different aspects of destinations and how these perceptions vary over time and between various locations (Afshardoost & Eshaghi, 2020; Chu et al., 2022; Lalicic et al., 2021). Creating a positive destination image is crucial as it influences the attractiveness of a place, with an emphasis on authenticity, availability of engaging activities, and aesthetics of the environment (Aditya et al., 2022). Destination image influences activities, expenditures, length of stay, and tourists' choice of itinerary (Borlido & Kastenholz, 2021, 2023), and if satisfied, the destination in question will be revisited (Acharya et al., 2023).

The image of a destination is fundamentally shaped by physical space and architectural structures, as the place as a visual and spatial framework often forms the visitor's first impression and serves as a

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symbol of the destination. Historical architecture contributes to the image of authenticity, cultural depth, and continuity, while modern architecture can express innovation, creativity, or status.

Scholz et al. (2023) state that destination image and sustainability are closely linked concepts today, as more and more tourists consider destinations' environmental and social responsibility when making travel decisions. A strong and positive destination image often also includes the perception of its sustainability. Sustainable practices (e.g., environmentally friendly transport and accommodation, recycling, protection of cultural heritage) reinforce a positive cognitive image – the city is perceived as responsible, modern, and "green". Many cities are actively working to create a "green" image – e.g., Copenhagen, Ljubljana, Amsterdam – through environmental policy and marketing.

The image of a destination is fundamentally influenced by the people who create, represent, and experience it (Yuliana et al., 2023). These are residents, tourists, tourism workers, or influencers – they are not just passive actors but active creators of the perception of the destination. Travel bloggers influence the perception of the destination through netnography. They significantly shape the destination's image and motivate their followers to visit, even if they did not know the destination before (Gholamhosseinzadeh et al., 2023). Different platforms address different groups (e.g., TikTok – young people, Instagram – visual culture, Facebook – older target group). Each group may have a different perception of the same city based on the content they consume. The image of cities is changing significantly with the advent of social networks – both in how cities present themselves, and visitors and locals perceive them. This process is dynamic, decentralized, and often beyond the control of official institutions. We can state that traditionally the image of cities was shaped by official institutions (DMC, city PR). Currently, the image of destinations is created and disseminated by ordinary users, e.g., travelers, influencers, and residents. The photos shared by users have a greater impact on improving the image of a destination than the content shared by official tourism organizations (Bernkopf & Nixon, 2019). The result is a plurality of city images, which may not be uniform or strategically managed. Social media provides more diverse and specific information about a destination than surveys, which offer deeper insight into tourists' subjective evaluations and emotional ties (Lin et al., 2021). Considerable emphasis is placed on visuality, and cities are increasingly perceived through visual content (photos, videos, reels, stories). Some locations are thus becoming viral, which leads to a change in tourist behavior – e.g., overtourism Instagram spots. Social networks present a city through emotions and personal experiences, whether positive or negative. This form of communication has a greater impact on perceptions of authenticity than formal marketing. It increases opportunity but also vulnerability. A city can gain publicity in a matter of hours.

The image of a destination is powerfully shaped by local culture and cuisine, as these elements create an authentic and sensory-rich experience that distinguishes one destination from another. Modern travelers often seek places, cultural contact, and taste experiences that shape their perception and memories of a destination. Cultural factors such as art and film also have an influence. For example, film locations can enhance the perception of authenticity and emotional attachment to a place, affecting tourists' willingness to participate in protecting cultural heritage (Borlido & Kastenholz, 2023). In an urban context, a destination's image is shaped by visitors' specific characteristics, such as their demographics or preferences. It is also strongly influenced by the visual impression on social networks like Instagram or YouTube. Technological advances and changes in society, such as the COVID-19 pandemic, have also affected the perception of the safety of destinations and, thus, their overall image. Perceptions of safety are closely linked to a positive destination image, especially in the areas of healthcare, infrastructure, and services provided. User-generated content (UGC) from social media is an essential marketing resource in the current digital age and a necessary means of understanding users' perspectives (Sang et al., 2024).

The image of a destination is also significantly influenced by shopping opportunities and the quality of accommodation, as these elements form an essential part of the perception of comfort, accessibility, and attractiveness of a place. While culture and nature shape the emotional identity, shopping, and accommodation shape the practical-hedonistic dimension of the destination image, especially in urban areas. Shopping is not only related to luxury – it includes markets, design districts, local shops, traditional crafts, souvenirs, and modern shopping centers. Quality and unique shopping can influence loyalty to a destination (Moscardo et al., 2025). Luxury hotels contribute to the image of exclusivity, while boutique and theme hotels can support a cultural or alternative image. Eco-friendly hotels and guesthouses strengthen the image of a responsible and environmentally conscious destination (Vrabcová et al., 2024), and ecological hotel practices increase the intention to visit a hotel in a given destination (Dang-Van et al., 2023).

Tourists often combine shopping, accommodation, culture, and gastronomy into a holistic perception of a destination – image is not perceived separately. Research on the image of urban destinations is dynamic and multifactorial, highlighting the importance of digital media, cultural factors, and tourist behavior. Understanding these aspects is key to effective marketing and sustainable urban tourism development.

2. Methods

The aim of the paper is to assess the perception of the image of three European metropolises – Prague, Vienna, and Budapest by Generation Y. Representatives of this generation, also referred to as millennials, include people born in 1981–1996. They are characterized by self-confidence, optimism, and unpredictability. They are focused on materialistic values, support the rights of homosexuals and minorities in society, are interested in the environment, prefer a healthy lifestyle, welcome change, and are also capable of rapid adaptation. Millennials are the first generation to grow up with access to digital technologies such as computers, mobile phones, and the internet, influencing their way of communicating, working, and having fun (Dimock, 2019). The following hypothesis H1 was set in connection with the aim: *There is a significant difference between the destination images of Prague, Vienna, and Budapest*. All the named cities are capitals located in Central Europe and are similar in size and population.

Quantitative data were collected through a structured questionnaire survey. Data collection took place from October 2020 to January 2021, and 200 respondents (men=106, women=94) participated. The questions included in the questionnaire survey were formulated analogously to the research already conducted in 2008 entitled Measuring the Destination Images of European Countries (Bozbay & Özen, 2008). Four closed questions were aimed at determining sociodemographic indicators. Specifically, questions were asked about gender, age (the question focused on age was selective; if the respondent did not fall into the listed categories, he was asked not to participate in the research further), and education. The fifth closed question was aimed at determining whether the respondent had already visited some or some of the surveyed cities in the past. There was an option to answer that the respondent had not yet visited any of the mentioned cities.

A total of 22 items were examined in five sections – Environmental Beauty & Convenience, City's Citizens, Local Culture & Cuisine, Shopping & Tourist Accommodation, and Place & Architectural Structure. *Environmental Beauty & Convenience* section consists of eight items: (1) there are many gardens and parks in this city, (2) this city has well developed transport system, (3) highways and roads are in good condition in this city, (4) it is easy to get good service in restaurants and hotels in this city, (5) this city is clean and green, (6) this city is an orderly city, (7) this city is a safe place to visit and (8) this city is a progressive city. *City's Citizens* section includes four items relating to (9) the local people are courteous, (10) the local people are honest, (11) the local people are friendly, and (12) the local people are hardworking. *Local Culture & Cuisine* section is composed of three items such as (13) the lifestyles and customs in this city are similar to those in my city, (14) the architectural styles of the buildings are similar to those in my city, and (15) the food in this city is similar to ours. *Shopping & Tourist Accommodation* section consists of four items such as (16) this city is a good place to shop, (17) good quality of products are available in this city, (18) food is varied and exotic in this city, and (19) there are a wide variety of products available in this city. The last section called *Place & Architectural Structure* includes variables like (20) there are many interesting places in this city, (21) there are many restful and relaxing places in this city, and (22) there are lots of natural scenic beauties in this city.

A Likert scale was used to valorize the importance of the sections, assigning the answer weight to the numbers 1 – I completely agree, 2 – I agree, 3 – I do not know, 4 – I rather disagree, and 5 – I disagree. ANOVA and Tukey HSD tests were used to evaluate the results.

3. Results and Discussion

Almost half of the respondents (47%) reported secondary school as their highest level of education, followed by respondents with university education (33%) and higher vocational education (18%), and the category with primary education as the highest level of education, was represented by 3% of respondents. Almost every respondent (91%) visited Prague, 73% of respondents visited Vienna, and 51% of respondents had the opportunity to visit Budapest. Only 5% of respondents did not visit any of the cities surveyed.

Respondents rated individual cities using a Likert scale (1 – completely agree, 5 – disagree), i.e., the lower the number, the better the city is. Regarding the beauty and comfort of the environment, Vienna

comes out best (average of 1.948), while Budapest comes out worst with an average of 2.313. The city of Vienna also came out best in terms of the city´s citizens (2.302) and shopping & tourist accommodation (1.775) – although in the latter case, Prague achieved practically the same value (1.776). Respondents perceived that the image of Prague in terms of local culture & cuisine (2.066) and place & architectural structure (1.698) is higher than that of Vienna and Budapest. On the other hand, the capital of Hungary was perceived as the worst of the five sections (except for the city´s citizens – 2.461). Within the three cities surveyed, the place & architectural structure section was rated best overall (table 1).

Table 1. Averages of individual sections within the surveyed cities

City		EB	CC	LC	ST	PA
Prague	Mean	2.145	2.632	**2.066**	1.776	**1.698**
	N	200	200	200	200	200
	Std. Deviation	.624	.836	1.077	.720	.715
Vienna	Mean	**1.948**	**2.302**	2.513	**1.775**	1.765
	N	200	200	200	200	200
	Std. Deviation	.630	.646	.981	.724	.703
Budapest	Mean	2.313	2.461	2.778	2.198	1.980
	N	200	200	200	200	200
	Std. Deviation	.686	.664	.938	.811	.804
Total	Mean	2.135	2.465	2.452	1.916	**1.814**
	N	600	600	600	600	600
	Std. Deviation	.663	.732	1.041	.778	.751

Note 1: EB – environmental beauty & convenience, CC – city´s citizens, LC – local culture & cuisine, ST – shopping & tourist accommodation, PA – place & architectural structure
Source: own processing (2025)

The perception of a destination differs fundamentally depending on whether the tourist has already visited the place or knows it only indirectly (e.g., from the media, social networks, or marketing). Before visiting, the image of a destination is often influenced by idealization, stereotypes, and expectations that may not correspond to reality. Such perception is mainly cognitive and symbolic, based on external information. On the contrary, after visiting, the image of the destination changes – it acquires an emotional dimension based on personal experience. Tourists then evaluate the destination more comprehensively, positively or negatively, and their perception is more realistic, individual, and multi-layered. This experience often influences the willingness to revisit the destination or recommend it to others (word-of-mouth).

Table 2. Averages of individual sections within the surveyed cities (visit vs. no visit)

City visit		EB	CC	LC	ST	PA
Prague – no	Mean	2.006	2.500	1.754	2.368	1.807
	N	19	19	19	19	19
	Std. Deviation	.391	.552	.941	.642	.748
Prague – yes	Mean	2.160	2.646	2.099	1.714	1.686
	N	181	181	181	181	181
	Std. Deviation	.642	.860	1.088	.701	.713
Vienna – no	Mean	2.3310	2.5926	2.6605	2.1852	2.1049
	N	54	54	54	54	54
	Std. Deviation	.6225	.6149	.9007	.6973	.7873
Vienna – yes	Mean	1.8065	2.1952	2.4589	1.6233	1.6393
	N	146	146	146	146	146
	Std. Deviation	.5739	.6259	1.0066	.6755	.6270
Budapest – no	Mean	2.5354	2.5960	2.9495	2.5025	2.2559
	N	99	99	99	99	99
	Std. Deviation	.6371	.7682	.7654	.7067	.8190
Budapest – yes	Mean	2.0953	2.2871	2.6106	1.9010	1.7112
	N	101	101	101	101	101
	Std. Deviation	.6659	.8641	1.0594	.8008	.6948

Note 1: EB – environmental beauty & convenience, CC – city´s citizens, LC – local culture & cuisine, ST – shopping & tourist accommodation, PA – place & architectural structure
Source: own processing (2025)

Out of 200 respondents, only 19 people had not visited Prague. The environmental beauty & convenience section was perceived better by people who had not visited Prague (2.006 vs. 2.160); the same was true for the city's citizens section (2.500 vs. 2.646). On the other hand, people who visited Prague perceived the shopping & tourist accommodation section better (1.714 vs. 2.368). More than a quarter of respondents had not been to Vienna (n=54), and almost half of respondents had not been to Budapest (n=99). Both cities surveyed had a better perception of their image in all sections by respondents who had already visited the respective metropolises (table 2).

The ANOVA (table 3) shows differences between the three cities, Prague, Vienna, and Budapest. Therefore, we confirm hypothesis H1. We found that by subsequent post hoc tests (Tukey HSD tests), almost all pairs of cities differed, and the p-value was less than 0.05. There was a statistically significant difference in the environmental beauty & convenience section (PRG vs. VIE p=0.007; PRG vs. BUD p=0.027). The city's citizen's section shows no significant difference between VIE vs. BUD, p=0.072, but VIE vs. PRG, p=0.000. In the local culture & cuisine section, a difference is found in all pairs (PRG vs. VIE p=0.000; BUD vs. VIE p=0.023). Shopping & tourist accommodation section indicates PRG vs. VIE p=1.000; VIE vs. BUD p=0.000. In the cities of Prague and Vienna, the values are almost the same (table 1). Place & architectural structure shows PRG vs. VIE p=0.642; VIE vs. BUD p=0.011.

Table 3. ANOVA

		sum of squares	df	mean square	F	sig.
environmental beauty & convenience	between groups	13.352	2	6.676	15.911	.000
	within groups	250.502	597	.420		
	total	263.854	599			
city´s citizens	between groups	10.895	2	5.448	10.489	.000
	within groups	310.075	597	.519		
	total	320.970	599			
local culture & cuisine	between groups	51.747	2	25.874	25.829	.000
	within groups	598.026	597	1.002		
	total	649.773	599			
shopping & tourist accommodation	between groups	23.871	2	11.936	21.022	.000
	within groups	338.962	597	.568		
	total	362.833	599			
place & architectural structure	between groups	8.722	2	4.361	7.910	.000
	within groups	329.153	597	.551		
	total	337.876	599			

Source: own processing (2025)

The questionnaire survey shows that the image of Prague, Vienna, and Budapest is perceived as positive by representatives of Generation Y and their perception of these cities is positive. According to respondents, Vienna has the best ideas and emotional thoughts, i.e., the best-formulated image, followed by Prague (2.064). On the contrary, according to respondents, Budapest has the least purposefully formed image (2.346).

Respondents said a high-quality and appropriately built image is not a problem for Vienna. The survey results of the questionnaire show that respondents perceive the city as clean, safe, and progressive. According to respondents, the city is presented as a place with many gardens and parks. Such a reaction was expected because half of the city's area is made up of greenery. According to respondents, many interesting places also highlight the city's presentation. Some places, even with their monuments, are combined with history and nobility; others are modern and entertaining. When creating its image, Vienna is aware that it is essential to incorporate all types of these places externally. Historical places have a mysterious, enigmatic effect and attract visitors who are interested in history and architecture (Hofburg, Stephen's Cathedral). Modern places and buildings reflect elegance and topicality (high-rise buildings of Donau City). Entertainment places evoke feelings of happiness, experience, and joy and attract visitors with children or the young generation, i.e., individuals of Generation Y (Schönbrunn Zoo, Prater Park, bars). According to respondents, Vienna's positive image is built on natural and cultural-historical monuments and countless streets inviting people to shop or visit Viennese specialties. Most respondents stated that the food in Vienna is diverse and similar to ours. So many respondents found similarities in Czech and Austrian cuisine because some dishes were adopted from Czech cuisine into Austrian cuisine

and vice versa. Thus, Czech and Viennese cuisines intertwine. These city characteristics also play an essential role in association with Vienna, therefore completing the city's positive image.

Prague lagged behind Vienna by only 0.003 points on average and was chosen by respondents as a city with a powerful image. The capital of the Czech Republic builds this image on its greatest strengths, which, according to respondents, are its interesting natural places and buildings. This fact met expectations because the first associations that can be made with Prague are undoubtedly Prague buildings, or rather Prague monuments - Prague Castle, Vyšehrad, the National Theatre, and many others. Prague monuments evoke mystery, expectation, and surprise in people - something visitors and residents want to see with their own eyes. The positive image of Prague is also built by its rich history, the possibility of tasting typical Czech dishes, and the famous Czech drink - beer. This will be appreciated not only by representatives of Generation Y. Prague has a truly well-built image in recent years; the city has become typical for overtourism. Construction of new hotels and, compared to other major European cities, low accommodation prices (ADR € 116, OCC 75.2%), catering, and additional services. Steps should have been taken to ensure visitors do not disrupt the city's character. This retention can only be achieved when the number of visitors arriving at this destination is regulated and areas are not overloaded, where the excessive load would cause devastation. Regulating visitors can be helped by limiting the number of buses arriving in some parts of the city, increasing the fee for a recreational stay, etc. Less burden on highly visited areas could be achieved by a partial (e.g., temporary) or complete ban on entry to these places, by collecting fees in these places or by increased promotion of areas that are not yet frequently visited by tourists, e.g., Nový Svět alleys, Dívčí hrady, Divoká Šárka valley). Therefore, the starting point seems to be that Prague's image is so strong that it can attract many visitors. We believe that if more and more visitors were to flow into Prague, the result would be the devastation of monuments, deterioration of relations between locals and visitors, deterioration of the environment (e.g., excessive noise), and thus an overall deterioration of the city's image.

The results of the questionnaire survey show that representatives of Generation Y perceive the least developed image of the city of Budapest. It is positive but insufficient. This statement can be supported by the fact that individuals in the questionnaire survey most often answered with the word "I do not know". Therefore, they were unsure how the city affected them in the individual sections. It can also be stated that Budapest was not at the forefront in any of the surveyed sections. Respondents identified the least with the given statements that determined the respondents' view of the city, compared to Prague and Vienna. This is because Budapest was visited by the smallest number of respondents out of all three surveyed cities. Persons who have not visited the city (n=99) cannot have a formulated image based on their experiences. It is then formulated only from information from the mass media, family, or other sources. The image of Budapest should be strengthened. Direct personal experience creates a stronger image of the visitor. If a person does not have direct experience, they must have enough truthful information to help them formulate an image, even without direct knowledge. It is also crucial that this information can create a strong enough image that subsequently makes the individual want to gain direct experience with the city. According to respondents, Budapest does not offer many natural and cultural-historical attractions like Prague and Vienna. The capital of Hungary is aware of this and therefore uses its other strengths to create an image, such as the tradition of spas (Hévíz, Eger, etc.) or gastronomy (Szeged goulash, chabaika, wine).

Creating a destination image about Generation Y is gaining importance, especially in the context of the digital transformation of tourism and the changing value orientations of this generation. The use of modern technologies such as Big Data and artificial intelligence allows for a deeper understanding of how tourists – including millennials – perceive and evaluate destinations (Arabadzhyan et al., 2021; Wang, 2025). These technologies can segment the behavior and preferences of target groups in real time and thus purposefully shape the destination's image through personalized content, dynamic visual marketing, and predictive behavior models.

Generation Y is characterized by digital literacy, a strong focus on experience, and a growing interest in sustainability and responsible travel. This is where the space for synergy between destination image, digital tools and sustainable forms of tourism, such as ecotourism, is created. Although research systematically examines the relationships between image, experience, satisfaction, and tourist behavior (Bratić et al., 2024; Ghaderi et al., 2024; Kim et al., 2019; Najar & Rather, 2023; Pramanik, 2023) relatively little attention has been paid to the specific loyalty of millennials to ecotourism destinations (Djatola et al., 2025). This group is likelier to return to destinations that match their ethical and environmental preferences. Therefore, to effectively shape their image, destinations should not only adapt

technologically but also value-profile: create an image of a place that is digitally accessible, culturally authentic, and environmentally responsible – characteristics that resonate with the preferences of Generation Y.

Conclusion

The aim of the paper was to evaluate Generation Y's perception of the image of three European metropolises – Prague, Vienna, and Budapest. The questionnaire survey shows that the image of Prague, Vienna, and Budapest is perceived as positive by representatives of Generation Y and their perception of these cities is positive. According to respondents, Vienna had the best-formulated image (2.061), followed by Prague (2.064). On the contrary, according to respondents, Budapest had the least purposefully formed image (2.346). Within the individual sections, Prague (1.698) and Budapest (1.980) received the best rating in the place & architectural structure section; Vienna was most liked by respondents for shopping & tourist accommodation (1.775). From the results, it is clear that although all three cities offer rich and diverse attractions, the key factor in their tourist attractiveness is how these cities are perceived and presented – i.e., their image. An effectively created and communicated image can influence the preferences and decisions of visitors, especially among the younger generation Y, who often choose destinations based not only on content but also on the overall impression and emotional appeal of the place. A city connecting its cultural-historical heritage, local character, and current trends with authentic and consistent marketing builds a stronger position in the tourism market. The results indicate that image is not just a passive reflection of reality but an active tool that shapes visitors' expectations, experiences, and return visits.

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Ensuring Digital Accessibility Under the European Accessibility Act: Legal Obligations for E-Commerce Platforms and Travel Agencies

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Abstract

Research background: The European Accessibility Act - Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on accessibility requirements for products and services (OJ L 151, 7.6.2019) (hereinafter „EAA"), entering into force in June 2025, establishes a comprehensive legal framework aimed at ensuring the accessibility of selected products and services within the internal market. Among the entities affected are operators of e-commerce platforms, including travel agencies and travel agents, whose digital interfaces must now comply with enhanced accessibility standards.
Purpose of the article: The article seeks to examine the new legal obligations imposed under the EAA on travel agencies and travel agents offering their services through e-commerce platforms, with particular focus on the practical implementation measures necessary to ensure compliance with digital accessibility requirements.
Methods: The research methodology is based on legal analysis, involving a critical examination of the EAA's provisions and corresponding national implementing legislation - especially act n. 351/2022 Coll. and regulation n. 283/2023 Coll. Furthermore, the article engages in a normative assessment of compliance practices, particularly with respect to content-rich websites frequently operated by travel service providers.
Findings & added value: The analysis reveals that operators must ensure functionalities such as full keyboard operability, provision of alternative text for visual content, and general adherence to recognized accessibility standards. Breaches of these obligations may give rise to administrative sanctions and reputational consequences. This contribution elucidates the practical implications of the EAA for travel agencies and travel agents presenting their services also through e-commerce platforms, offering a systematic framework for achieving compliance and thereby mitigating exposure to legal and financial risks.

Keywords: Accessibility, E-commerce, Digital rights, Travel services, European Accessibility Act

JEL classification: K15, K22, K40

1. Introduction

The European Commission estimates that approximately 87 million people in the European union (hereinafter „**EU**") live with some form of disability (Strategy for the Rights of Persons with Disabilities 2021 - 2030). Ensuring their full participation in society (particularly in the digital environment) is not only a matter of equality but also of fundamental rights.

Over the years, both national and international institutions have emphasized the need to remove barriers to accessibility, recognizing it as essential to social inclusion and economic growth. Numerous strategic documents have been adopted to support the sustainable growth of the EU economy (Streimikis et al., 2024), all of which can be regarded as integral components of this broader effort. These strategies often include accessibility as a critical dimension of inclusive growth. Complementing these long-term policy goals, the European Commission has introduced targeted initiatives and legislative actions aimed at strengthening social cohesion and digital inclusion at the Member State level. (Gáll & Michalková, 2023)

A major milestone in this process was the adoption of the United Nations Convention on the Rights of Persons with Disabilities (CRPD), which the EU ratified in 2010, marked a turning point by affirming

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accessibility as a key component of inclusion and non-discrimination. In response to these obligations and ongoing social demands, the EU introduced **the European Accessibility Act (EAA)**.

EAA represents a significant step in the EU's ongoing efforts to strengthen the rights of persons with disabilities and promote digital inclusion. Set to be fully enforced by June 2025, the EAA establishes harmonized accessibility requirements for a range of products and services, including e-commerce platforms. This directive aims to remove barriers that hinder the effective participation of individuals with disabilities in the digital single market.

In addition to fulfilling legal and ethical obligations, digital accessibility also makes sound economic sense, particularly in sectors driven by innovation and digital transformation. It has been shown that the capacity to optimize innovative processes plays a critical role in maintaining competitiveness (Benešová et al., 2018). Business services are characterised by high level of knowledge, innovative intensity, high degree of specialisation and interaction (Benešová et al., 2018) making accessibility a natural extension of these qualities. This perspective is especially relevant in the tourism, which, as noted by Kubičková, is directly dependent on innovation. (Kubičková et al., 2023)

Innovation not only enhances the quality of tourism products but also increases their competitiveness and economic value for service providers, destinations, and the industry as a whole. In this context, the EAA should not be viewed merely as a regulatory burden, but rather as a strategic opportunity for innovation-led growth. In fact, the tourism sector is being transformed by new technologies like never before (Mura & Stehlíková, 2025), making digital presence and accessibility key differentiators. Adopting accessibility standards can therefore serve as a means of building brand identity and consumer trust, expanding market reach, and fostering long-term digital sustainability (Chlpek et al., 2024), that contributes significantly to the sustainable growth of enterprises. Thus, beyond legal compliance, embracing digital accessibility enables businesses to open up to a wider demographic, including persons with disabilities, older adults, and users with temporary impairments. Accessible platforms can enhance user satisfaction, brand reputation, and customer loyalty. Thus, compliance with the EAA should be viewed not as a constraint but as an opportunity for inclusive digital innovation.

As noted by Kubičková, tourism has evolved into a truly global and digitally driven industry (Kubičková et al., 2024) that increasingly relies on online interactions and consumer-facing platforms. In this context e-commerce operators, particularly travel agencies and travel agents, are among the service providers most directly impacted by the EAA. These entities manage content-rich websites and booking systems that must now align with the enhanced accessibility obligations. Non-compliance may not only expose operators to administrative sanctions but also damage their reputation and restrict access to markets. As Jurčová explains in the context of EU law, breaches of directive-based obligations can even result in state liability when national implementations are deficient. (Jurčová, 2024)

In the following part the article explores the legal, technical, and temporal implications of the EAA for digital interfaces used in e-commerce, with an emphasis on travel services.

1.1 Legal implications

Slovakia has transposed the EAA into its national legal framework through Act No. 351/2022 Coll. (hereinafter „**the Act**"), that also amended, *inter alia*, Act No. 452/2024 Coll. on Electronic Communications (adding a new § 83a entitled *Accessibility Requirements for Services for Persons with Disabilities*), and Act No. 264/2022 Coll. on Media Services (adding a new Title II to Part Eight entitled *Multimodal Access and Multimodal Access Services*, specifically Sections 60a–60b and Section 145a concerning sanctions for non-compliance).

Pursuant to the enabling provision in Article 11 of the Act, the Government of the Slovak republic adopted Regulation No. 282/2023 Coll. (hereinafter „**the Regulation**"), which specifies:

a) **the accessibility requirements for services** for persons with disabilities, as outlined in Annex 1 and further detailed in Annex 2. These annexes contain specific obligations for services related to air, bus, rail, and waterborne passenger transport, as well as information society services;
b) **the functionality criteria** pursuant to Article 5(1) of the Act, detailed in Annex 3, that are categorized according the limitations of the users, such as absence or limitation of vision, colour perception, hearing, vocal abilities, motor skills, reach and cognitive capacities;
c) **the criteria for assessing undue burden** under § 7(1)(b) of the Act, as provided in Annex 4. These reflect point 65 of the EAA which emphasizes the „*Think Small First*" principle, advocating for proportionate rules for **small and medium-sized enterprises** (**SMEs**) rather than blanket exemptions.

1.2 Technical implications

The technical implications of the EAA are primarily defined by the principles and standards of digital accessibility set out in Directive (EU) 2016/2102 and referenced in Article 47 of the EAA. These principles include:

a) **perceivability**, meaning that information and user interface components must be presentable to users in ways they can perceive;
b) **operability,** meaning that user interface components and navigation must be operable;
c) **understand ability**, meaning that information and the operation of the user interface must be understandable and
d) **robustness**, meaning that content must be robust enough to be interpreted reliably by a wide variety of user agents, including assistive technologies.

The EAA also mandates compliance with technical norms and standards such as the **Web Content Accessibility Guidelines (WCAG) 2.1**, which, while international in origin, are recognised within Slovakia as a benchmark.

In Slovakia, the relevant technical standard is **STN EN 301 549**. This standard addresses the accessibility of digital products and services (including websites, mobile applications, and electronic documents) and effectively incorporates the WCAG 2.1 criteria. Based on the European standard EN 301 549 it ensures alignment with EU-wide accessibility requirements.

1.3 Temporal implications and transitional provisions

The EAA will take effect on 28 June 2025. However, transitional provisions are foreseen to facilitate implementation over time. Article 32 of the EAA requires member states to establish a transitional period lasting until 28 June 2030. During this time, service providers may continue using products lawfully employed before the EAA's entry into force. Furthermore, service contracts concluded prior to 28 June 2025 may remain valid without requiring immediate compliance, but only until the end of their term and no later than 28 June 2030.

In line with these EU-level provisions, Section 12 of the Act stipulates that services provided under contracts signed before 28 June 2025 are exempt from accessibility requirements until the end of the contract term or 28 June 2030, whichever comes first.

The Act also specifies exemptions for certain categories of digital content:

a) pre-recorded time-based media published before 28 June 2025;
b) office file formats published before 28 June 2025;
c) archived websites and mobile applications that contain only content not updated or edited after 28 June 2025.

These transitional measures aim to strike a balance between effective implementation of accessibility standards and the need for continuity in service provision and contractual obligations.

2. Methods

In order to achieve the main aim of this paper, which is (as we stated in the introduction) to examine the new legal obligations imposed under the EAA on travel agencies and travel agents offering their services through e-commerce platforms, with particular focus on the practical implementation measures necessary to ensure compliance with digital accessibility requirements, the applied research methodology is primarily doctrinal in nature.

We had to meet the subsidiary aims before we could meet the main aim. It involves a close textual and systematic analysis of the EAA and Slovakian's relevant national implementing measures. It also includes analysis of legal definitions, obligations, exemptions and enforcement provisions as they pertain to digital services and e-commerce platforms.

Additionally, the paper incorporates a normative assessment of existing accessibility practices within the travel service sector. Legal commentaries and guidance documents issued by EU institutions are also used to supplement the analysis.

Using the synthesis of the obtained knowledge we formulate practical recommendations. The aim is to bridge the gap between formal legal requirements and their real-world application in commercial practice.

3. Results

The doctrinal and normative analyses yield several key findings regarding the obligations and challenges faced by e-commerce operators under the EAA. These findings reflect both the legal expectations arising from the European and national legislative frameworks and the practical implications for service providers (particularly travel agencies) who must adapt their digital services to ensure accessibility.

The results also highlight areas where further guidance or support may be necessary to facilitate effective and proportionate compliance (especially for SMEs).

3.1 Applications of the EAA and the Act and exemptions

The EAA applies to a defined list of products and services, including e-commerce platforms, mobile applications and ticketing services related to travel.

The scope of application is defined in the Section 2 of the Act. It mirrors the scope defined in the EAA. Among others the services covered by the Directive include electronic communication services, transport-related services and also e-commerce services.

Travel agencies come under the scope of the legislation in cases where they offer their services through digital platforms (such as websites or mobile applications) which enable consumers searching, booking and purchasing travel-related products online. In doing so, they function as e-commerce service providers (as defined both by the EAA and the Slovak implementing act). Therefore, when travel agencies use digital means to offer, advertise, or conclude contracts with consumers, they are required to comply with the accessibility requirements aimed at ensuring that persons with disabilities can access and use these services on an equal basis with others. The EAA reinforces a wider EU trend aimed at correcting the structural imbalance between professional sellers and consumers, particularly in online environments, where information asymmetry is prevalent. „A consumer, as the weaker contracting party, is subject to a certain form of increased protection, as they are in a factually unequal position compared to the professional trader due to the latter's greater expertise and legal experience." (Šťastová & Vozár, 2024, p. 490)

The Act does not apply to services provided in the context of urban transport, suburban transport and regional transport services and content on websites and mobile applications (online maps and mapping services and content not created or funded by the service provider). Nor does the law apply to services provided by micro-enterprises (Section 2 (3) of the Act).

3.2 Obligations of the service providers pursuant the Act

Pursuant to Section 6(1) of the Act, the service provider shall be obliged to:

a) ensure that the service meets the accessibility requirements in both its design and provision;
b) make publicly available information concerning the established accessibility requirements applicable to the service and the extent to which the provided service complies with those requirements;
c) put in place procedures to ensure that the provision of the service remains in compliance with the accessibility requirements, even in the event of changes to the service or modifications to the accessibility requirements;
d) notify the supervisory authority without undue delay of any reasons for non-compliance of the service with the accessibility requirements, as well as the corrective measures referred to in point (e);
e) take the necessary corrective measures to bring the service into compliance with the accessibility requirements no later than one year from the date of notification;
f) provide the supervisory authority with all documentation and information necessary to demonstrate the service's compliance with the applicable accessibility requirements and to offer the necessary cooperation.

3.2.1 Obligations pursuant to Section 6(1)(a)(c) of the Act

According these clauses the service providers are obliged to ensure that the provision of their services comply with the established accessibility requirements and also to maintain accessibility compliance when the service is modified or when the applicable accessibility requirements change. These accessibility requirements are defined in Annex 1 and Annex 2 of the Regulation. These annexes detail technical and functional requirements relevant to a wide range of services, including those offered through digital platforms.

A travel agency operating through e-commerce platforms or websites is required to ensure that users with disabilities can access and interact with digital content without encountering barriers. These obligations can be divided into three key categories:

1. **operability and navigation -** travel service providers must ensure that users with disabilities can perceive, navigate, and interact with digital content without encountering barriers. This includes:
   a) **keyboard accessibility**: all functions must be operable using a keyboard interface to accommodate users who cannot use a mouse;
   b) **consistent navigation**: menus, buttons, and links must follow a logical order and use clear, descriptive labels to facilitate efficient browsing;
   c) **error feedback and guidance**: if a user makes an input error (e.g. while filling out a booking form) the site must provide clear and accessible instructions for correction.

These requirements are not only technical but also reflect broader legal principles of transparency and fairness in consumer protection. Transparency and readability of consumer contracts are central to both national and EU-level rules. „The key is that consumer contracts must not contain provisions that would [...] cause a certain degree of imbalance [...] and be unclear, unintelligible, or vague to the consumer." (Šťastová & Vozár, 2024, p. 499)

2. **perceivability and content presentation -** users must be able to perceive and understand all the content on the website. This includes:
   a) **text alternatives**: all non-text content (e.g. images, icons, videos) must include alternative text, captions or transcripts to support screen readers and users with sensory impairments;
   b) **readable and adjustable text**: all text must be clear and adaptable to user preferences (e.g. font size and style);
   c) **scalable text:** users should be able to enlarge text up to 200% without losing content or functionality;
   d) **high contrast settings**: sites should support high-contrast modes to aid users with visual difficulties. This can include options to toggle between light and dark themes.

3. **assistive technology compatibility** - websites must be fully interoperable with assistive technologies used by people with disabilities. This includes:
   a) **screen reader support**: for instance booking forms must be compatible with screen readers, ensuring that form fields and error messages (e.g. „Please enter a valid passport number") are conveyed both visually and audibly;
   b) **compatibility with braille displays and speech recognition tools**: websites must work seamlessly with a wide range of assistive devices to ensure equal access.

It is important to mention, that the travel agencies are not required to provide assistive technologies (e.g. screen readers) themselves. Instead their digital platforms must be compatible with tools that users already possess. That means that a user might employ their own screen reader or keyboard navigation device. The responsibility of the travel agency is to ensure that the website's structure, code, and content are accessible to these tools (so the user can complete tasks like searching for a trip, booking a tour, or reading travel terms with ease).

3.2.2 Obligation to disclose information pursuant to Section 6(1)(b) of the Act

The service provider is obliged to include information on the accessibility requirements and the extent to which the service complies with them in the general terms and conditions for the provision of the service or in a comparable document. This information must include:

a) a general description of the service in accessible formats;
b) descriptions and explanations necessary to understand how the service functions;
c) a statement outlining how the service meets the established accessibility requirements for persons with disabilities.

This information must be made available in both written and oral formats, including in ways that are accessible to persons with disabilities. It must also remain accessible throughout the entire duration of the service provision.

For travel agencies operating online or through digital platforms, this obligation means that:

a) the general terms and conditions on the agency's website should include a dedicated section on accessibility, clearly stating how the booking process, payment system, and customer service channels comply with accessibility requirements.
b) booking confirmations, customer support contact options, and pre-departure information should be available in multiple formats, including text-to-speech, easy-to-read versions, and large print, if requested.
c) agencies should also provide a customer service number or chat where trained staff can offer verbal explanations of the services to clients with visual or cognitive disabilities.
d) all digital interfaces, including websites and mobile apps, should meet the technical accessibility standards (e.g. WCAG 2.1), allowing users with assistive technologies (e.g. screen readers, alternative input devices) to navigate and complete bookings independently.

3.2.3 Obligations pursuant to Section 6(1)(d)(e) of the Act

In practice, the obligation to notify the supervisory authority without undue delay means that if a service provider (e.g. a travel agency) discovers that its website or booking system does not meet accessibility requirements (e.g. the site is incompatible with screen readers or does not allow keyboard navigation) it must inform the relevant authority promptly. This notification must include the reasons for the non-compliance and outline how the provider intends to address the issue.

The law then grants the provider a maximum of one year from the date of notification to implement the necessary corrective measures. For instance, this may involve updating the website's code to comply with WCAG 2.1 standards, adding text alternatives to images or improving colour contrast. Failure to meet these obligations within the timeframe may result in sanctions. These rules ensure that accessibility issues are transparently addressed and resolved within a reasonable and foreseeable period.

3.3 Slovakian's relevant authority

The Slovak trade inspection (Slovenská obchodná inšpekcia) is the designated supervisory authority responsible for overseeing compliance with service accessibility requirements and the obligations of service providers. Specifically, it monitors whether services provided to persons with disabilities meet the required accessibility standards and whether service providers fulfil the duties set out in the legislation.

The authority is also empowered to investigate complaints concerning non-compliance with accessibility obligations and to handle administrative offence proceedings. The procedures governing the exercise of its supervisory powers are laid down in Act No. 128/2002 Coll. on State control of the internal market in consumer protection matters, as amended.

The legislator has also tasked the Slovak trade inspection with publishing regular reports on its activities. These reports may offer valuable insights - particularly given that this public body could play a crucial role in facilitating the transition to accessible services. Ideally, its role should extend beyond enforcement and penalties to include guidance and support. Through the development of practical guidelines, training programs, and potentially support mechanisms, the authority can assist e-commerce providers in meeting their legal obligations. For example, coordinated initiatives promoting open-source accessibility tools or subsidising accessibility audits for SMEs could significantly ease the compliance burden. Likewise, the inclusion of accessibility requirements in public procurement processes could foster wider adoption of inclusive technologies.

However, whether the Slovak trade inspection will take on this broader, more supportive role remains to be seen and can only be evaluated in retrospect.

3.4 Enforcement provisions and sanctions

Non-compliance with the obligations arising from Section 6 of the Act constitutes an administrative offence under Section 10, for which the supervisory authority may impose a fine ranging from EUR 200 up to 3% of the turnover for the preceding accounting period. The upper limit of the fine is constrained not only by the percentage cap but also by a fixed monetary ceiling, as illustrated in the table below.

To reinforce the preventive function of supervision, the legislator has included the possibility of waiving the fine in specific cases. Namely when the service provider has taken appropriate corrective action or when it is demonstrated that fulfilling the accessibility requirements would necessitate changes so substantial that they would alter the essential nature of the service or would impose an undue burden on the provider (section 7(1) of the Act). Such an assessment must be conducted in accordance with Annex 5 of the Regulation.

Table 1. Enforcement provisions and sanctions

Legal clause	Description of the duty	Maximum amount of sanction	Possibility of waiving the imposition of a sanction
Section 6 (1) (a) of the Act	Obligation to ensure that the service meets the accessibility requirement for persons with disabilities	6.000,- €	If the provider takes corrective action pursuant to Section 6 (1)(e) or proves that the fulfilment of the obligation is in breach of Section 7(1)
Section 6 (1) (b) of the Act	Make information on the accessibility requirements of the service provided available to the public	6.000,- €	xxx
Section 6 (1) (c) of the Act	Ensure that procedures are in place to maintain accessibility even when the service provided changes	20.000,- €	If the provider takes corrective action pursuant to Section 6 (1)(e) or proves that the fulfilment of the obligation is in breach of Section 7(1)
Section 6 (1) (d) of the Act	Inform the supervisory authority without delay of the reasons why the service provided does not comply with the accessibility requirements of the service	20.000,- €	xxx
Section 6 (1) (e) of the Act	Take the necessary corrective action to bring the service provided into compliance with the accessibility requirements of the service	20.000,- €	xxx
Section 6 (1) (f) of the Act	Provide the supervisory authority with documentation and all information necessary to demonstrate compliance of the service provided with the accessibility requirements of the service	30.000,- €	xxx

Source: own processing (2025)

4. Discussion

As outlined above, the EAA represents a paradigm shift in the regulation of digital accessibility within the EU - moving from soft law instruments and voluntary guidelines to binding legal obligations. For tourism e-commerce operators this transition demands both strategic planning and technical adaptation. Travel service providers typically operate websites with complex functionalities such as real-time availability updates, booking systems, and multimedia content. These features, while essential for consumer engagement, can present serious accessibility challenges if not properly designed.

As Krošláková et al. (2024) observe, visual identity in the digital environment is typically associated with a specific product or service and the range of associations in consumers' minds is relatively limited. This makes accessible design all the more critical, as poor usability or inaccessibility can quickly diminish brand perception and user trust. Ensuring EAA compliance will therefore require targeted investments in web development, user experience (**UX**) design, and accessibility audits-steps necessary not only for legal compliance but also for preserving brand identity and consumer loyalty.

In this context, values such as transparency, fairness, and clarity, emphasized not only in accessibility legislation but also in related fields like AI governance and consumer protection, are becoming central benchmarks for trustworthy digital service provision (Pintérová, 2024).

In practical terms, travel agencies shall:

a) conduct accessibility assessments of their digital platforms and execute regular accessibility audits using automated tools such as WAVE (**Web Accessibility Evaluation Tool**), axe DevTools, Google Lighthouse etc;
b) implement WCAG 2.1 as a minimum benchmark;
c) train staff in accessibility best practices and
d) regularly update content to maintain compliance.

To meet these technical obligations, travel agencies may need to hire web developers or accessibility consultants with experience in WCAG 2.1 and EN 301 549 implementation. While the benefits of compliance are clear, the implementation process may be particularly challenging for SMEs, which often lack the technical expertise or financial capacity to overhaul their digital infrastructure.

Moreover, the EAA does not provide a detailed technical manual, which creates interpretative uncertainties. National transpositions may differ in scope or emphasis, potentially leading to fragmented compliance expectations across EU countries - ultimately to the detriment of the consumer. This is especially problematic in the travel sector, where clients frequently cross borders and should be able to rely on consistent legal standards throughout the EU.

While the Directive aims to harmonize accessibility requirements (see relevant recitals), its transposition may vary from member state. Jurčová (2024) reminds, that the consequences of improper implementation of EU directives are not merely theoretical but can lead to concrete liabilities, including for the state. It will be important to conduct a comparative analysis of how selected member states have transposed the EAA and, over time, to evaluate whether these national implementations effectively fulfil the practical purpose of the Directive.

Conclusion

The regulation of digital accessibility within the EU moved with EAA from soft law to binding legal obligations. We can say that it is a crucial milestone, because soft law lacks enforceability and only binding norms ensure the necessary legal certainty and accountability in digital environments. (Pintérová, 2024)

Binding accessibility requirements introduced by EEA will significantly reshape the digital landscape across the EU. For e-commerce operators (particularly for travel service providers) the directive necessitates a proactive and structured approach to ensuring accessible user experiences.

This article has analysed the legal obligations imposed by the EAA, highlighted essential compliance measures and discussed implementation challenges and opportunities. While the road to full compliance may be complex, the long-term benefits (both in terms of legal security and inclusive market access) are substantial.

To meet the EAA's standards by the June 2025 deadline, e-commerce operators should begin by conducting accessibility audits, aligning their digital content with WCAG 2.1 and engaging in continuous staff training. State authorities should also contribute by offering guidance and support mechanisms. In sum, the EAA provides a compelling legal and ethical framework for advancing accessibility and successful implementation will require cooperation across legal, technical, and commercial domains.

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Digital Technology Preferences in Transport Services

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Abstract

Research background: With the significant period of digital transformation, digital tools in transport services are also increasing in the tourism market. Digital innovations support smarter and more sustainable transport networks in both the public and private sectors. Their application brings many benefits such as increasing efficiency, speed, safety and overall customer satisfaction. Whether it is information, navigation or service, they can help streamline operations, reduce costs and more.
Purpose of the article: The aim of this paper is the identification of the digital tools used in transport services and the interest of travellers in their use while taking part in tourism activities.
Methods: To obtain primary data, questionnaire research as the dominant research method was conducted on a sample of Slovak respondents. Primary data obatined from questionnaire were evaluated using the statistical programme Statistica. The collected data from the research were processed using advanced statistical methods, to gain insight into the perception of interest in using digital tools, serving as orientation and navigation digital tools or operation digital tools.
Findings & Value added: The research results point to a growing interest in the use of digital tools in transport services in the modern digital age and the overall intensifying digital transformation. Within the two categories as well as individual specific tools, different interest was found, which can be influenced by various factors.

Keywords: Digital tourism, Digital tools, Digitalization in services, Digital transformation

JEL classification: O31, R41

1. Introduction

The rapid development of digital technology is increasingly influencing the way in which tourism enterprises embrace constant innovation or pursue digital transformation (Zvaigzne et al., 2023). Current modern digital age makes significant use of the implementation of digital technologies in tourism services, which can bring many advantages (Šaffová et al. 2024). The essence of digitalization in tourism lies in the integration of digital technologies into all aspects of the tourism sector to meet the needs of tourists, on the one hand, and to create new business models and new sources of income and value, on the other hand (Polukhina et al., 2025). The cause of this trend is the compounding of a wide range of factors, among them being the COVID-19 pandemic in the sense that it accelerated the migration of the majority of professions to the virtual environment and made way for the emergence of new forms of remote work (Martins et al., 2024). However, to ensure the success of digital transformation in tourism,there needs to be a collaborative effort between service providers, governments and otherstakeholders to ensure that technology is used appropriately and adds significant value totourists' travel experience (Tandafatu et al. 2024).

Digital innovation was delineated by the literature as how new products, services, processes, and business models are created through the establishment and implementation of digital technologies (Li et al., 2022). Digitalization increasingly becomes an important driver for reconstituting destinations as dynamic, interactive, and responsive systems, adding not only to optimizing operational effectiveness but also improving the customer experience (Safonov et al., 2024). On the other hand, high-speed progress of technology simultaneously puts forward a challenge to provide accurate and up-to-date data and information support for most of the decision-making fields in the tourism management domain. OECD (2025) highlights that while there are certain indicators of the variety of digital tools and skills, there usually are limited

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indicators measuring the destinations' digital strategy and organizational culture. This gap highlights the need for more analysis and uptake of digital solutions in tourism, including of transport as a critical component of the tourist experience. Every ecosystem of our economy and our society, digitalisation impacts and transforms tourism. Digital tools greatly impact how we live and do tourism. The European Commission pays close attention to this process to support the competitiveness, sustainability, and resilience (European Commission 2025). However there is a big need to be aware, as (Bathla et al., 2024) state, digitalisation also presents obstacles. Tourism may grow too dependent on tech-nology, reducing its spontaneity. However, the real positive impacts can be significantly beneficial for the tourism industry, but it is very important to be aware of them because, as they state (Bathla et al. 2024), digitalization may also present obstacles when tourism can become too dependent on technology, which reduces its spontaneity.

1.1 Digital tool in tourism services

With today's rate of international "smartization," the contribution of sophisticated digital technologies to tourism is on the rise, justifying their strategic relevance to the public policies in most nations (Kochuma et al., 2025). Digital tools and policies are now part of the functioning of the industry, which impacts the nature of work, efficiency of operations, and quality of service (Han, 2024). Their importance encompasses, among others, the ability to improve data collection, enable better resource allocation, and promote visitor convenience through better navigation and information provision (Korcz et al., 2024). Empirical research testifies that firms which have put investment into wide web presence have realized higher customer engagement and increased revenues compared to competition involving modest web engagement (Arya et al., 2019). The main digitalization technologies that make journeys safe and comfortable are digital certificates, mobile applications and websites providing information on epidemiological situation in real time, travel restrictions and requirements, automated processes (web payments and bookings), robotization (disinfection robots or robotic room service), and contactless technologies (Melnychenko et al., 2021). These technologies have a direct impact on the development of new transport and tourism services models. Surveys of public acceptance indicate that technologies such as self-service bag check-in, electronic scanning of documents, and holographic control units are highly accepted, while humanoid robots or biometric check-in are more doubted, mostly on concerns that pertain to privacy, reliability, and undue complexity in solutions. A key element of the theoretical framework is therefore also understanding determinants of willingness on the part of tourists to adopt new digital solutions—spanning from level of digital expertise and prior experience to perceived usefulness and reliability of the technology.

1.2 Digital tools in transport services

Digital tools play an increasingly significant role in improving transport services' level of efficiency, safety for passengers, and comfort in general. Modern technologies enable not only automation but also personalization of services and more rapid response to the requirements raised by passengers at a given time. Their use results in smoother passenger flow, reduced operational costs, and improved competitiveness of transport operators (Han, 2024; Korcz et al., 2024). Among the most notable solutions in this area is the installation of contactless information and navigation kiosks, which provide immediate access to information and navigation without touching, thus improving hygiene levels and convenience for users. Another category includes humanoid information and navigation robots, which offer an interactive way of communicating with customers; however, their adoption tends to be conditional upon technological trust and value addition perception. Modern solutions also include holographic control functionalities, which enable contactless device control, improving safety while giving a modern visual experience. Electronic scanning of tickets for travels and personal documents plays a great part in speeding up the check-in process and decreasing contact at document control. Self-check-in for luggage decreases waiting time and the need for staff intervention directly. Biometric check-in has the possibility of making procedures for identification much easier for passengers; however, adoption has to involve comprehensive resolution to concerns about privacy and protection of personal data. Last but not least, autonomous service vehicles within transport hubs automate the transport of passengers or bags within terminals, resulting in optimized logistics and smoother flows (Kochuma et al., 2025). The findings of the study show that among the tools, the highest acceptance levels are for digital document scanning and self-service bag check-in, which the interviewees rated as being very important or important. By contrast, technologies such as humanoid robots and biometric check-in invoke greater caution and a split of opinions, mainly due to concerns about personal data protection, technical reliability, and unjustified complexity. From an implementation perspective, successful uptake of digital technologies in transport services is dependent on

a combination of factors: technical reliability, ease of use, clear communication of benefits to end-users, and guarantee of personal data protection (Li et al., 2022). Destinations and transport operators who meet these conditions can expect higher public acceptance and long-term sustainability of such solutions.

2. Methods

The aim of the research was to identify and analytically evaluate the interest in using digital tools among passengers using transport services. To obtain primary data, a questionnaire survey was chosen as the main research method. It was oriented towards people using transport services in tourism. Specifically, it was of interest to find out their attitude towards the current possibilities of applying digital technologies to transport processes, using the example of two selected categories, namely: *orientation and navigation digital tools and operation digital tools*. The questionnaire was distributed between Januray 2025 and April 2025. Its distibution was held through online platforms and in-person methods. The combination of these two methods allowed for ensuring the diversity of the demographic composition of respondents and ensured a high-quality sample, i.e. a random and non-random, accessible sample. Respondents were asked about two categories of digital tools. In each of them, 5 specific tools were selected that are used in practice in transport services. To find out more detailed attitudes towards their attractiveness and overall interest, a 5-point Likert scale was used (with response options: definitely yes; yes; neither yes nor no; no; definitely no). This scale enabled respondents to express the intensity of their agreement or disagreement with the presented statements. For data analysis, a combination of descriptive and inferential statistical methods was used. The data were initially processed in Microsoft Excel, while more advanced statistical analyses were conducted using the Statistica programme for, ensuring methodological precision and research replicability, with the calculation of Anova, p-value,ccompliance coefficient etc. For the purpose of the study, hypotheses was stated: H0: *There is an assumption that preferences/popularity of using the digital (orientation/navigation and operation) tools differ significantly among respondents.*

3. Results

The research sample comprised a total of 343 respondents, distributed by gender and place of residence. In terms of gender composition, the sample included 89 men (25.95%) and 254 women (74.05%). This gender distribution indicates a marked predominance of female participants, comprising nearly three-quarters of the sample.Regarding residenc e, participants were further categorized based on whether they resided in urban or rural areas. Among city residents, 57 were men (16.62% of the total sample) and 137 were women (39.94%), yielding a total of 194 urban participants (56.56%). In contrast, the countryside group comprised 149 individuals (43.44%), including 32 men (9.33%) and 117 women (34.11%). The data reveal two key trends: a higher proportion of women in the overall sample and a predominance of women in both urban and rural subgroups. Notably, the rural female subgroup (34.11%) was more than three times larger than the rural male subgroup (9.33%), suggesting a significant gender imbalance particularly in non-urban settings. The cumulative frequency and relative frequency distributions confirm a consistent pattern of female majority across all categories. This distribution may influence the generalizability of results, particularly in analyses where gender or place of residence constitutes a key variable. Consequently, the demographic composition of the sample should be taken into account when interpreting research findings, especially in relation to gendered or geographical differentials in attitudes or behaviors.

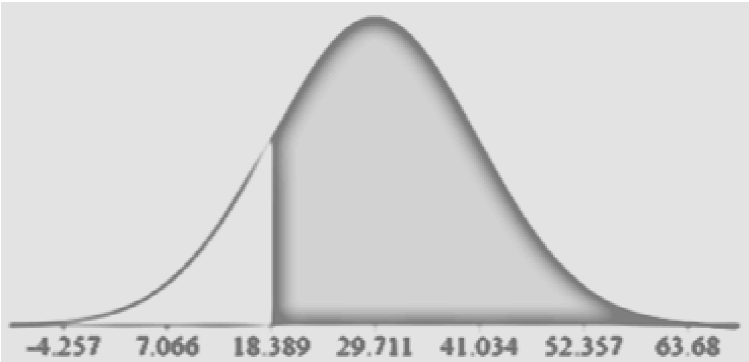

Figure 1. Age distribution of respondents
Source: own processing

Descriptive statistics of the research sample included comparisons of demographic factors. In terms of age, the lowest respondent age was 17 years, the highest was 69 years, the mean age was 29,7 years, and the median age was 24 years. The standard deviation was $\sigma = 11.322778926226$. The distribution of respondents by age within a Gaussian distribution, like a normal distribution, had a mean value of 18.389 (Figure 1).

Table 1. Interest in orientation and navigation digital tools in the operation of transport services

	Contactless information kiosks	**Contactless navigation kiosks**	**Humanoid information robots**	**Humanoid navigation robots**	**Holographic buttons**
	Frequency	**Frequency**	**Frequency**	**Frequency**	**Frequency**
absolutely important	17	15	18	16	22
significantly important	73	51	26	28	48
moderately important	124	111	65	61	95
neither important nor unimportant	72	88	110	115	115
moderately unimportant	28	33	38	31	24
rather unimportant	18	23	53	60	23
absolutely unimportant	11	22	32	32	16
	343	343	343	343	343

Source: own processing

The evaluation of user responses regarding *Contactless Information Kiosks* reveals insightful patterns about public acceptance and perceived importance of this emerging technology. Based on responses from 343 participants, the data shows a generally favorable attitude, with a notable concentration in the upper tiers of the importance scale. The highest frequency was observed in the "moderately important" category (n = 124), accounting for 36.2% of the total sample. This suggests that while users may not consider the technology critically essential, they recognize its relevance and potential benefits. On the lower end of the importance spectrum, a total of 57 respondents (16.6%) rated the technology as unimportant to varying degrees: "moderately unimportant" (n = 28), "rather unimportant" (n = 18), and "absolutely unimportant" (n = 11). Notably, the "absolutely unimportant" category had the lowest response count, suggesting that outright rejection of the technology is relatively rare.

The evaluation of public responses toward *Contactless Navigation Kiosks* provides valuable insight into user attitudes toward touchless wayfinding technologies. The results reflect a moderately positive, though slightly more divided, perception compared to similar technologies such as contactless information kiosks. The highest number of responses was recorded in the "moderately important" category (n = 111), accounting for 32.4% of the total sample. This suggests a generally favorable disposition toward contactless navigation kiosks, although with less intensity than more widely embraced technologies. A notable proportion of respondents—88 individuals (25.7%)—selected "neither important nor unimportant." This is the highest neutral response across the importance spectrum for this tool and suggests that a significant portion of users may be undecided, possibly due to limited personal experience with such kiosks or perceived redundancy if smartphone-based navigation is already accessible. On the unimportant side of the scale, 78 respondents (22.7%) rated the kiosks as unimportant to varying degrees: "moderately unimportant" (n = 33), "rather unimportant" (n = 23), and "absolutely unimportant" (n = 22). This relatively high count of negative responses compared to the more positively rated tools (such as contactless information kiosks) suggests a more polarized opinion toward this specific application. One potential explanation on more polarized for this divide may lie in perceived practicality. Unlike information kiosks, which serve as immediate access points to critical content, navigation kiosks may be seen as less essential in an era of GPS-enabled smartphones and wearable devices. Furthermore, user expectations for real-time and personalized navigation might not be fully met by static or semi-interactive kiosks.

The analysis of public perceptions concerning *Humanoid Information Robots* presents a more polarized set of responses compared to other digital tools such as contactless kiosks. Based on data from 343 participants, this technology shows signs of both intrigue and skepticism, reflecting a complex relationship between users and anthropomorphic machines in informational roles. The most frequent response (32,1%) was "neither important nor unimportant". This high proportion of neutral responses suggests a significant

level of ambivalence or uncertainty among respondents. It is possible that this group lacks firsthand experience with humanoid robots, or they may be undecided due to a balance of perceived benefits (e.g., interactivity, accessibility) and drawbacks (e.g., cost, complexity, or social discomfort). On the other end of the spectrum, 123 respondents (35.9%) evaluated the technology as unimportant: "moderately unimportant" (n = 38), "rather unimportant" (n = 53), and "absolutely unimportant" (n = 32). This is the highest total proportion of negative responses observed thus far in the dataset, suggesting a meaningful level of resistance to or disinterest in humanoid information robots. Several factors could account for this resistance. First, the novelty and complexity of humanoid systems may intimidate some users or be perceived as unnecessary compared to more conventional digital interfaces. Second, cost-effectiveness, maintenance, and reliability concerns may influence public judgment, particularly in environments where simpler solutions suffice. Finally, cultural factors and attitudes toward robotic automation likely play a role in acceptance levels.

The user evaluation of *Humanoid Navigation Robots* reveals a relatively cautious and ambivalent public stance toward this emerging technology. The frequency distribution demonstrates limited perceived importance and a significant degree of skepticism.The largest proportion of responses was observed in the "neither important nor unimportant" category (n = 115), accounting for 33.5% of participants. This high rate of neutrality suggests that a large segment of the population may be unfamiliar with, unconvinced by, or indifferent to the concept of humanoid robots serving as navigation assistants. This ambivalence might stem from limited exposure to such systems or uncertainty regarding their practical value compared to other, less complex navigation tools (e.g., maps, mobile apps, digital kiosks). Negative sentiment toward this technology is relatively strong. This is one of the highest proportions of negative responses across all evaluated tools, indicating a widespread skepticism or rejection of humanoid robots in navigational roles.This trend may be attributed to several factors. First, users may perceive humanoid navigation robots as unnecessarily complex or costly compared to existing solutions. Second, concerns about reliability, maintenance, or awkward human-robot interaction may lower perceived usefulness. Third, in navigation tasks—especially those that require rapid, clear direction—users may favor static or screen-based systems that are quicker and more intuitive to engage with.

The assessment of user perceptions regarding *Holographic Buttons* reveals a generally favorable yet nuanced perspective. This digital interaction technology demonstrates a relatively high level of acceptance, especially when compared to other advanced interface tools such as humanoid robots. The strongest signal of user interest lies in the positive importance ratings. Nearly half of all respondents perceive holographic buttons as a beneficial or promising innovation. A notable finding is the relatively high number of "absolutely important" responses compared to other technologies evaluated. This result indicates a strong interest among a subset of users for fully touchless interfaces. Given the increasing emphasis on hygiene, accessibility, and futuristic design in public and commercial environments, this may reflect a public preference for non-contact alternatives, especially in high-traffic or shared spaces like elevators, ATMs, or kiosks. Negative responses were comparatively lower than in other technologies.

Table 2. Interest in operation digital tools in the of transport services

	Digital scanning of personal documents (boarding pass, passports, IDs, ...)	**Self-service baggage check-in before boarding the vehicle**	**Biometric check-in service**	**Autonomously controlled service vehicles at transport hubs**	**Separate, fully automated process before boarding the vehicle**
	Frequency		**Frequency**	**Frequency**	**Frequency**
absolutely important	27	39	16	18	31
significantly important	78	109	50	42	98
moderately important	121	98	113	95	102
neither important nor unimportant	56	57	86	107	63
moderately unimportant	26	13	35	27	24
rather unimportant	23	14	19	32	14
absolutely unimportant	12	13	24	22	11
	343	343	343	343	343

Source: own processing

The data concerning public perception of *Digital Scanning of Personal Documents*—including boarding passes, passports, and IDs—indicates a strong consensus on the importance and relevance of this technology. Among the 343 respondents surveyed, the distribution of responses suggests high levels of acceptance, perceived utility, and integration readiness, particularly within travel, administrative, and security contexts. The highest number of responses fell under “moderately important” (n = 121), accounting for 35.3% of the total. Nearly two-thirds of participants see digital document scanning as important to some degree. This is the highest combined positive response rate among all technologies evaluated so far, underscoring the perceived utility and real-world relevance of this digital tool. Active resistance or rejection of digital document scanning is limited. These reservations may relate to concerns around data privacy, digital literacy, or system reliability.

The analysis of user perceptions regarding *Self-Service Baggage Check-in Before Boarding* to vehicle reveals a strong positive inclination toward this technology. With a sample of 343 respondents, the data demonstrates widespread recognition of the convenience, efficiency, and autonomy this digital tool offers, particularly in transportation and travel contexts. Low level of rejection suggests minimal resistance to the adoption of self-service baggage check-in, which may be attributed to its clear convenience and time-saving benefits.The high positive ratings for this technology likely derive from the increasing demand for contactless services, enhanced user autonomy, and reduced reliance on staffed check-in counters. Moreover, self-service baggage check-in can improve operational efficiency, reduce waiting times, and enhance traveler satisfaction, all of which resonate well with contemporary expectations.

The data reflecting public attitudes toward *Biometric Check-in Services*—which utilize biometric identifiers such as facial recognition or fingerprint scanning—reveals a predominantly positive, yet somewhat cautious, perception among the surveyed population. Majority recognize the importance of biometric technologies in streamlining check-in procedures, though a notable portion remains ambivalent or skeptical. The data also show also substantial neutrality and resistance. This could be due to concerns about privacy, data security, or the novelty of biometric technologies in everyday use. Relatively higher proportion of negative sentiment compared to some other digital tools likely reflects ongoing apprehensions related to biometric data misuse, ethical considerations, and technical reliability.

The largest group of respondents (107) rated *autonomous service vehicles* as "neither important nor unimportant," indicating a general ambivalence or lack of strong opinion. This neutral stance represents approximately 31% of the total responses, suggesting that for many, such technology is not yet seen as a priority or its benefits remain unclear.

The data reflects public sentiment regarding the importance of autonomously controlled service vehicles at transport hubs. The data on the perceived importance of a separate, *fully automated process before boarding a vehicle* reveals a generally positive public attitude toward such automation, with a clear majority favoring its implementation. Majority of positive responses indicates considerable support for introducing automation in the pre-boarding phase, likely due to expectations of improved efficiency, safety, or convenience. Interestingly, 18% of respondents selected "neither important nor unimportant," pointing to a group that may be undecided or lacks sufficient information to form an opinion. This neutral stance is smaller than in the previous dataset, indicating that the concept of pre-boarding automation might be more tangible or relatable for respondents. The minority expresses skepticism or disinterest, possibly due to concerns over cost, safety, or practicality.

Table 3. Overview of interest in orientation and navigation digital tools digital in transport services

	ANOVA X^2	**p-value**	**Compliance coefficient**	**Average ranking r**
	2353,826	0	0,224	0,2226
Variable	**Average ranking**	**Sum of orders**	**Average**	**Standard deviation**
Contactless information kiosks	9,2143	5095,5	4,7233	1,3491
Contactless navigation kiosks	9,2252	5096,2	4,7247	1,3503
Humanoid information robots	5,7848	3199	3,7776	1,6048
Humanoid navigation robots	5,7852	3197	3,7769	1,6052
Holographic buttons	8,2541	4564,5	4,4756	1,4471

Source: own processing

Table 4. Overview of interest in operation digital tools digital in transport services

	ANOVA X^2	p-value	Compliance coefficient	Average ranking r
	2353,826	0	0,224	0,2226
Variable	**Average ranking**	**Sum of orders**	**Average**	**Standard deviation**
Digitalized scanning of personal documents (boarding pass, passports, IDs,	10,1573	5617	4,8535	1,4958
Self-service baggage check-in before boarding the vehicle	10,8047	5975	4,9747	1,4693
Biometric check-in service	8,2098	4540	4,4304	1,5438
Autonomously controlled service vehicles at transport hubs	7,5199	4158,5	4,264	1,5201
A separate, fully automated process before boarding the vehicle	10,1989	5640	4,8969	1,4085

Source: own processing

The main hypothesis H0, which assumes differences in continent preferences among respondents, **was confirmed**, indicating that the differences in the overall distribution of preferences are highly statistically significant. The differences in perception in both categories (orientation/navigation and operation digital tools) are clear. Even within the above categories, individual digital tool (5 selected in each category) were perceived differently. A general assessment can be made that travelers using transport services perceive digital tools as an opportunity of the present time and probably as an obvious necessity for the coming years.

4. Discussion

Discussion for orientation and navigation digital tools in transport services

These results indicate that Contactless Information Kiosks are largely viewed as a moderately to significantly important innovation, particularly in environments where hygiene, efficiency, and accessibility are prioritized. The low number of negative ratings, combined with a strong showing in the upper-mid ranges, implies public openness to wider implementation—especially if the kiosks are designed to be user-friendly, accessible to diverse populations, and efficient in delivering information. In conclusion, while not viewed as absolutely essential by the majority, contactless information kiosks are positively received by a significant portion of respondents. Their potential role in public infrastructure and customer service contexts is supported by the data, suggesting a readiness for their continued integration into smart environments. Contactless Navigation Kiosks are generally viewed positively, with over half of users expressing moderate to high importance. However, the comparatively high neutral and negative response rates indicate a need for improved awareness, interface design, and integration into broader digital ecosystems. Enhancing user experience and emphasizing the value of contactless navigation in high-traffic, device-restricted settings may further boost public acceptance. The results indicate that Humanoid Information Robots are viewed with mixed sentiment. While a notable minority sees potential in the technology, a larger portion remains either indifferent or skeptical. For broader adoption and public acceptance, future development must focus on enhancing usability, ensuring human-like interactions offer meaningful value, and addressing ethical and practical concerns about robotic integration into public and customer service domains. Humanoid Navigation Robots face considerable challenges in public acceptance, with only a minority of users viewing them as important and a significant portion either neutral or negative. For this technology to gain wider support, developers must focus on demonstrating clear functional advantages, minimizing operational complexity, and enhancing social acceptance through improved interaction design. Holographic Buttons appear to be one of the more positively received digital tools in the dataset, combining moderate-to-high importance ratings with relatively low negative sentiment. While a substantial portion of users remains neutral—likely due to unfamiliarity or lack of practical exposure—there is clear potential for broader acceptance. Future adoption may be enhanced by public demonstrations, integration into everyday interfaces, and emphasizing the hygienic and aesthetic benefits of contactless control technologies.

Discussion for operation digital tools in transport services

Digital Scanning of Personal Documents is among the most widely accepted and highly valued digital tools assessed in this study. The strong positive sentiment likely stems from the technology's already widespread adoption and clear benefits in terms of speed, hygiene, and security. The relatively low rate of negative responses and smaller neutral group further affirm its established role in modern service environments, particularly within transportation and public administration sectors. Self-Service Baggage Check-in Before Boarding is widely regarded as a highly important digital tool by users, with a strong majority endorsing its adoption and integration in transportation systems. Continued investment in this area could yield significant improvements in passenger experience and operational workflow efficiency. Biometric Check-in Services enjoy moderate user approval, balanced by significant neutrality and a minority of resistance. To increase adoption and trust, efforts should focus on enhancing data protection transparency, improving user education, and demonstrating the practical benefits of biometric technologies in travel and security settings. In case of autonomously controlled service vehicles at transport hubs there is a need for greater public awareness, education on benefits and risks, and perhaps visible pilot implementations to shift perceptions further toward strong support or informed opposition. The data suggests strong public support for a fully automated process before vehicle boarding, with only minimal opposition. The trend indicates growing openness to automation in transport infrastructure, especially when framed around user experience and operational efficiency. For policymakers and designers, this presents an opportunity to further develop and pilot such systems with confidence in public backing.

Limitation and suggestions for further research

While this study offers valuable insights into public perceptions of various digital tools in transport services, several limitations must be acknowledged that may affect the generalizability and interpretation of the results. First, the study relies exclusively on self-reported data collected through a structured survey, which is inherently subject to response bias. Participants may have responded in socially desirable ways, overestimating the importance of technologies they believe are expected in modern systems, or underreporting concerns such as privacy or technological skepticism. Second, the demographic profile of respondents for this study was not controlled or stratified by key variables such as age, digital literacy, frequency of travel, or socioeconomic background. Since attitudes toward digital tools—especially advanced ones like biometric check-in or humanoid robots—can vary significantly across these variables, the results may not accurately reflect the views of all population segments.Additionally, the study did not investigate the contextual factors influencing participants' responses, such as prior exposure to the technologies in question, cultural attitudes toward automation, or privacy concerns. These factors could play a critical role in shaping acceptance or rejection of digital tools.Overall, while informative, the findings should be interpreted with these methodological constraints in mind, and future research should aim to address these limitations.

Conclusion

The integration of digital tools in transport services is increasingly recognized as a critical component in enhancing operational efficiency, user autonomy, and safety. Based on the evaluation of public perceptions across various digital technologies—such as contactless kiosks, biometric check-in, holographic interfaces, and humanoid robots—it is evident that users exhibit varying degrees of acceptance and perceived importance, shaped by familiarity, perceived utility, and technological complexity.

Among the tools assessed, self-service baggage check-in and digital scanning of personal documents emerged as the most positively received, with a majority of respondents rating these services as significantly or absolutely important. These technologies are already widely implemented in airport and transport terminals, suggesting that familiarity and demonstrated efficiency drive user acceptance. Similarly, contactless information kiosks and holographic buttons were well regarded, particularly in light of increasing demands for hygienic, touch-free solutions post-pandemic. Conversely, humanoid robots, particularly in navigation roles, received more ambivalent or negative responses. This indicates that anthropomorphic systems may not yet align with public expectations or may be viewed as overly complex for relatively simple tasks. Biometric check-in services, though moderately supported, also drew privacy-related concerns, as reflected in the proportion of neutral and negative responses.

Overall, the findings suggest a clear public preference for functional, intuitive, and privacy-conscious technologies in transport environments. User acceptance appears closely tied to direct utility, ease of use, and prior exposure, highlighting the need for gradual implementation, public education, and transparent communication regarding data security and system reliability. In conclusion, while digital transformation in transport is widely supported, the success of future implementations will depend on addressing public concerns, aligning solutions with user needs, and promoting trust through user-centered design and robust digital governance frameworks.

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Travel Behavior Across Generations: Evidence from Slovak Women

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Abstract

Research background: Travel behavior is strongly influenced by generational differences, reflecting varying lifestyles, financial capacities, and attitudes toward tourism. While international travel is an important part of modern life, limited research has examined how Slovak women from different generations approach vacation planning, budgeting, and frequency of travel.
Purpose of the article: This study aims to examine intergenerational differences in the international travel behavior of Slovak women, with a particular focus on vacation planning, budget allocation, and travel frequency.
Methods: The research is based on a questionnaire survey conducted among Slovak women from Generations X, Y, and Z. Three hypotheses were formulated and tested using the Chi-square test at a 0.05 significance level. Data were processed and analyzed with Gretl and Microsoft Excel.
Findings & Value added: The results confirm significant generational differences in all three aspects of travel behavior. Generation Y showed the strongest preference for independent vacation planning, while Generation Z relied more on travel companions. In terms of budgeting, Generations X and Y allocated higher amounts for vacations, with Generation X most often represented in the €2000+ category, whereas Generation Z remained concentrated in the lower ranges (€500–999). Regarding travel frequency, Generations X and Y reported taking more vacations per year, while Generation Z most often traveled only once annually. These findings highlight the importance of considering generational preferences in tourism research and practice, offering valuable insights for tailoring tourism services and marketing strategies to different age cohorts.

Keywords: Travel, Behavior, Tourism, Generations, Women

JEL classification: L83

1. Introduction

The study of travel behavior, which has evolved over the past half-century, has yielded important insights into the choices that individuals and households make in relation to their daily travel. These insights have contributed to the development of increasingly sophisticated models for forecasting passenger behavior and predicting changes in behavior (Clifton & Handy, 2003).

The diverse consumer behavior of different generations is well known, but in the case of tourism, it is a somewhat less researched area (Gonda & Rátz, 2023). The travel behavior of each generation reflects distinct characteristics shaped by multiple factors (Jamal & Newbold, 2020). Generational differences may arise from variations in travel purposes, such as commuting or social trips, as well as differing perceptions of the physical and natural environment, including issues of safety and sustainability. Moreover, historical, cultural, socioeconomic, and technological experiences unique to each cohort play a significant role in shaping their mobility patterns (Circella et al., 2016).

Liu et al. (2024) examined intergenerational dynamics in family tourism and demonstrated how solidarity and conflict shape travel motivation, satisfaction, and well-being. Their findings underline the importance of considering generational relationships in understanding travel behavior, supporting the relevance of a generational perspective in tourism research.

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Intergenerational differences are important for making conclusions in the scientific field, for classification, and for making the right decisions. Every generation has important turning points in its life cycle. Some important events cause significant changes in the economic, political, or social sphere. Differences in forms of production, changes in consumption, and their impact on lifestyle leave different marks on individuals who experience these periods. It is important to track these marks and changes, observe social changes, and draw conclusions about the future (Buzlukçu & Şahin, 2021).

This paper aims to examine generational differences in travel preferences among Slovak women, with a specific focus on their international travel behavior. This research stands out by concentrating exclusively on women, allowing for a more detailed examination of their unique travel behaviors. The growing recognition of women's role in tourism has drawn increasing scholarly interest. Studies that place women at the center of tourism analysis not only advance theoretical understanding but also support the development of gender-sensitive tourism strategies and policies. A number of researchers have specifically investigated women's travel behaviors, preferences, and challenges across diverse tourism contexts (Bayanbayeva et al., 2023; Uludag et al., 2023; Melnyk & Vašaničová, 2024; Vašaničová & Melnyk, 2025; Wu et al., 2025). Examining generational differences in tourism offers valuable insights into the distinct needs and behaviors of each cohort. Recognizing these variations helps businesses and destinations tailor services, create more personalized experiences, and design strategies that resonate with specific groups. Applying a generational perspective in tourism research thus provides both practical and theoretical benefits (Li et al., 2013).

The paper is structured as follows: Section 2 outlines the methodology, including the research aim and hypotheses, the method, and the research sample. Section 3 presents the results of hypothesis testing, while Section 4 provides a discussion of the findings. The paper concludes with a summary of key insights and implications, limitations, and future research directions.

2. Methods

The following section presents the methodological framework of the study, providing an overview of the research aim and hypotheses, the methods applied for data collection and analysis, and the characteristics of the research sample.

2.1 Research Aim and Hypotheses

This study aims to examine intergenerational differences in the international travel behavior of Slovak women, with a particular focus on vacation planning, budget allocation, and travel frequency. In line with the research aim, the following hypotheses were formulated:

- Hypothesis 1: Generational differences (X, Y, Z) exist in women's vacation planning for international travel.

  Generational affiliation may shape the ways in which women engage in travel planning, whether through independent organization, reliance on a companion, use of professional services, or joint decision-making. While older generations may demonstrate stronger ties to conventional planning practices or shared responsibility, younger cohorts often exhibit greater autonomy or a preference for collaborative approaches (Vašaničová & Melnyk, 2025).
- Hypothesis 2: Generational differences (X, Y, Z) exist in the vacation budget planned by women traveling abroad.

  This hypothesis is based on the assumption that financial resources, income levels, and spending priorities differ across generations. Older cohorts (Generations X and Y) are typically more financially stable and established in their careers (e.g., Lyons et al., 2015), which may allow them to allocate higher budgets for travel. In contrast, younger individuals (Generation Z), who are often still studying or at the beginning of their careers (e.g., Rubin et al., 2024), may have more limited resources and therefore plan lower travel budgets. This proposition is consistent with the findings of Octaviany & Mardiyana (2024), who reported notable generational differences in travel preferences and expenditures.
- Hypothesis 3: Generational differences (X, Y, Z) exist in the frequency of women's international vacations.

  This hypothesis is grounded in the assumption that lifestyle, financial stability, and life stage influence how often individuals can travel abroad. Older generations, such as X and Y, may have more disposable income and established careers (e.g., Lyons et al., 2015), enabling them to afford multiple vacations per year. They may also prioritize leisure travel as part of their lifestyle. In contrast, younger

individuals from Generation Z are more likely to face financial constraints due to studying or early career stages (e.g., Rubin et al., 2024), which can limit their ability to travel frequently.

2.2 Method

Research hypotheses were tested using the Chi-square test of independence, with the significance level set at 0.05. This method was chosen to identify statistically significant associations between generational groups (X, Y, Z) and selected variables related to international travel behavior. Prior to testing, the dataset was checked for completeness and accuracy. Data processing and statistical analyses were conducted using Gretl for statistical computations and Microsoft Excel for data preparation.

2.3 Research Sample

The analysis of differences was conducted using data collected through an unstructured questionnaire, which was distributed electronically to Slovak women between October and December 2023. The research sample was limited to women who expressed a preference for foreign tourism over domestic tourism. In total, the sample consisted of 261 respondents. The youngest participant was 18 years old, while the oldest was 57. The average age was 33 years (median = 33; standard deviation = 11.215). Out of the total 261 Slovak women surveyed, 25.67% (67) were classified as belonging to Generation X (aged 43–58 years, born 1967–1982), 36.40% (95) to Generation Y (aged 27–42 years, born 1983–1998), and 37.93% (99) to Generation Z (aged 18–26 years, born 1999–2007). This classification reflects the generational division applied in the study.

3. Results

This section presents the findings of the analysis of intergenerational differences in travel behavior among Slovak women.

3.1 Testing Hypothesis 1: Generational Differences in Vacation Planning

Table 1 presents the results of the verification of Hypothesis 1. This hypothesis was derived from the questionnaire item “How do you plan your vacation abroad?”, which offered four possible response options: (1) I plan it myself, (2) The person I travel with plans it, (3) I use services of a travel agency, and (4) I plan it together with the person I travel with.

Table 1. Results of the Chi-square test for Hypothesis 1: Generation vs. Vacation Planning

Generation	Myself	The Person I Travel with	Services of the Travel Agency	Together with the Person I Travel with	Total
X	39 (58.2%)	12 (17.9%)	12 (17.9%)	4 (6.0%)	67
Y	64 (67.4%)	14 (14.7%)	14 (14.7%)	3 (3.2%)	95
Z	48 (48.5%)	34 (34.3%)	8 (8.1%)	9 (9.1%)	99
Total	151	60	34	16	261
Pearson chi-square test = 18.1945, df = 6, p-value = 0.0058					

Source: own processing

The Chi-square test produced a value of 18.1945 with 6 degrees of freedom and a p-value of 0.0058. Since the p-value is below the significance threshold of 0.05, Hypothesis 1 is supported, confirming that statistically significant generational differences exist in how Slovak women plan their international vacations

Across all generations, the most common approach was planning vacations independently. This was most pronounced among Generation Y (67.4%). In contrast, Generation Z displayed the highest reliance on their travel companions for planning (34.3%). Use of travel agency services was most frequent among Generation X (17.9%) and Generation Y (14.7%), whereas joint planning was most typical of Generation Z (9.1%).

3.2 Testing Hypothesis 2: Generational Differences in Planned Vacation Budgets

Table 2 presents the results of the verification of Hypothesis 2. This hypothesis was derived from the survey question: “What is your planned budget per person for a vacation abroad (in euros)?” The response categories are shown in the table and served as the basis for the analysis.

Table 2. Results of the Chi-square Test for Hypothesis 2: Generation vs. Planned Vacation Budget

Generation	Up to €500	€500–999	€1000–1499	€1500–1999	€2000 and above	Total
X	12 (17.9%)	21 (31.3%)	14 (20.9%)	6 (9.0%)	14 (20.9%)	67
Y	11 (11.6%)	44 (46.3%)	24 (25.3%)	6 (6.3%)	10 (10.5%)	95
Z	35 (35.4%)	44 (44.4%)	15 (15.2%)	4 (4.0%)	1 (1.0%)	99
Total	58	109	53	16	25	261
Pearson chi-square test = 36.1439, df = 6, p-value = 0.0000						

Source: own processing

The Chi-square test produced a value of 36.1439 with 6 degrees of freedom and a p-value < 0.001. Since the p-value is well below the 0.05 significance threshold, Hypothesis 2 is supported. This confirms that statistically significant generational differences exist in the planned vacation budgets of women traveling abroad.

Across all three generations, the most common budget category was €500–999, reported by 31.3% of Generation X, 46.3% of Generation Y, and 44.4% of Generation Z. However, notable differences appear in the higher budget categories. Generation X was most represented in the €2000 and above group (20.9%), while Generation Y showed relatively strong preferences for both the €500–999 (46.3%) and €1000–1499 (25.3%) ranges. By contrast, Generation Z was heavily concentrated in the lowest two categories, with 35.4% budgeting up to €500 and 44.4% budgeting €500–999, and only 1.0% planning to spend €2000 or more.

These results suggest that older generations (X and Y) are more willing and able to allocate higher amounts to international vacations, while Generation Z tends to remain within lower budget categories. This outcome may be influenced by factors such as income level, financial independence, or life stage.

3.3 Testing Hypothesis 3: Generational Differences in Vacation Frequency

Table 3 presents the results of the verification of Hypothesis 3, which examined the frequency of vacations taken by different generations of Slovak women.

Table 3. Results of the Chi-square Test for Hypothesis 3: Generation vs. Vacation Frequency

Generation	Once a year	Twice a year	Three times a year	Four times a year	More than four times a year	Total
X	16 (23.9%)	23 (34.3%)	14 (20.9%)	9 (13.4%)	5 (7.5%)	67
Y	25 (26.3%)	28 (29.5%)	22 (23.2%)	14 (14.7%)	6 (6.3%)	95
Z	47 (47.5%)	30 (30.3%)	14 (14.1%)	7 (7.1%)	1 (1.0%)	99
Total	88	81	50	30	12	261
Pearson chi-square test = 18.9000, df = 8, p-value = 0.0154						

Source: own processing

The Chi-square test produced a value of 18.9 with 8 degrees of freedom and a p-value of 0.0154. Since the p-value is below the significance level of 0.05, Hypothesis 3 is supported, confirming that there are statistically significant generational differences in the frequency of vacations.

The data reveal that Generation Z respondents most often go on vacation once a year (47.5%), while Generations X (34.3%) and Y (29.5%) most frequently reported taking two vacations per year. Generations X and Y also displayed a more balanced distribution across categories compared to Generation Z. A clear decreasing trend can be observed in all groups as the number of vacations per year increases. Notably, about 6–7% of respondents from Generations X and Y reported taking more than four vacations annually, whereas only 1.0% of Generation Z respondents selected this option.

Overall, the results suggest that younger respondents (Generation Z) tend to limit their vacations to once per year, while older generations demonstrate a higher propensity for more frequent travel. This difference may be related to financial resources, lifestyle, or life stage.

4. Discussion

The findings of this study provide evidence that Slovak women's international travel behavior varies significantly across generations, supporting all three proposed hypotheses. These differences

manifest most clearly in vacation planning styles, budget allocations, and travel frequency, reflecting broader generational distinctions in financial resources, decision-making patterns, and lifestyle preferences.

Regarding vacation planning (Hypothesis 1), the results indicate that independent planning is the dominant approach across all age groups, particularly among Generation Y. This finding aligns with broader trends of increasing autonomy and digital competence among younger adults, who are accustomed to using online platforms to arrange their travel. However, the higher reliance of Generation Z on their travel companions suggests a greater emphasis on shared decision-making or a lack of confidence in planning independently, possibly due to their younger age and more limited travel experience. The somewhat greater use of travel agencies among Generations X and Y may reflect both established consumption habits and a higher willingness to pay for professional services that simplify travel arrangements. Generational variations in vacation planning were systematically examined by Uysal (2022), who emphasized the distinctive planning patterns and criteria employed by travelers from Generations X, Y, and Z. Cenamor et al. (2017) emphasize the increasing role of social networks in shaping travel planning, noting that this influence is particularly strong among younger cohorts such as Generation Z, which may help explain their tendency toward more collaborative approaches to organizing trips. Similarly, Salazar et al. (2016) showed that younger cohorts, particularly Generations X and Y, make more frequent use of travel websites compared to older groups, highlighting the need for tourism and hospitality providers to consider generational differences in online engagement, as younger travelers are more inclined to consult and compare multiple sources when planning their vacations.

Spending patterns, including the share of household income devoted to leisure travel, are crucial determinants of the tourist experience. Scholars have emphasized that examining tourists' budgets is essential for gaining insights into their behavior and spending patterns (e.g., Disegna & Osti, 2016; Park et al., 2020). When examining vacation budgets (Hypothesis 2), significant generational differences again emerged. Generation Z is concentrated in the lowest budget categories, while Generations X and Y demonstrate a stronger presence in higher spending ranges, with Generation X particularly prominent in the €2000 and above category. These results are consistent with differences in income levels, financial stability, and life stage. Younger women (Generation Z), many of whom may still be studying or at the beginning of their careers, are more constrained in terms of disposable income. In contrast, Generations X and Y are more financially established and therefore capable of allocating larger sums to leisure activities such as international travel. This suggests that financial independence and purchasing power are key drivers of international travel preferences. Generational distinctions in travel preferences, particularly in relation to budget and expenditure habits, were examined by Octaviany & Mardiyana (2024) when comparing Generations X and Z.

Finally, vacation frequency (Hypothesis 3) also varied across generations. Generation Z respondents most commonly reported traveling abroad once per year, whereas Generations X and Y were more likely to take two annual vacations, with a small proportion even reporting more than four trips per year. This pattern is consistent with the budget results, as financial resources strongly influence the ability to travel more frequently. According to Špindler et al. (2025) and Șchiopu et al. (2023), representatives of Generation Y take the highest number of trips per year. The lower travel frequency of Generation Z may also be linked to their stage of life, with academic responsibilities or early career demands limiting available time for extended travel. By contrast, members of Generation X, who are generally more financially secure and established, appear better positioned to enjoy multiple vacations annually. Variations in trip duration preferences among different generations were analyzed by Uysal (2022). The frequency of travel was also examined in previous research by Kamboj & Sharma (2016), although this study did not address the issue from a generational perspective.

Taken together, these findings highlight how generational differences in life stage, financial capacity, and decision-making approaches shape international travel behavior among Slovak women. While all groups value the experience of traveling abroad, their approaches differ: Generation Z tends to travel less frequently and on smaller budgets, relying more on companions for planning, whereas Generations X and Y show stronger preferences for independent planning, higher budgets, and more frequent trips. These insights suggest that tourism marketers and service providers should tailor their offerings to the specific needs and constraints of different generational cohorts, whether by promoting affordable packages to younger travelers or premium experiences to older groups.

Conclusion

This study examined intergenerational differences in the international travel behavior of Slovak women, with a particular focus on vacation planning, budget allocation, and travel frequency. The findings confirmed all three research hypotheses, demonstrating that generational differences (X, Y, Z) significantly shape how women approach their vacations abroad.

First, regarding vacation planning, women across all generations most often preferred to organize their trips independently. However, notable variations were observed: Generation Y exhibited the strongest tendency to plan vacations on their own, while Generation Z relied more heavily on their travel companions. These differences highlight distinct approaches to autonomy and collaboration in travel preparation.

Second, the analysis of vacation budgets revealed clear intergenerational patterns. Although all groups most frequently reported budgets between €500–999, Generations X and Y were more strongly represented in higher budget categories, including €1000–1499 and above €2000. In contrast, Generation Z was concentrated in the lower budget ranges, with very few respondents allocating more than €2000. These results suggest that financial capacity, shaped by life stage, income, and family responsibilities, plays a crucial role in shaping generational travel behavior.

Third, the frequency of vacations also varied across generations. Generation Z most often reported traveling once a year, while Generations X and Y were more likely to take two or more trips annually. A small but notable share of older respondents indicated traveling more than four times a year—an option rarely selected by younger participants. This further underlines the impact of financial independence and lifestyle factors on travel frequency.

Taken together, the results indicate that older generations (X and Y) generally display greater financial flexibility and a higher propensity for frequent travel, while younger respondents (Generation Z) tend to adopt more modest travel budgets and travel less frequently. These findings provide valuable insights for the tourism industry, particularly in tailoring products and services to the needs and expectations of different generational segments.

Although the study provides valuable insights, several limitations should be acknowledged. The research was based on self-reported survey data, which may be subject to recall bias or social desirability bias. Moreover, the sample focused exclusively on Slovak women, which limits the generalizability of the findings to other countries or to male travelers.

Future research could broaden the scope by incorporating a more diverse demographic sample, including both women and men, and by comparing domestic and international travel behavior. In addition, examining factors such as cultural influences, digital technology use, sustainability considerations, and socio-economic characteristics (e.g., income, education, marital status) would provide a more comprehensive understanding of generational travel patterns in Slovakia and beyond.

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Regeneration through SMART Tourism in Central European Countries

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Abstract

Research background: Smart tourism represents a critical component of sustainable regional development in new principal conditions. The new value represents regeneration, especially in the dynamically evolving economies of Central Europe. Countries like Germany, Austria, Czech Republic, Slovakia, Hungary, and Poland increasingly recognize the potential of smart innovations in boosting competitiveness and visitor experience. However, strategic orientation and policy responses vary. This article addresses how these countries embed smart tourism and innovation in their capital cities strategic frameworks and what innovation patterns emerge.
Purpose of the article: The aim of this article is to explore and compare strategic documents of the capital cities, action plans, and innovation frameworks related to smart tourism in the Central European countries in the context of European influence. It seeks to identify key priorities and recurring themes that support digital transformation and innovation in tourism.
Methods: The study is based on content analysis and comparative analysis of strategic documents, supplemented by a cluster analysis of countries' performance in the European Capital of Smart Tourism Project.
Findings & Value added: The article provides valuable insights into SMART tourism policies and implementation dynamics across Central European countries. It contributes to the discussion on management of smart tourism and innovation practices. Furthermore, it provides a better understanding of regional innovation gaps and highlights transferable practices for future smart tourism development.

Keywords: Smart Tourism, Tourism, Central Europe, Policies, Innovation

JEL classification: Z30, Z32, Z38

1. Introduction

The concept of SMART destinations has lately gained significant attention in tourism studies and regional development discourse. Rooted in the principles of SMART cities, SMART destinations apply digital technologies and innovative governance to enhance destination management, sustainability, and the visitor experience (Samancioglu et al., 2024). These destinations are increasingly defined as technologically advanced and accessible environments that promote sustainable development, support deep interaction between tourists and place, and improve both visitor satisfaction and residents' quality of life. Moreover, SMART destinations are becoming testbeds for new digital services and act as platforms for social innovation and citizen engagement in decision-making processes. (Sustacha et al., 2023).

The term SMART destination emerged in response to tourism's digital transformation and the need for more effective governance. Inspired by the SMART city model, early definitions emphasized two dimensions: soft intelligence (leadership, innovation, and stakeholder collaboration) and hard intelligence (digital infrastructure and ICT systems). El Archi et al. (2023) argue that technology alone is insufficient. Smartness stems from integrating technology with human capital and institutional capacity. This holistic view enhances destination resilience and supports long-term strategic development. Lin et al. (2024) examine the role of technology in promoting sustainable and resilient travel and tourism management by synthesizing knowledge from literature regarding how ICTs affect the economic impacts of the tourism

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industry. Authors emphasize the importance of bridging the digital divide to create opportunities and ensure the responsible and safe application of technology.

Over time, the SMART destination concept has evolved into a complex ecosystem combining technological, economic, social, and environmental dimensions (Sustacha et al., 2023). Recent literature emphasizes knowledge-based innovation and data-sharing platforms in destination management. These platforms connect stakeholders and support real-time decision-making to optimize service delivery and sustainability. They also help reduce informational asymmetries between tourists, service providers, and local governments (Sustacha et al., 2023; Wei et al., 2024).

Accessibility and inclusivity are also highlighted as essential characteristics of SMART destinations. Wei et al. (2024) assert that these destinations must cater to diverse visitor groups while actively involving local communities across all phases of the tourism experience. This includes participatory planning, digital literacy programs for residents, and tools that empower communities to co-decide on tourism development.

At the core of the SMART destination paradigm lies advanced technological infrastructure. Xu et al. (2025) describe the implementation of ICT tools such as sensor networks, the Internet of Things (IoT), high-speed connectivity, data platforms, mobile

applications, and cloud services as foundational. These technologies enable real-time data collection, communication, and automation of processes within destinations. According to Novera et al. (2022) and El Archi et al. (2023), such systems form the backbone of SMART tourism ecosystems, allowing continuous monitoring of visitor flows, transport, and resource use, facilitating agile, responsive destination management by providing analytical capabilities for predictive modeling and planning, contributing to better preparedness for seasonal fluctuations and extraordinary events.

Among the emerging technological trends, artificial intelligence (AI), machine learning, robotics, and immersive media (e.g., virtual and augmented reality) are gaining prominence. Palomo Santiago and Parra López (2024) identify these technologies as transformative tools for service personalization, demand forecasting, and enhancing visitor engagement. Novera et al. (2022) particularly stress the role of IoT as a key trend in tourism, offering opportunities for destinations to attract and serve visitors more effectively through interconnected smart devices.

SMART products build on the SMART destination framework by turning systemic smartness into personalized, tech-enhanced experiences. They combine digital infrastructure with organizational innovations, such as stakeholder collaboration. According to El Archi et al. (2023), this marks a new phase of e-tourism, defined by interactivity, connectivity, and customization, which strengthens destination competitiveness. They also rely on digital infrastructure, such as IoT, mobile connectivity, and wearables, to collect real-time data on visitor behavior and service usage. Advances in AI and cloud systems enable destinations to offer hyper-personalized, context-aware services such as dynamic pricing and content tailored to emotional and behavioral data. (Buhalis et al., 2023).

One concrete application is the development of recommendation engines that analyze user data. Such as location, search history, and peer reviews to offer tailored suggestions for attractions, dining, and itineraries. Shen et al. (2024) underscore the growing potential of such systems to improve travel planning and on-site experiences. These technological innovations not only provide more relevant and seamless services but also contribute to increased visitor satisfaction and loyalty. Alsharif et al. (2024) report that personalized and efficient SMART services foster positive attitudes and long-term engagement with destinations.

The literature distinguishes between SMART destinations and SMART products along with several key dimensions. SMART destinations operate at a macro level (e.g., cities or regions), emphasizing strategic governance, data infrastructure, and sustainability goals. In contrast, SMART products are situated at the micro level (e.g., individual services or experiences), focusing on customer satisfaction through personalization and technological enhancement. This distinction is crucial for policy planning and investment strategies, which should aim to connect both levels and support their synergy. Table 1 summarizes the main differences:

Table 2. Difference between SMART Destination and SMART Product

Aspect	SMART Destination	SMART Product
Definition	Technologically managed destination	Technology enhanced experience
Scale	Macro (city, region)	Micro (individual, service)
Core Elements	ICT infrastructure, governance, data integration	AI, IoT, personalization, AR/VR
Impact	Efficiency and sustainability	Customer experience and satisfaction
Challenges	Coordination, interoperability	Privacy, technology accessibility

Source: Own processing based on literature review

Recent literature has also begun to situate SMART tourism within the broader shift from sustainability to regeneration. Regenerative tourism, as presented by Luong et al. (2024), positions itself beyond the mitigation logic of sustainable tourism, aiming instead to produce net-positive impacts, restore ecosystems, revitalize communities, and foster co-evolving relationships between tourism and place.

Bellato et al. (2024) define regenerative tourism as a transformational approach focused on healing the relationships between people, places, and tourism systems. Unlike sustainability, which aims to "do no harm," regeneration emphasizes leaving destinations better than before through active renewal and system thinking. It reinterprets tourism's purpose not merely as a driver of economic development but as a catalyst for socio-ecological regeneration.

In this context, SMART destinations and technologies enable regeneration rather than only sustainability. Alsahafi et al. (2023) view SMART tourism as part of the broader vision of SMART societies, emphasizing the need for stakeholder cooperation, responsible innovation, and awareness of global-local interdependencies.

Digital tools, including IoT sensors, AI, and blockchain, can enhance adaptiveness and ecological responsiveness in tourism systems. However, achieving truly regenerative outcomes requires embedding these tools within inclusive governance structures, focusing on resilience, capacity-building, and potentially post-growth development models (El Archi et al., 2023; Paddison & Hall, 2024).

2. Methods

This study employs a triangulation of qualitative and quantitative approaches to examine approaches to smart tourism in six Central European countries: Germany, Austria, Czech Republic, Slovakia, Hungary, and Poland. The core of the research is a content and comparative analysis of strategic documents of the national capital cities, their ranking in IDM Smart City Index, and an analysis of these countries' performance in best practices in the European Capital of Smart Tourism project, supported by a cluster analysis of these countries based on the number of their placements in the categories of Digitalization, Sustainability, Accessibility, and Cultural Heritage & Creativity from the year 2020 to 2025.

To achieve the objective of this article, the authors formulated two research questions:

Q1: How do the level and structure of participation of Central European countries in the European Capital of Smart Tourism initiative differ?

Q2: Does the capital city promote a balanced application of smart principles specifically in Tourism related activities?

Additionally, the analysis incorporates data from the Travel & Tourism Development Index (TTDI) published by the World Economic Forum. This index serves as a valuable benchmark for assessing the digital readiness and innovation capacity of tourism sectors across countries. By integrating TTDI scores, the study enhances the comparative dimension of the research and provides a clearer understanding of each country's competitiveness in the context of smart tourism development.

The content analysis identified key priorities and recurring themes related to digitalization, innovation, and sustainability. A comparative analysis was then conducted to assess capital cities approaches to smart tourism. Finally, cluster analysis was conducted based on the differences among the European countries studied in terms of their European Capital of Smart Tourism best practices. This methodological design offers a comprehensive perspective on how smart tourism is integrated into regional development strategies across Central Europe.

The study also proposes the development of a map scheme that visualizes smart tourism and captures the complexity of services involved in the visitor experience. This scheme encompasses five key dimensions: core tourism services (such as accommodation and transport), complementary urban services

(e.g., parking, public transport), cultural infrastructure (including museums, galleries, and heritage sites), the MICE sector (covering conferences, congresses, outdoor events, fairs, and exhibitions), and indirectly consumed services by visitors, such as waste management, water cleanliness, etc. The scheme will be primarily based on the context of the capital cities of the analyzed countries, as they represent key nodes of tourism innovation and infrastructure. By integrating these layers, the final scheme aims to reflect the interconnectedness of tourism with broader urban systems and sustainability goals, providing a more holistic perspective on smart tourism development.

3. Results

The Travel & Tourism Development Index (TTDI) 2024 data reveal notable disparities among Central European countries in terms of tourism-related performance indicators, as seen in Table 2. Germany leads the region and ranks sixth globally with an overall TTDI score of 5.00, driven by strong ICT readiness (6.12) and environmental sustainability (5.62). Austria ranks 15th worldwide, with similarly high scores in ICT readiness (6.09) and environmental sustainability (5.70); however, its socioeconomic impact and demand sustainability scores are notably lower.

Poland and the Czech Republic occupy mid-tier positions (27th and 33rd, respectively), reflecting solid performance in ICT readiness (5.89 and 6.01) but more modest scores in tourism impact and demand sustainability. Hungary and Slovakia, ranking 37th and 54th, respectively, display consistent but comparatively lower performance across most dimensions. Notably, Slovakia's T&T socioeconomic impact score (3.56) and demand sustainability (2.61) are among the lowest in the group, suggesting challenges in translating tourism development into broader economic and social benefits.

These findings highlight a regional divide, where Germany and Austria exhibit a more balanced and mature tourism development landscape. At the same time, other countries exhibit varying degrees of progress, often hindered by weaker socioeconomic impacts and a demand for sustainability.

Table 3. Countries ranking in the TTDI 2024

Country	Rank (worldwide)	TTDI Score (Total)	ICT Readiness	Environmental Sustainability	T&T Socioeconomic Impact	T&T Demand Sustainability
Germany	6.	5	6.12	5.62	3.41	3.35
Austria	15.	4.65	6.09	5.7	2.91	3.22
Poland	27.	4.4	5.89	4.97	3.75	3.38
Czech Republic	33.	4.31	6.01	5.26	3.01	2.74
Hungary	37.	4.27	5.82	5.43	3.71	3.15
Slovakia	54.	4	5.78	5.8	3.56	2.61

Source: Own processing based on WEF (2024)

European Capital of Smart Tourism Project

The number of best practices across the years reveals significant variation between the countries. Poland demonstrated the highest level of engagement, with a total of 35 placements over the five years. Poland’s presence remained consistent, with particularly strong participation in 2022, 2023, and 2025. Germany followed with 30 placements, demonstrating stable involvement each year, except in 2025, when no placements were recorded. Germany had its peak years in 2020 and 2024, with both years featuring nine entries.

Austria achieved nine placements, all in 2020, indicating a strong initial engagement that was not sustained in later years. Hungary joined the initiative more recently, with six placements, all of which occurred in 2023. Slovakia participated only in 2020 with one placement, and the Czech Republic did not record any placements during the analyzed period, suggesting either non-participation or lack of success in the selection process.

These results highlight a clear dominance of Poland and Germany, both in terms of overall numbers and continuity across years, while other Central European countries showed limited or sporadic involvement.

The initiative recognizes excellence in four main categories: Accessibility, Cultural Heritage & creativity, digitalization, and Sustainability.

Poland stood out particularly in the Cultural Heritage & Creativity category, with 13 recognitions, the highest among all countries. It also scored well in Sustainability (9 placements) and Accessibility (7), demonstrating a broad and balanced portfolio. Germany showed strong, relatively even distribution across all categories, excelling most in Sustainability (11 placements) and digitalization (8), reflecting a focus on technological advancement and environmental responsibility.

Austria's achievements were focused primarily on cultural heritage & creativity, as well as digitalization (each with three placements), and to a lesser extent, on Accessibility (two) and Sustainability (one). Hungary's profile was narrower, with three placements in Sustainability, 2 in Accessibility, and only one in digitalization. Slovakia was only represented in Sustainability (one placement), while the Czech Republic again recorded no placements in any category. As shown in table 3

Table 4. Countries by their Performance in Different Categories

Country	Accessibility	Cultural Heritage & Creativity	Digitalisation	Sustainability
Austria	2	3	3	1
Germany	6	5	8	11
Hungary	2	0	1	3
Poland	7	13	6	9
Slovakia	0	0	0	1
Czech Republic	0	0	0	0

Source: Own processing based on European Capital of Smart Tourism Project

To further understand the similarities and differences in participation profiles, a cluster analysis was conducted using Euclidean distances. The results reveal two dominant clusters: The results are shown in Figure 1.

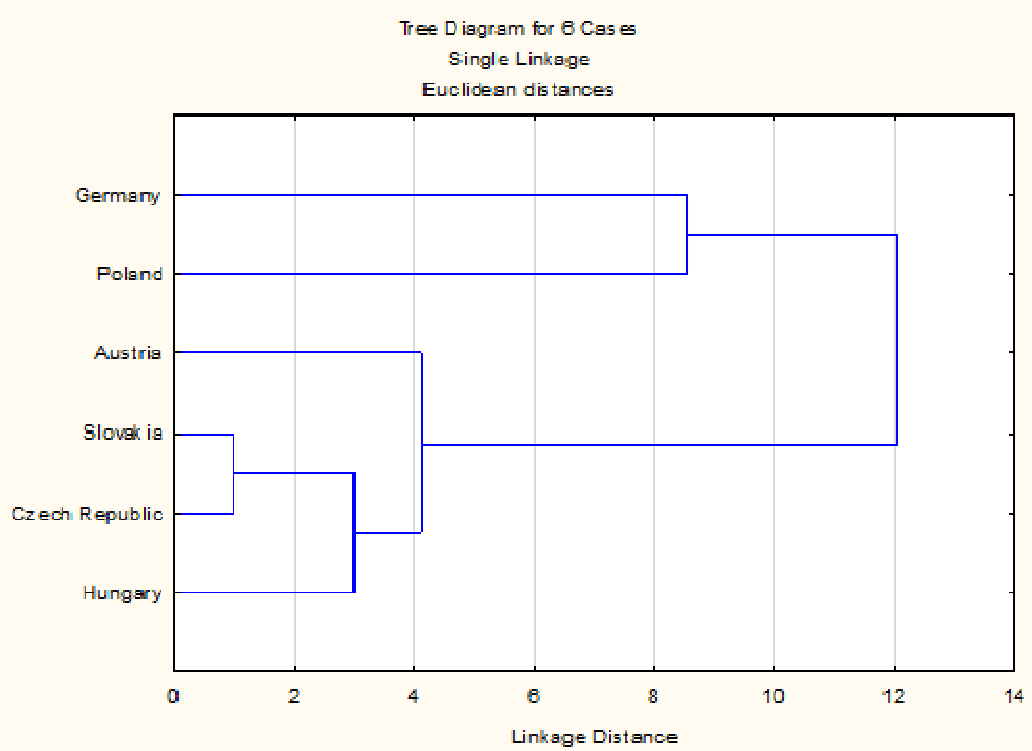

Figure 7. Cluster Analysis based on the European Capital of Smart Tourism
Source: Own processing in Statistica software based on European Capital of Smart Tourism Project

Cluster 1: High-performing, broadly engaged countries

This cluster consists primarily of Germany and Poland. Despite some differences in specific category emphasis, their overall engagement profiles are relatively close (distance = 8.5), especially when compared to other pairwise combinations. Both countries demonstrate consistent participation across multiple years and categories, suggesting a comprehensive and institutionalized approach to smart tourism. In contrast, Poland and the Czech Republic showed the most significant distance (18.3), reflecting a complete absence of Czech participation and a robust Polish presence.

Cluster 2: Selectively or minimally engaged countries

This includes Austria, Hungary, Slovakia, and the Czech Republic. These countries have fewer total placements, narrower category representation, and sporadic or early-only participation. Internal distances within this group are notably smaller: Austria and Hungary (distance = 4.1), Slovakia and Czech Republic (1.0), and Hungary and Slovakia (3.0). These similarities suggest that more localized or isolated efforts may drive their participation.

These clusters reveal both the extent and strategic coherence of involvement across the countries, underscoring the divide between highly engaged nations and those with marginal or no participation.

Analysis of individual cities shows further disparities. Gdynia, Poland, is the leading city in terms of total placements, with 19 recognitions between 2022 and 2024, indicating a strong, sustained commitment to the initiative. Other notable Polish cities include Lublin (7 placements in 2025), Poznań (5), and Szczecin (3), suggesting a geographically diverse and well-coordinated national effort.

In Germany, Karlsruhe recorded 13 placements in 2020 and 2022, followed by Essen (8, primarily in 2023–2024) and Bremerhaven (6 in 2024). These cities show Germany's consistency in nominating and promoting multiple urban centers.

Austrian cities were present only in 2020, with Linz (4 placements), Klagenfurt (2), and Innsbruck (3), reflecting the country's early engagement. Hungary was represented solely by Szeged, which achieved six placements in 2023. Slovakia had only Bratislava (1 placement in 2020), and no Czech cities appeared in the rankings.

These results align with national-level trends and reinforce the view that Germany and Poland lead not only in aggregate terms but also in supporting a broader array of participating cities.

The Capital Cities of Central European countries regarding to „smart"

All strategic documents share a common basic principles. According to these principles „Smart" Cities are: Ecological, Innovative, Friendly and Motivating, Digital and Open; Safe and Resilient.[1] Smart cities projects aim for sustainable growth and a high quality of life for its residents. (Smart Prague, n.d.)

Table 4 shows a comparison of the individual capital cities on analyzed countries based on the Smart City Index and their strategic approaches.

IMD Smart City Index (SCI) is considered one of the world's leading assessments of smart cities. It evaluates cities through two main pillars: Structures, which relate to the existing infrastructure, and Technology, which covers the technological solutions and services available to residents. The index is unique in that it is based on residents' perceptions, reflecting how well cities meet the needs of their citizens through smart initiatives. The 2025 edition of the SCI ranks 146 cities worldwide, drawing on feedback from approximately 100 residents in each location.

According to the international IMD Smart City Index evaluation, three of the studied cities, Vienna, Prague, and Berlin, were placed in the top tier, classified as Group 1 smart city A and Bratislava smart city BB. Meanwhile, Warsaw BBB and Budapest CCC were ranked in the second group, indicating strong but slightly lower performance in smart city development. Smart projects and smart activities are evaluated in the capital cities of Central European countries using quantitative indicators. Prague assesses its "smart" initiatives through the Smart Prague Index. Warsaw has established a set of indicators differentiated by specific groups of smart activities. Other studied capital cities have developed their own evaluation systems, which are linked to assessment frameworks aligned with the requirements of their funding sources.

[1] The mentioned smart principles are commonly found under various or similar names in all the capital cities of Central European countries studied. These primarily include smart governance, including Data HUBs, waste management, and integrated transport; smart environment, including energy systems, smart buildings, environmentally friendly transport, air quality monitoring, and noise level monitoring; smart society, including education, research, digitalization, and online communication; and smart economy, including investments, innovation, and the circular economy. Tourism is partially reflected in individual smart activity projects. The most significant connection to tourism is evident in the implementation of digitalization across all services used by tourists.

Table 5. Smart City Index and Concept of Smart Development of Capital Cities

State/ Capital	Ranking IMD Smart City Index evaluation 2024/2025	Factors	Projects/number	Direct smart projects in Tourism
GROUP 1				
Austria Vienna	Smart city A Ranking 23/26	Structures A Technologies A	Energy supply/14 *Mobility & transport/9 *Buildings/9 *Economy & Employment/6 *Zero waste & circular economy/3 *Adapting to climate changes/5 *Urban ecology, environment & water *Health and social inclusion/3 *Education, science & research *Digitalization/11 *Participation, engagement & culture ***Direct Tourism/1 (within Energy and Building**	City hotel with a zero-energy balance 2014 E-Mobility 2024
Czechia Prague	Smart city AA Ranking 14/12	Structures AA Technologies AA	*Mobility of the Future/13 *Smart Buildings and Energies/16 *Waste-free City/3 ***Direct tourism: Attractive Tourism/1** *People and the City *Environment/31 *Data area/2	Prague Visitor Pass
Germany Berlin	Smart city A Ranking 37/37	Structures BBB Technologies BBB	*Regenerative Economy: /18 *Future Opportunities for All *Inclusive Urban Design *Enabling Administration	
Slovakia Bratislava	Smart city BB Ranking 56/57	Structures BB Technologies BBB	Society: *Modern education *Creative culture Pleasant and safety city to live in: Public relax area, reconstruction, green *Circular economy *Ecological town *Protection of culture heritage *** A tourist friendly city** * Development of MICE * Sport facilities in the public area /1	Bikesharing Urban-E Up! City GNSS system in the public transport Public free of charge WIFI connection on outdoor spaces
GROUP 2				
Hungary Budapest	Smart city CCC Ranking 84/89	Structures B Technologies BBB	*TRAM NETWORK OF BUDAPEST. *SOCIETY/3 Created the scene of improving living quality and harmonious coexistence, also, the value and knowledge; Open urban governance Conscious society BUDAPEST CITY IDENTITY NONPROFIT LTD. *SMART ECONOMY/3 strengthened. Smart Budapest to serve the implementation of Budapest 2030 global objectives by using broadly defined smart practices. Sustainable economy Competitive local economy BROWNFIELD REGISTER BUDAPEST MICRO LOAN PROGRAMME	

Poland Warsaw	Smart city BBB Ranking 3 8/28	Structures A Technologies A	Smart mobility Smart Economy Smart environment Smart society Smart living Smart government	VETURILO 600 km urban bike system VaVel platform Mobile apps Car sharing Electromobility

Source: Own processing of documents from capital cities regarding smart cities

The capital cities of all Central European countries have incorporated smart city principles into their strategic documents and have also established timelines for their implementation in urban life. In most capital cities, smart tourism is addressed indirectly by integrating it into various thematic activities. Only three capital cities, Prague, Bratislava, and Warsaw, explicitly define projects aimed primarily at meeting the needs of city visitors.

The benefits of smart principles from the perspective of visitors and the satisfaction of their needs are not a priority for the cities. In the future, it will be worthwhile to analyze these issues through primary qualitative research.

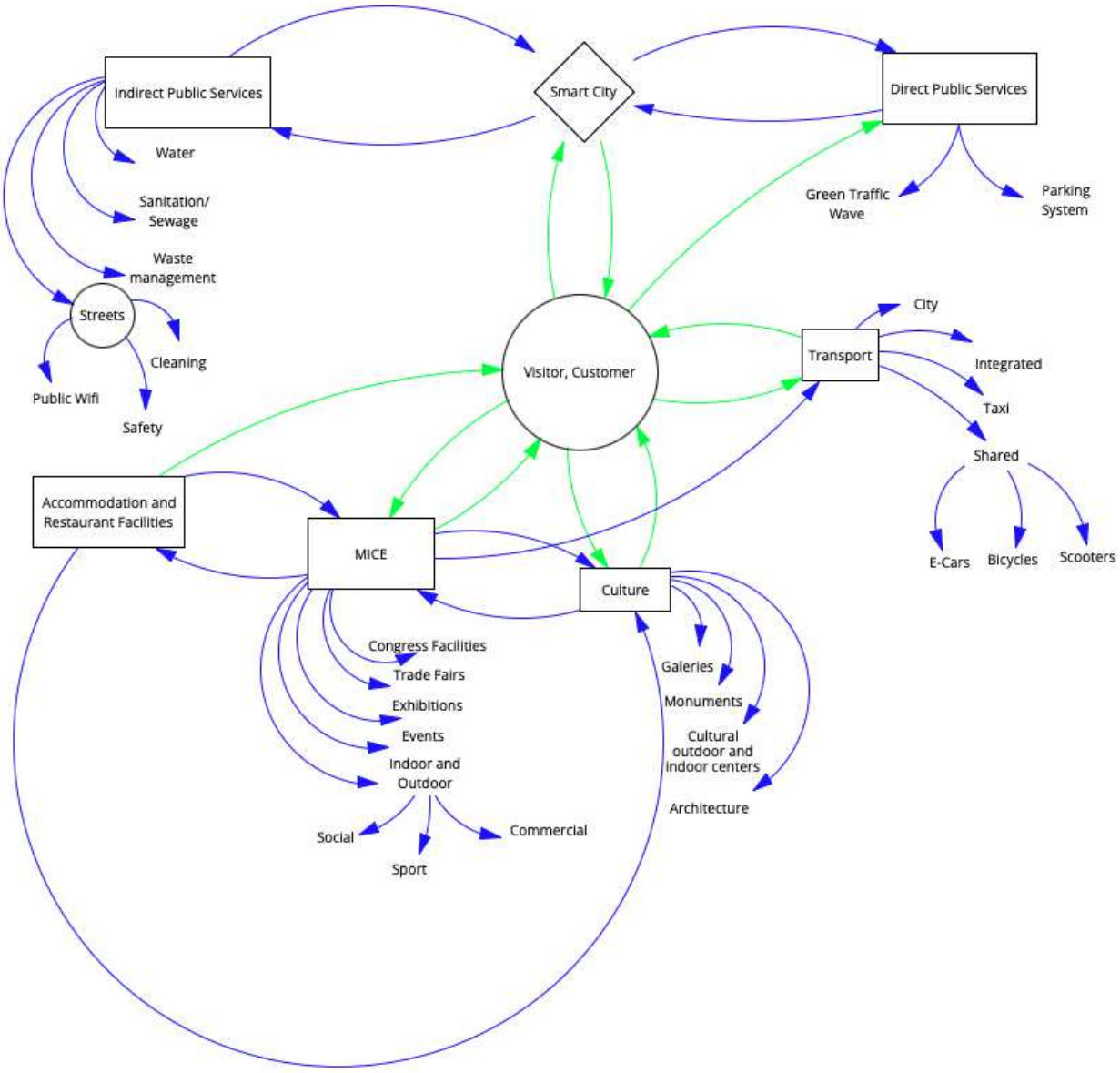

Figure 8. Smart map scheme within the consumption of tourism services
Source: Own processing in Vensim software

Tourism has an interdisciplinary character and is reflected in various sectors. Therefore, it is understandable that basic documents on smart cities do not often or regularly address smart solutions for tourism as a separate sector. Smart hotels are included under green buildings, environmentally friendly smart transport vehicles are part of the transport sector, and the digitalization of artworks, literature, or monuments is part of culture, and so on.

Public services are primarily intended for the local population. On the other hand, they also contribute to the indirect consumption by participants in tourism. In the smart map, they are outlined within the framework of indirect public consumption of services (waste, water, sewerage, cleaning, green and blue care, hygiene, safety) as well as within direct consumption (transport, transport conditions, etc.).

Funding for smart initiatives is not directly allocated to tourism, but it is important not to overlook the financing and implementation of smart solutions in activities that are part of tourism services.

4. Discussion

The findings of this study highlight the uneven progress of smart tourism development across Central European countries and their capital cities. While Germany and Poland demonstrate systematic and institutionalized approaches with consistent participation in the European Capital of Smart Tourism initiative, the remaining countries display selective or fragmented engagement. This divergence reflects not only differences in national policy orientations but also in institutional capacity, funding mechanisms, and local stakeholder involvement.

A key insight emerging from the analysis is the gap between strategic declarations and operational implementation. Most capital cities integrate smart solutions primarily in sectors aimed at improving residents' quality of life, such as transport, energy, or waste management, while tourism-related projects remain marginal. This reinforces the interdisciplinary character of tourism, but also suggests that visitors' needs are often addressed only indirectly, which aligns with the finding of Sustacha et al. (2023). From a regenerative tourism perspective, this limited integration represents a missed opportunity, as smart technologies could be leveraged more explicitly to enhance both visitor experience and local well-being.

Another important aspect concerns the regional imbalance revealed by the cluster analysis. The divide between broadly engaged countries (Germany, Poland) and minimally involved ones (Austria, Slovakia, Hungary, Czech Republic) mirrors wider patterns of innovation adoption in Central Europe. This suggests that smart tourism development is closely but not entirely linked to broader digital readiness and innovation ecosystems, as reflected in the TTDI results. The weak socioeconomic impact scores for countries like Slovakia and Hungary further underline that smart initiatives do not automatically translate into broader societal benefits without coherent policy support.

From a theoretical perspective, the study also contributes to the ongoing debate on the transition from sustainable to regenerative tourism. While smart city initiatives are often justified in terms of efficiency and sustainability, their potential to foster regenerative outcomes remains underutilized. To achieve this, digital innovations must be integrated into participatory governance structures that emphasize inclusivity, resilience, and long-term value creation. Without this shift, smart tourism risks reinforcing existing inequalities rather than serving as a transformative force. As Bellato et al. (2024) argue, regenerative tourism seeks to leave destinations better than before by fostering socio-ecological renewal. Smart technologies, such as IoT, AI, or immersive media, can support such outcomes, but only when embedded in participatory governance and inclusive decision-making (Paddison & Hall, 2024).

Finally, the study underscores several practical implications. Policymakers should strengthen cross-border collaboration and knowledge exchange, particularly between high- and low-performing countries. Conducted research also suggests that there is a compelling need to support the mutual synergy of smart projects that benefit both stakeholders in the destination, the local community, and visitors. This conclusion is indirectly confirmed by analyses done by Lin et al. (2024) regarding the role of technology in promoting sustainable and resilient travel and tourism management. The importance of the next level of regenerative development was mentioned by Luong et al. (2024) and Bellato et al. (2024). Funding programs could be redesigned to encourage tourism-focused smart projects that generate direct benefits for visitors while supporting regeneration goals.

Conclusion

This study analyzed the strategic documents of the capital cities of six Central European countries and their participation in the European Capital of Smart Tourism initiative. The research revealed that the concept of SMART tourism is still in its early phase in the region, with significant disparities in its

implementation across different countries and cities. The purpose was fulfilled, and the findings provide evidence to answer both research questions.

Q1: The level and structure of participation by Central European countries in the European Capital of Smart Tourism initiative vary significantly. Poland and Germany stand out as the most active participants, with high numbers of placements across categories and years, indicating a systematic and institutionalized approach to SMART tourism. In contrast, countries such as the Czech Republic, Slovakia, and Austria show limited engagement, with the Czech Republic recording no placements at all. Cluster analysis confirmed this divide, highlighting two dominant groups: highly engaged countries (Germany, Poland) and selectively or minimally involved countries (Austria, Hungary, Slovakia, Czech Republic).

Q2: The capital cities prioritize the implementation of smart principles in the everyday lives of their residents. Tourism is perceived in an interdisciplinary manner to the greatest extent. Smart innovations in tourism are seen as part of the broader smart agenda for the local community. The introduction of smart solutions into urban life is primarily realized through elements aimed at improving residents' quality of life. Independent tourism-focused projects have been presented mainly by Prague, Bratislava, and Warsaw, particularly in the area of transportation.

The results suggest that when smart tourism is meaningfully integrated into broader urban development strategies, it goes beyond enhancing visitor experience and competitiveness. It can also lay the groundwork for truly regenerative tourism. In this setting, technology is not just a means to improve efficiency; it plays a crucial role in driving more profound change by promoting inclusive decision-making, enhancing environmental resilience, and empowering local communities.

Still, there are clear obstacles. Differences in socioeconomic impact, the sustainability of tourism demand, and the consistency of strategic efforts highlight the need for more targeted capacity-building, enhanced international collaboration, and closer alignment between technology investments and policy objectives. A more coordinated and regionally cohesive approach could help Central Europe position itself more strongly within the global smart tourism landscape.

It is clear that funding for smart initiatives does not need to be allocated directly to tourism, but it is important not to overlook funding for smart solutions in activities that are part of tourism services. The benefits of smart principles from the perspective of visitors and the satisfaction of their needs are not a priority for the cities. In the future, it will be worthwhile to further analyze these issues through primary qualitative research.

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Cultural Tourism in the Perspective of Wellness: Towards a Model of Smart Wellness Destination Cultural Driven

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Abstract

Research background Cultural heritage plays a fundamental role in the creation of tourism value, contributing to the enhancement of the symbolic capital of places and to the differentiation of the value propositions of businesses and tourist destinations. In Italy, this function is amplified by the country's extraordinary historical and cultural wealth, vibrant human presence, and distinctive biodiversity. However, Italian cultural heritage today faces a paradox: while some destinations, such as major art cities, are affected by overtourism, many others—such as historic villages and inland areas—suffer from under tourism, risking abandonment and a loss of value.
Purpose of the article: Considering this imbalance, the paper proposes an interpretive model that distinguishes between different types of cultural destinations, highlighting their characteristics, challenges, and opportunities in relation to the growing wellness tourism market. It explores how cultural heritage—both tangible and intangible—can serve as a strategic asset to attract an increasingly international demand for authentic wellness experiences, by promoting the Italian lifestyle encapsulated in the slogan "Italian way of living."
Methods: This study adopts a conceptual research design based on a qualitative and interpretive approach, aimed at developing a theoretical framework that integrates culture and well-being into a new typology of tourism destinations. The goal is to explore the interconnections between cultural resources, experiential well-being, and sustainability. .
Findings & Value added: The study provides a new interpretation of culturally driven tourist destinations, combining the ability of destinations to generate well-being for tourists by proposing personalized value offers in a slow manner or standardized offers that can be used quickly.
Moreover, the concept of smart wellness destinations cultural driven is introduced to generate value and well-being for both travellers and host communities, while respecting ecosystem limits and local specificities, and revitalizing areas currently excluded from major tourism flows.

Keywords: Tourist destination, Wellness destination, Cultural tourism, Smart tourism

JEL classification: L83

1. Introduction

In Italy, cultural tourism holds significant socio-economic potential thanks to the widespread presence of both tangible and intangible heritage assets. These resources—shaped by history, nature, and local communities—represent a distinctive national strength that supports the attractiveness and competitiveness of Italian destinations. The country's vast and capillary distribution of cultural sites qualifies it as an authentic "open-air museum" (Solima, 2020), with nearly one in three municipalities hosting at least one museum, and over 50% of municipalities in some regions.

Tourism, as a global phenomenon, has progressively evolved toward experiential models that emphasize not only the discovery of cultural heritage but also the pursuit of personal well-being. Within this framework, cultural tourism is undergoing a significant conceptual expansion, increasingly overlapping with wellness tourism. Italy—thanks to its rich landscapes, diverse cultural and culinary

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traditions, and unique artistic and historical heritage—offers fertile ground for developing tourism models that integrate well-being as a key value proposition.

While early definitions of cultural tourism, such as the UNWTO's 1985 formulation, focused on narrowly defined motivations (e.g., study trips, festival participation, visits to monuments and museums), more recent perspectives embrace a broader and more inclusive view. According to the UNWTO (2019), cultural tourism encompasses "tourist activities whose essential motivation is to learn, discover, experience, and consume tangible and intangible cultural attractions and products in a destination." These include not only traditional artistic and architectural assets but also lifestyles, values, traditions, and creative industries. In line with this holistic approach, Italian institutions (ISTAT, 2022b) now include natural and landscape heritage within the domain of cultural tourism, aligning with the spirit of the Faro Convention.

Statistical data confirms the territorial expansion of cultural tourism demand: many Italian municipalities that possess both cultural and scenic value have seen significant visitor growth. In regions such as Lazio, Umbria, and Campania, over 80% of tourist stays occur in culturally-oriented municipalities. Tuscany, Sicily, Emilia-Romagna, Marche, and Trentino-Alto Adige also exceed the national average (ISTAT, 2023).

Yet, this vast cultural capital remains underutilized. On one hand, it often fails to generate adequate economic and touristic value; on the other, its long-term sustainability is at risk. Tourism revenues could play a crucial role in ensuring the conservation and active use of heritage resources, preventing them from becoming static "cemeteries of cultural memory" with aesthetic but no experiential value.

This highlights the strong value-generating potential arising from the synergy between culture and tourism—what may be seen as a "marriage of interests". Cultural and tourism sectors share complementarities in terms of policies, activities, and services. Cultural assets benefit from tourism infrastructures—transport, accommodation, hospitality, and services—which enhance visitor experiences and contribute to the usability and perceived value of heritage.

The integration of cultural elements in tourism offerings increases distinctiveness and market positioning, boosting destination competitiveness. Italy's uniqueness lies not only in the beauty of its landscapes—common to many global destinations—but in the richness of its cultural, historical, and human biodiversity, which turns natural environments into anthropic landscapes. This uniqueness is central to the country's branding as the "Bel Paese."

This evolution calls for a shift in how cultural tourism is conceived: no longer as a form of passive consumption, but as a set of value-creating, well-being-enhancing, and socially responsible experiences. Culturally driven destinations, when designed with a focus on well-being, sustainability, and inclusiveness, can act as platforms for individual and collective regeneration. The real challenge is to balance heritage enhancement with the protection of natural and social capital, mitigating the risks of over-tourism and cultural homogenization that often affect iconic mass destinations.

Cultural heritage thus becomes a multistakeholder and multidimensional source of value: it generates economic benefits for tourism enterprises, social cohesion for local communities, and cognitive, emotional, and symbolic enrichment for citizens and visitors alike. It also supports the preservation of natural and cultural capital, including traditions, local identities, and the genius loci.

In this context, experience-based tourism—framed within the "experience economy" paradigm (Pine & Gilmore, 1998)—offers a powerful model. Tourists today seek transformative experiences that enhance personal well-being and foster self-improvement. Cultural tourism can meet this demand by offering meaningful engagement with places, narratives, and communities. These experiences, especially when bundled into coherent, integrated offerings, can differentiate destinations and promote their sustainable regeneration, especially in less-travelled areas such as inland villages and peripheral regions in Southern and Central Italy.

Achieving this vision requires a multidisciplinary and collaborative approach to destination planning—one that integrates urban policy, tourism marketing, and cultural resource management, and actively involves stakeholders at all levels. In doing so, cultural tourism becomes a transformative opportunity for the Italian tourism sector—capable of elevating quality of life, promoting sustainable development, and strengthening the socio-cultural fabric of local communities.

The challenge is to design cultural-driven wellness destinations— "smart" ecosystems (Dini & Pencarelli, 2020)—that combine digital innovation, community-based governance, and holistic value creation across economic, social, and environmental dimensions.

In this context, there is a lack of conceptual studies that explicitly frame tourism destinations through the lens of both cultural heritage and wellness, within a smart and sustainable development perspective. Existing literature tends to explore these elements in isolation or through fragmented disciplinary approaches. This article aims to bridge that gap by proposing an integrated conceptual framework for interpreting "culturally-driven smart wellness destinations." Our objective is to develop a classification model that captures the diversity of such destinations, while highlighting the conditions under which cultural resources can generate value in line with the principles of well-being, sustainability, and digital innovation.

To this end, the study addresses the following research questions:

1. How can cultural heritage—both tangible and intangible—be strategically integrated into wellness tourism offerings to generate multidimensional value for destinations and stakeholders?
2. What are the main types of culturally-driven wellness destinations, and how can they be classified according to the levels of personalization, well-being generation, and intensity of visitor flows?

2. Literature Review

2.1 Wellness Tourism: a holistic perspective

Academic research on wellness tourism has primarily analyzed the phenomenon from three complementary perspectives: tourist demand, destination development, and community well-being (Hartwell et al., 2018). From the community perspective, recent studies emphasize a paradigm shift toward recognizing the holistic benefits that tourism can provide to local populations. Sustainable and competitive destination management practices are increasingly being oriented toward the health and well-being of both tourists and residents, highlighting well-being as a strategic objective for tourism development.

From the demand side, scholars have explored the growing interest among tourists in wellness experiences that integrate multiple dimensions—physical, emotional, spiritual, and cultural (Kim et al., 2017; Lim et al., 2016; Damijanić & Šergo, 2013). Konu et al. (2010) proposed a segmentation of wellness tourists into six groups, based on combinations of motivations and activities related to sport, nature, spirituality, and culture. These include, among others, tech-savvy sport and nature enthusiasts, family-oriented health seekers, and culturally motivated autodidacts. Damijanić and Šergo (2013) highlighted the relevance of sociodemographic variables—such as income, gender, and education—in shaping wellness travel motivations, and noted the particular appeal of destinations rich in natural and cultural assets. Lim et al. (2016) identified the attractiveness of biodiversity and iconic attractions as key pull factors, especially for first-time and returning visitors.

Additional research has explored how wellness tourism offerings should respond to the expectations of new market segments. For example, Lee et al. (2019) suggest that hotels catering to millennials should offer services that enhance intellectual and spiritual well-being, such as reading spaces, educational workshops, natural medicine options, and holistic nutrition. These insights reinforce the growing consensus that wellness tourism must be understood from a holistic standpoint, encompassing physical, emotional, spiritual, intellectual, social, and environmental dimensions (Bushell & Sheldon, 2009).

This multidimensional view is echoed in various definitions of wellness tourism, ranging from those that emphasize harmony between body, mind, and spirit (Smith & Puczkó, 2014, p. 208), to others that focus more narrowly on health-related motivations (Heung & Kucukusta, 2013). More recently, scholars studying wellness destinations have moved beyond clinical and medical paradigms (Kamassi et al., 2020), increasingly embracing an integrative conception of well-being that includes cultural and social enrichment as core components of the tourist experience (Majeed & Kim, 2023; Dilette et al., 2020).

In line with this evolution, Dini and Pencarelli (2022) propose a broader understanding of wellness tourism that aligns with international contributions (Suban, 2023; Hwang & Lee, 2019; Sharma & Nayak, 2018; GWI, 2020). Their perspective integrates the diverse existential needs of travelers with an array of destination offerings designed to foster well-being. These include body care, gastronomy, nature immersion, cultural engagement, spiritual experiences, and entertainment—constituting a comprehensive "wellness value proposition."

Wellness tourism, therefore, should be understood as a means of actively or passively supporting human well-being through tourism experiences that respond to the increasing demand for not only hedonic but also eudaimonic and transformative travel (Rahmani et al., 2018; Zhao & Agyeiwaah, 2023). Within this framework, culture emerges as a central and distinctive element—serving as a catalyst for deeper, more meaningful forms of tourism that are rooted in the local identity, values, and uniqueness of place.

2.2 Culture and wellness tourism: an integrated perspective

In the context of wellness-oriented destinations, culture should not be reduced to a static collection of tangible assets to be admired but rather understood as a dynamic cultural ecosystem that interacts with visitors (Ghermandi et al., 2020). Cultural heritage becomes a powerful medium through which tourists can connect with history, art, traditions, and the everyday life of local communities—thereby promoting a form of tourism that is more responsible, participatory, and transformative. Integrating culture into wellness tourism means going beyond monuments, museums, and archaeological sites, and embracing landscapes, festivals, gastronomy, and local craftsmanship. This allows visitors to develop a deeper and more authentic understanding of places—not only as natural legacies, but as expressions of human presence and collective identity.

This approach moves away from a narrow, elitist view of cultural tourism—traditionally reserved for highly educated segments—and promotes instead a more democratic and inclusive model, where active and conscious participation enhances curiosity, learning, intercultural exchange, and genuine contact with host communities.

Several studies have investigated the cultural dimensions of wellness in tourism. Feng et al. (2021) and Huang & Xu (2014), for instance, explore the role of traditional Chinese medicine in enhancing tourist well-being. Esfehani and Albrecht (2019) and Maharjan et al. (2022) focus on intangible cultural heritage and its capacity to transform places into meaningful tourism destinations. Their work highlights the interdependence between material and immaterial elements in shaping culturally embedded well-being experiences.

Adopting a broad definition of cultural tourism enables the inclusion of multiple wellness-related travel forms, such as spiritual tourism (Bandyopadhyay & Nair, 2019; Ashton, 2018), inspired by Feng Shui, yoga, or New Age movements (Drury, 2004); nature-based tourism centered on wilderness, forests, mountains, lakes or geothermal springs; as well as wellness tourism linked to local festivals and events (Malyshev et al., 2016), and food and beverage tourism (Forlani et al., 2022; Dilette et al., 2020).

Although the literature reflects the growing diversity of wellness tourism forms, much of it remains analytically fragmented—often failing to recognize the complex interdependencies among cultural, natural, and social elements. However, recent studies by Tülek (2023) and Smith & Ram (2017) address this gap by advancing the concept of cultural ecosystem services (CES): non-material benefits—such as well-being—derived from cultural, spiritual, recreational, and aesthetic experiences associated with ecosystems.

The CES framework represents a conceptual innovation in tourism and heritage studies. It replaces isolated analyses of cultural assets with a systemic approach that recognizes the interconnections among spiritual practices, culinary traditions, artistic expressions, and other cultural dimensions. This allows for a more holistic understanding of how tourism—especially cultural tourism—affects both the environment and society (Bachi et al., 2020).

The CES approach fills a critical gap in the academic literature by moving beyond disciplinary silos and illuminating how cultural expressions collectively contribute to tourists' well-being and the long-term sustainability of tourism destinations. Within tourism contexts, CES provide the interface through which visitors experience and value both natural and cultural environments. A scenic landscape, for example, offers aesthetic pleasure that attracts tourists, while historic sites offer a deeper sense of place and identity—ultimately enhancing personal enrichment and well-being (Bachi et al., 2020).

In this light, the CES perspective is particularly relevant for sustainable tourism management, as it emphasizes the importance of preserving and enhancing the availability and quality of cultural ecosystem services—not only for future tourism development, but also for the well-being of both visitors and local communities.

3. Methods

This study adopts a conceptual research design based on a qualitative and interpretive approach, aimed at developing a theoretical framework that integrates culture and well-being into a new typology of tourism destinations. The goal is to explore the interconnections between cultural resources, experiential well-being, and sustainability.

The methodological process followed three main phases. First, a review of scientific literature was conducted through targeted searches on international academic databases (including Scopus), using keyword combinations such as *"wellness tourism", "cultural tourism", "cultural ecosystem services",*

"destination well-being", and *"smart tourism destinations"*. The focus was placed on conceptual papers, theoretical reviews, and recent studies that address the integration of culture, well-being, and tourism.

Second, a critical reading of over 40 selected abstracts and articles was undertaken. The selection included studies that, although from different perspectives, addressed the transformative role of culture in tourism, with particular attention to the creation of experiential value and territorial regeneration.

Third, the literature was analyzed using a methodological approach inspired by the principles of *Grounded Theory* (Glaser & Strauss, 2017) and *theory building from literature* (Shepherd & Suddaby, 2017; Jaakkola, 2020). According to these approaches, theoretical categories are not predetermined but emerge progressively through an iterative process of comparison between concepts, sources, and analytical reflections. In this sense, the conceptual model proposed is the result of an exploratory and reflective process of theoretical synthesis and conceptual classification.

This approach fits within the tradition of conceptual research aimed at constructing new theoretical frameworks by means of interpretive literature synthesis, in the absence of primary empirical data but with the objective of addressing gaps in interpretation and systematization. Following this process, the paper proposes a model of culturally-driven smart wellness destinations that respond to the growing demand for enriching, sustainable, and culturally grounded tourism experiences.

4. A new conceptual perspective for designing culturally-driven tourism destinations

In outlining a conceptual model for cultural wellness tourism, it becomes essential to adopt a broad and integrated approach that considers the well-being of all stakeholders involved—tourists, local communities, tourism enterprises, and workers. This foundation enables the design of tourism experiences that are not only culturally enriching and wellness-oriented, but also socially responsible and both ecologically and economically sustainable (Dini & Pencarelli, 2020).

In this context—and following the framework of Cultural Ecosystem Services (CES) (Bachi et al., 2020)—cultural destinations can be envisioned as regenerative platforms that enhance the well-being of both visitors and host communities, in contrast to the often-degenerative dynamics of mass tourism. The design of such destinations must also integrate the principles of smart tourism (Pencarelli, 2020; Della Corte, 2017; Buhalis & Amaranggana, 2013) with the holistic perspective of well-being (Dini & Pencarelli, 2022; Dilette et al., 2020). This integration ensures that tourism offerings not only protect but also enhance cultural and natural heritage—leveraging new technologies to promote the socio-economic development of local communities (Solima, 2020, p. 177).

At the core of this approach lies the need to balance heritage enhancement and accessibility with the imperative of environmental protection and social regeneration, avoiding the risks of overcrowding, cultural homogenization, and negative ecological impacts typically associated with mass tourism in major urban destinations.

This contribution proposes a descriptive and interpretative model of tourism destinations (see Figure 1), built around two key variables that help distinguish four types of cultural tourism experiences:

- Whether the destination offers slow and personalized experiences for small groups, or fast and standardized ones for large numbers (mass tourism);
- Whether the experiences generate low or high levels of well-being, considering both hedonic and eudaimonic dimensions.

Hedonic well-being refers to the pursuit of happiness through immediate sensory pleasure and comfort. In cultural tourism, this can include aesthetic appreciation of art, tasting of local foods, relaxing atmospheres, or the enjoyment derived from exploring cultural, environmental, or scenic sites.

Eudaimonic well-being, by contrast, is linked to personal growth, self-realization, and the pursuit of meaning and purpose in life. It is achieved through experiences that stimulate reflection, learning, and inner development—such as participating in cultural workshops, attending spiritual events, guided hikes to heritage sites, meeting local artisans, or engaging in community-based volunteer projects.

In short, hedonic experiences focus on immediate pleasure and relaxation in culturally rich settings—such as food and wine tastings, stays in historic houses or agritourism, or wellness therapies. Eudaimonic experiences, on the other hand, emphasize long-term fulfillment, identity building, and connection with local culture and communities—through craft workshops, educational farms, spiritual retreats, or meditation programs.

The typology illustrated in Figure 1 captures this conceptual model of culturally-driven wellness destinations, offering a framework for rethinking tourism experiences in light of their regenerative potential for people and places.

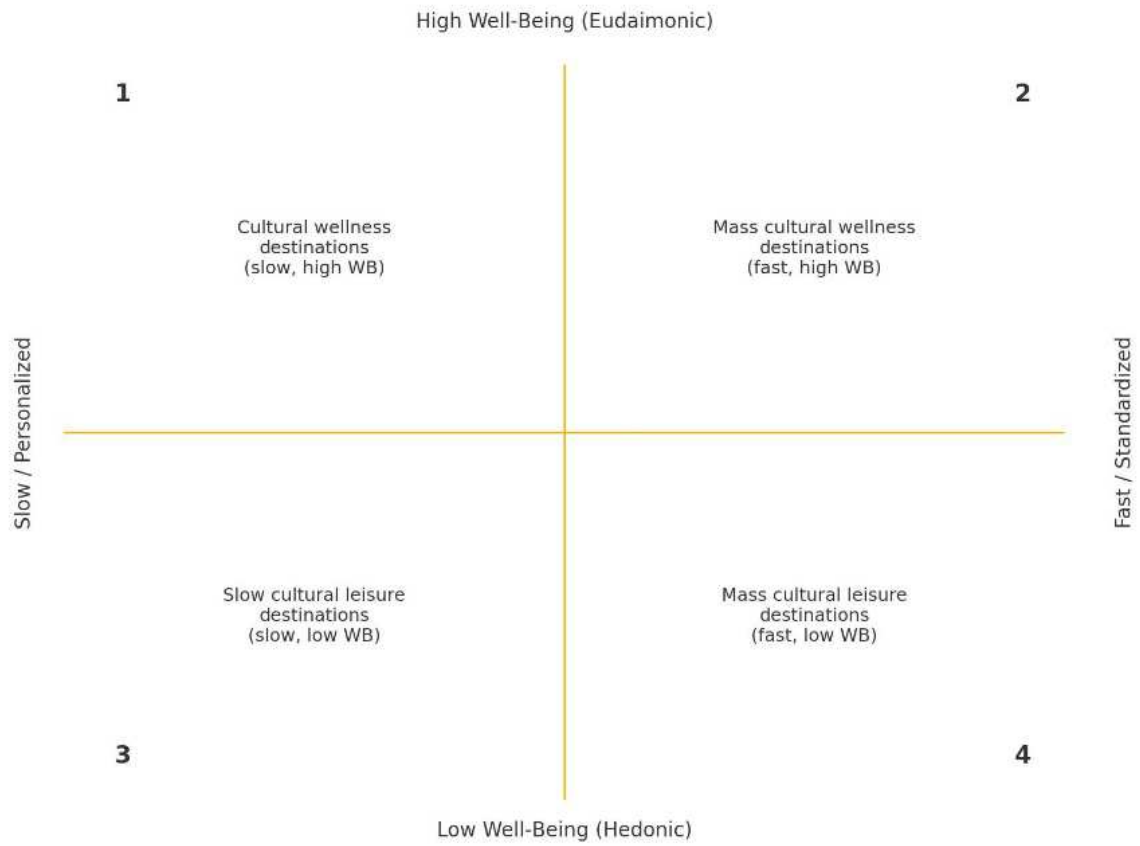

Figure 1. Typology of Culturally-Driven Wellness Destinations
Source: author's elaboration (2025)

4.1 Slow Cultural Tourism Destinations with high well-being (Quadrant I)

In the upper-left quadrant (I), we find destinations where slow cultural tourism blends harmoniously with a strong sense of visitor well-being, creating an atmosphere of serenity and personal enrichment. Experiences are carefully curated to enable deep immersion in the local culture, following a relaxed pace that allows tourists to truly connect with the environment and traditions. Far from the pressures of everyday life, these destinations offer space for reflection and rest, fostering authentic interaction with local culture and the host community.

These types of destinations are typically found in medium-sized historic and artistic cities, located in urban contexts that provide essential services, acceptable accessibility, and a well-organized tourism infrastructure.

Destination Characteristics:

- Destinations that emphasize quality over quantity, offering authentic and meaningful tourism experiences.
- Personalized itineraries that encourage a reflective and in-depth approach to local culture.
- Active engagement with the local community, fostering meaningful cultural exchange.
- A relaxed environment and ample time to enjoy each experience, reducing stress and promoting high levels of well-being.
- Absence of overcrowding, ensuring that services and experiences remain easily accessible.
- Sustainability principles are integrated into spatial planning, providing ideal conditions for implementing sustainable development initiatives.
- Existence of programs aligned with the socio-environmental sustainability paradigm, aimed at preserving cultural and natural heritage while creating value for both communities and visitors.
- Technology is used discreetly to enhance the cultural experience, without overwhelming it.

Implications for Policy Makers and Destination Management Organizations (DMOs):

For tourism professionals, promoting well-being in culturally-driven destinations requires a deep understanding of the territory's cultural and natural assets, along with careful experience design to ensure that offerings are not only authentic and enriching, but also aligned with principles of sustainability and social responsibility.

Close collaboration with local communities is essential to co-create experiences that generate mutual benefits for both visitors and residents, fostering tourism as a lever for development and positive transformation. The well-being achievable in culturally-driven destinations stems from a tourism approach that embraces travel as an opportunity for personal growth and deep connection—both with oneself and with the surrounding world—thus paving the way for a more conscious, sustainable, and human-centered tourism paradigm.

4.2 Slow Cultural Tourism Destinations with low well-being (Quadrant II)

This typology, positioned in Quadrant II, reflects a particular tension found in destinations where slow cultural tourism is present but fails to generate significant well-being for visitors. These are places where the authenticity of the cultural experience is partially overshadowed by contextual limitations that negatively affect the quality of the visitor experience.

Although such destinations aspire to offer rich and meaningful cultural immersion, often located in off-the-beaten-path settings like small villages, inner rural areas, craft workshops, or locally significant historical sites, they may lack adequate infrastructure and services—such as tourist information, hospitality, transport, or food services. These gaps can lead to disappointment and limit the potential for well-being, especially among tourists who rely more heavily on accessibility and support services (e.g., elderly visitors or those with disabilities).

Despite their potential for promoting cultural and environmental sustainability and rediscovering hidden heritage resources, these destinations risk falling short of becoming true tourism platforms unless they invest in service quality and systemic organization. A critical reflection is needed on how to better integrate cultural richness with visitor well-being, making slow tourism not only authentic, but also welcoming and satisfying.

Destination Characteristics:

- Destinations offering authentic cultural experiences, yet generating a limited perception of well-being due to insufficient services or accessibility challenges.
- Opportunities for direct engagement with residents through traditional events, festivals, or hands-on learning from artisans.
- A strong focus on depth of cultural experience, hindered by constraints that prevent full relaxation or immersion.
- Limited or problematic access to key services, often caused by geographic isolation or infrastructural gaps.
- Absence or fragmentation of a structured tourism system.
- Low tourist impact, which in turn results in minimal economic benefits and limited development opportunities for the destination.
- Minimal and unsystematic use of digital technologies to enhance the tourism offering.

Implications for Policy Makers and Destination Management Organizations (DMOs):

Policy makers and DMOs must develop targeted marketing strategies capable of attracting mindful and respectful cultural tourists, avoiding the risks associated with undertourism. It is essential to design policies that encourage responsible travel behaviors, promoting respectful and conscious use of local resources, as well as participation in activities that contribute to the conservation of cultural and natural heritage.

Moreover, because accessibility, infrastructure, and tourism services play a critical role in enhancing visitor experience, improving access to these destinations is key to making them available to a broader audience. However, this should be done carefully, without compromising the integrity of their cultural and natural landscapes. Investments should focus on sustainable infrastructure and services that are sensitive to the local context and capable of enhancing the visitor experience while protecting the destination's identity and environment.

4.3 Mass Cultural Tourism Destinations generating high well-being (Quadrant III)

Contrary to common narratives, Quadrant III highlights that mass cultural tourism can also be associated with high levels of tourist well-being. Characterized by a rich and diverse cultural offering, this type of destination successfully combines access to iconic sites and attractions with high-quality services and infrastructure that enhance comfort and satisfaction. Effective and strategic management of tourist flows allow visitors to enjoy cultural treasures without suffering the discomforts typically linked to overcrowded destinations. These environments, though vibrant and dynamic, remain enjoyable and rewarding thanks to efficient destination governance.

Such destinations manage to balance high tourist density with the preservation of experience quality, proving that mass tourism does not necessarily diminish visitor well-being. They are distinguished by a broad, accessible cultural offer capable of attracting diverse audiences and generating full satisfaction through an array of experiences: historical and artistic sites, museums, festivals, art exhibitions, local markets, and events that celebrate both tradition and innovation. Even when standardized, these experiences are delivered with a high degree of comfort and quality, especially appealing to tourists with strong cognitive and financial capital, who may view such experiences as opportunities to reinforce their cultural knowledge, social identity, and elite status. As such, these destinations may also provide symbolic and status-related benefits through a form of ostentatious cultural consumption.

The destinations classified in Quadrant III are often major art cities, renowned not only for their historic heritage but also for their extraordinary capacity to innovate and regenerate. In these contexts, mass cultural tourism should not be viewed solely in negative terms, but rather as a powerful opportunity to share and disseminate culture on a large scale.

Destination Characteristics:

- Destinations that provide mass cultural experiences capable of generating well-being thanks to optimized services, advanced digital technologies, well-developed infrastructure, and effective flow management.
- A rich and varied cultural offering, including world-class museums, art galleries, theaters, UNESCO sites, and historic centers that blend tradition with contemporary expressions.
- High global reputation, with strong promotion of immersive community experiences such as local festivals, traditional markets, street performances, and public celebrations that allow authentic contact with local culture.
- Technological innovation is leveraged to enhance the visitor experience: mobile apps with interactive guides, augmented reality for site visits, digital ticketing systems, sensors to monitor visitor density, and apps to distribute tourist traffic help reduce congestion and improve service delivery.
- Sustainability efforts include eco-friendly practices at cultural attractions, the use of renewable energy, promotion of green transportation, and support for responsible tourism initiatives that minimize environmental impact and support local economies.
- Protection and enhancement of cultural heritage are prioritized, with ongoing investments in conservation and education programs that raise awareness among both visitors and residents.
- Sustainability policies also address social inclusion, ensuring that tourism benefits are distributed equitably by supporting local enterprises, valuing indigenous cultures, and involving minority groups in tourism offerings.

Implications for Policy Makers and Destination Management Organizations (DMOs):

For policy makers and DMOs, the key challenge is to manage the balance between accessibility, experience quality, and sustainability through a highly strategic approach—positioned at the intersection of technological innovation, sustainability, and cultural authenticity.

From a technological perspective, the adoption of smart solutions is essential to improve visitor experience and efficiently manage tourist flows. Smart data systems can help monitor and redistribute visitor numbers, reducing pressure on high-demand sites and contributing to a more balanced spatial distribution of tourism. These technologies also provide valuable insights into visitor behavior, informing future destination development and marketing strategies.

From a sustainability standpoint, destination managers must promote responsible tourism practices—supporting eco-mobility, green accommodations, and low-impact experiences—while ensuring that tourism growth does not jeopardize cultural or environmental integrity. The social dimension of

sustainability calls for mechanisms that share economic benefits with local communities, supporting their long-term prosperity and cultural continuity.

Ultimately, the equilibrium between accessibility and conservation remains central. While it is important to open cultural heritage to a wide audience, it is equally crucial to safeguard its authenticity. Policies such as limiting visitor numbers, promoting alternative circuits, and investing in low-impact infrastructure are essential tools for ensuring sustainable and meaningful mass cultural tourism.

4.4 Mass Cultural Tourism Destinations incompatible with visitor well-being (Quadrant IV)

Quadrant IV captures the limitations of mass cultural tourism in its most critical form, where the emphasis on quantity over quality gives rise to long-term sustainability issues such as overtourism. These destinations are characterized by excessive tourist flows, which exceed their carrying capacity and lead to a series of negative consequences. The high density of visitors, coupled with inefficient services, creates a chaotic atmosphere in which poor management of cultural and infrastructural resources undermines the overall well-being of tourists.

Consequences include the degradation of cultural heritage, erosion of local identity, increased housing and consumer prices that may exclude local residents, and environmental pressures related to overcrowding and resource overuse. From an environmental standpoint, these challenges often manifest in pollution, poor waste and water management, biodiversity loss, and degradation of cultural and natural sites—issues that require urgent intervention.

The experience in these destinations is often superficial and hurried. Local traditions and cultural diversity are flattened to meet the expectations of a global mass audience, resulting in a homogenization of tourism products. From an economic perspective, while mass tourism may generate substantial revenue, questions arise regarding the equitable distribution of its benefits. Overreliance on tourism may also render local economies vulnerable to market fluctuations, while the rising cost of living can erode residents' purchasing power.

Destination Characteristics:

- Destinations where overcrowding, rushed experiences, and superficial cultural engagement dominate.
- Significant issues related to managing large tourist flows, leading to discomfort, stress, and low levels of perceived well-being.
- Cultural and natural heritage degradation due to excessive visitor numbers and overuse of resources.
- Erosion of the destination's image and competitive positioning.
- Loss of authenticity through the homogenization of tourism experiences that threaten cultural uniqueness and identity.
- Rising tensions between residents and tourists, with locals perceiving tourism as an invasive force that disrupts social and cultural cohesion.
- Unequal distribution of tourism's economic benefits, with many residents experiencing little or no tangible improvement in quality of life.
- Increased pollution, biodiversity loss, and environmental deterioration caused by unsustainable tourism pressure.

Implications for Policy Makers and Destination Management Organizations (DMOs):

Designing and managing destinations that suffer from poor cultural tourism experiences requires innovative and proactive strategies. These should include regulating tourist flows, investing in sustainable infrastructure, promoting alternative forms of tourism, and enhancing authentic experiences that encourage more even visitor distribution. Active participation of local communities in tourism planning and governance is essential to ensure that adopted strategies are inclusive and aligned with residents' values and aspirations.

In these destinations, the tourism sector faces major challenges and must strive to rebalance economic development with the preservation of cultural, social, and environmental values. Seeking responsible and sustainable solutions is imperative to ensure that tourism remains a positive force for both places and communities.

5. Discussion and conclusion

To effectively integrate cultural tourism within wellness tourism, it is essential to consider the growing influence of digital technologies on both demand and supply in tourism and culture (Pencarelli et

al., 2020). In this concluding section, we propose a conceptual model of culturally-driven smart wellness destinations, inspired by smart destination and smart city frameworks. In today's digital society, where institutions, businesses, places, and people are increasingly connected, future tourism destinations must also evolve as smart systems (Pencarelli, 2020).

The smart wellness destination model seeks to balance resident and tourist needs through sustainability and inclusivity, optimizing resource use via digital technologies. Being "smart" goes beyond infrastructure; it means aligning technology with social and environmental sustainability and enhancing residents' quality of life. These destinations must create value for all stakeholders by safeguarding and promoting cultural heritage while generating shared economic, environmental, and social value.

The typical components of a smart destination (Buhalis & Amaranggana, 2013) adapted for wellness and culture include:

- Smart People: Attract and leverage qualified human capital for tourism and cultural innovation, capable of operating with available knowledge and digital resources in tourism and cultural sectors.
- Smart Environment: Use ICT for sustainable management and conservation of natural, historical, and cultural heritage, promoting ecosystem protection (Pencarelli et al., 2020).
- Smart Mobility: Promote inclusive and sustainable transportation solutions (e.g., car sharing, bike sharing), with special attention to elderly and differently-abled tourists to improve accessibility and well-being.
- Smart Economy: Foster a vibrant, innovation-driven local economy supported by digital infrastructure, enabling the enhancement and sustainable use of cultural assets.
- Smart Governance: Encourage participatory, transparent, and inclusive governance involving residents and tourists, fostering intercultural dialogue and social integration.
- Smart Living: Ensure high quality of life, social cohesion, and a rich cultural environment that supports creative and fulfilling leisure for both locals and visitors.

To be tourism-ready, these destinations must be attractive, accessible (physically, economically, and informationally), well-equipped with hospitality and cultural services, and integrated into tour operator packages. Their value propositions should be rooted in a holistic view of wellness, offering both tangible and intangible cultural experiences—visits to museums and heritage sites, gastronomy, spirituality, nature-based activities, and wellness services—that contribute to the overall life satisfaction of tourists.

Tourists should be empowered to co-create value through digital technologies, transitioning from passive consumers to active co-producers of cultural and wellness experiences. This aligns with the co-creation model adapted from Cimbaljevic (2019) by Dini and Pencarelli (2020), where the visitor is not just a recipient but a central actor in value generation.

The challenge for culturally-driven wellness destinations lies in leveraging the potential of cultural resources within digital ecosystems to fuel sustainable territorial development and long-term vitality. Achieving this goal requires coordinated actions between public and private stakeholders, as well as multi-level institutional collaboration—particularly between ministries of culture and tourism, whose cooperation is essential for advancing cultural tourism.

Finally, in line with the principles of sustainability, especially social sustainability, the use of digital technologies must respect fundamental human rights. This includes safeguarding individual privacy, avoiding misuse of images and personal data, and preventing discrimination based on gender, ethnicity, or sexual orientation. These issues, now central to the public debate and ethical discourse surrounding artificial intelligence and digital transformation, must be actively addressed in the design of culturally-driven smart wellness destinations.

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Environmental Management and Eco-labeling: Perceptions of Managers and Owners in the Lodging Industry

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Abstract

Research background: In the context of the current global drive for greater environmental responsibility, the hospitality industry is taking significant steps towards sustainability. One of the key initiatives in this area is the introduction of eco-certification of accommodation facilities.
Purpose of the article: The aim of the paper is to evaluate hotel managers' and accommodation owners' perceptions of environmental management and eco-labeling in Czechia.
Methods: The research was conducted between January 2020 and June 2022, using a mixed research design (n = 936) to collect data. Correspondence analysis was used to analyze the selected data from the questionnaire survey. For graphical representation, ArcGIS and STATISTICA 12 were used.
Findings & Value added: The results from the questionnaire survey show that the surveyed accommodation facilities perceive the main benefit of environmental management to be the protection and improvement of the environment, which has been confirmed across establishment categories overall. In relation to the financial intensity of implementing environmental measures, it was found that higher categories of accommodation establishments perceived this intensity as lower. Awareness of environmental certifications and labels among hotel managers remained below average, which was also reflected in the low level of awareness among guests, both existing and potential. The semi-structured interviews revealed that although the topic of sustainable business is perceived as relevant, some managers are concerned about possible guest attrition due to the emphasis on environmental measures, as guests often prefer to relax without actively engaging in environmentally friendly behavior during their stay.

Keywords: Accommodation facilities, Sustainable practices, Green certification, Environmental responsibility

JEL classification: L83, Q56

1. Introduction

Environmental management in accommodation facilities is usually focused on waste management, energy saving, water saving, improving indoor air quality, and educating employees and hotel guests to protect the environment. Accommodation facilities with an environmental orientation achieve higher profitability and market shares, better levels of employee engagement, higher guest satisfaction and can build guest loyalty in the form of repeat bookings and positive intentions through word of mouth or social networks (Scholz, 2021; Scholz et al., 2023; Vrabcová et al., 2024). One of the tools supporting effective environmental management in accommodation facilities is environmental certification, also known as ecolabeling. In 2004, upon joining the European Union, the Czech Republic became part of the program for awarding the European Union Ecolabel (The Flower). It is the only symbol for environmental friendliness throughout the entire life cycle of a product (from production to disposal). It can be awarded to products on the market throughout the European Union. The logo is a stylized flower with a green stem, a round inflorescence formed by blue stars, and the symbol € in the middle. The stylized inscription "EU Ecolabel" is an integral part of the mark. In Czechia, the role of intermediary for the award of the EU Ecolabel is played by CENIA, the Czech Environmental Information Agency. CENIA accepts applications from interested parties to award this ecolabel both from within the country and abroad. Due to its role, it

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also participates in the revisions of the criteria for the award of the EU Ecolabel and can thus influence their form (Cenia, 2022).

The EU Ecolabel can be awarded to 25 product groups, including tourist accommodation. This group includes hotels, campsites, and others, and appeals to conscious travellers looking for accommodation that aims to reduce the environmental impact of their activities. It guarantees that the accommodation optimizes environmental and waste management, reduces food waste, energy and water consumption, and reduces transport emissions and lowers chemical consumption. Over 700 tourist accommodation establishments have been certified, most of which are in France, Austria, and Italy. However, efforts are ongoing to increase these numbers rapidly. The findings indicate that while green certification labels or badges influence travelers' decisions when booking hotels online, their impact is comparatively less significant than cancellation policies, hotel ratings, price, and location (Assaker & O'Connor, 2023). The concept of an environmentally friendly hotel in the context of sustainable tourism has gained recognition as a business strategy, as well as a competitive advantage in the global tourism market (Scholz et al., 2023; Vrabcová et al., 2024). In the post-pandemic era, tourists are increasingly interested in sustainable consumption, mainly focusing on environmentally friendly hotels (Feng et al., 2024; Sharma et al., 2024). So, how can an environmentally friendly hotel be characterized? There are multiple definitions in Czechia and foreign professional literature, but there is no single definition. A guest can choose between two types of facilities that focus on implementing environmental steps. An environmentally friendly hotel is often called a synonym for green hotel, eco-hotel, or eco-friendly hotel. It is an environmentally friendly accommodation facility that uses various environmental elements and measures, technological processes, and environmental programs to protect the environment, reduces operating costs, and has its environmental certificate. Within the European Union, the most common certificate is "*The Flower*", while in Czechia, the most widespread ecolabel is "*Eco-Friendly Service*" (Figure 1).

Figure 1. Eco-labels used in the hospitality industry in Czechia
Source: Ekoznačka, n.d.

The second group of hotels consists of environmentally friendly accommodation facilities that comply with environmental standards and implement various environmental elements and measures, but do not have an environmental certificate. It means that an accommodation facility does not necessarily have to obtain a certificate to become eco-friendly and help improve the quality of its surroundings (Scholz, 2021). According to Yuniati (2021), environmentally friendly hotels not only have the concept of preserving water conservation, reducing energy consumption, and reducing the amount of solid waste, but also contribute to the environment on a broader scale, maintaining and developing the surrounding culture and actively participating in the development of the regional economic community (Lagioia et al., 2024; Shereni & Rogerson, 2023; Szczepańska-Woszczyna et al., 2024). An environmentally friendly hotel is characterized as one that is committed to protecting the environment, using energy, water, and materials related to the quality of the services offered and provided most efficiently (Fauzi et al., 2025). Hotels with environmental certificates try to offer and provide services in a way that minimizes the environmental impact. However, managers of these hotels should pay more attention to planning, which is one of the basic principles of sustainable tourism, and thanks to it, they can save considerable financial resources (Çelik & Çevirgen, 2021). Furthermore, managers of environmental hotels should regularly communicate to potential guests (Acampora et al., 2022; Bernard et al., 2024; Dai et al., 2024; MacInnes et al., 2024; Quan et al., 2023) that they can protect the environment by supporting this type of hotel, offering attractive packages and competitive prices to encourage hotel guests to stay in environmental hotels (Astuti & Ermawati, 2020; Mirando & Dassanayake, 2020; Wang et al., 2022).

2. Methods

The aim of the paper is to evaluate hotel managers' and accommodation owners' perceptions of environmental management and eco-labeling in Czechia. The basic set represented all mass accommodation facilities in Czechia (N = 10,104; data as of 31 March 2025; Czech Statistical Office, 2025). The sample consisted of 1,016 respondents, i.e., one tenth of the selected mass accommodation facilities from all regions of Czechia (figure 2).

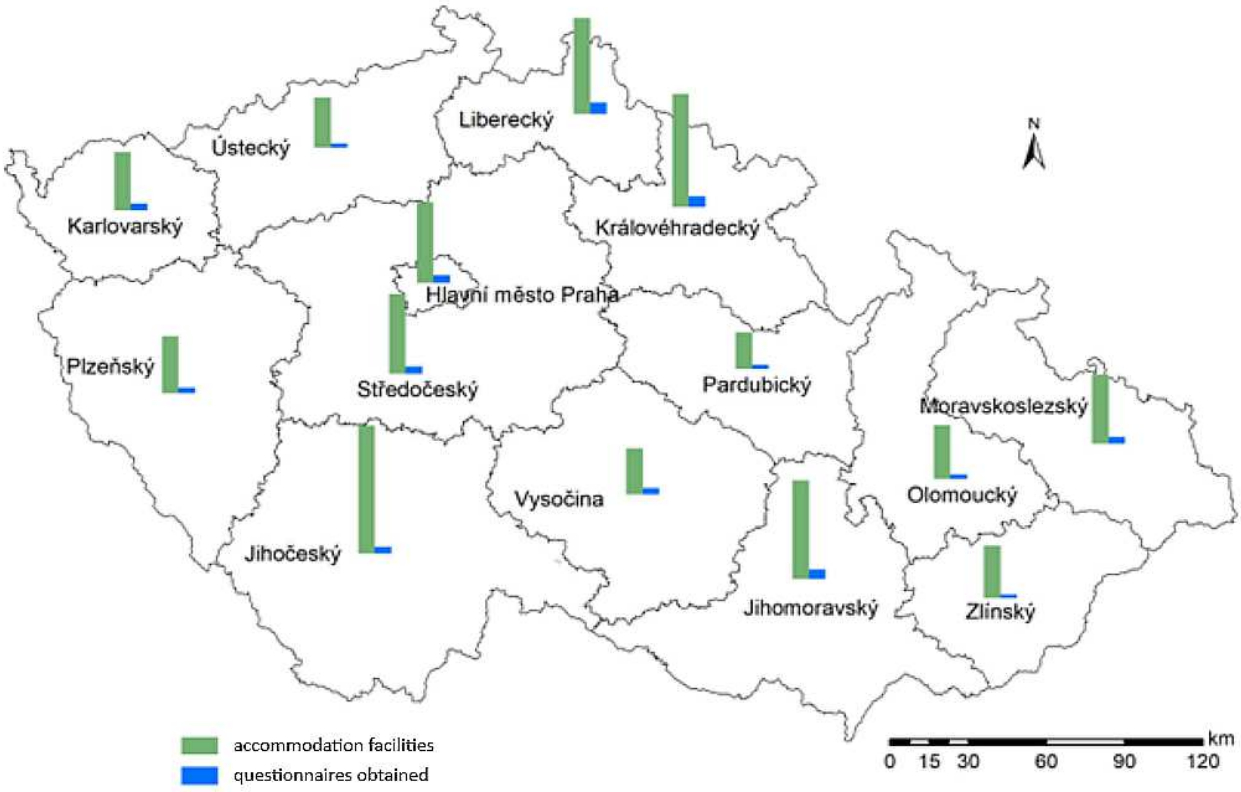

Figure 2. Location of accommodation facilities in individual regions
Source: own processing (2025)

The categories of mass accommodation facilities include hotel, hotel garni, motel, guesthouse, campsite, cottage settlement, tourist hostel, and others. Questionnaires were also obtained from the categories of apartment hotel/complex, cottage, and others. Since there were only pieces, or dozens of questionnaires, these categories were recoded into a common category called “other”.

In this paper, only the categories of hotel (n = 593) and guesthouse (n = 343) were used. The standard category of “other” (n = 80) was not very homogeneous; it involved different types of accommodation facilities, and moreover, there were significantly fewer of these accommodation facilities compared to the categories of hotel and guesthouse (table 1).

Table 1. Classes and categories of researched accommodation facilities

class / category	hotel	guesthouse	other	total
Tourist	4	5	1	10
Economy	25	31	5	61
Standard	342	222	13	577
First Class	190	35	6	231
Luxury	29	0	0	29
no stars	3	50	55	108
total	593	343	80	1,016

Source: own processing (2025)

The research was conducted from January 2020 to June 2022, and the so-called mixed research was used to obtain data. Semi-structured interviews (n = 18) were conducted mainly in cities with many mass accommodation facilities. The questionnaire consisted of fifteen questions. The first four questions were general and served to identify the respondent, i.e., the accommodation facility and its division into the relevant category and class, number of rooms, etc. The next part of the questionnaire dealt with individual measures and elements of environmental management. The questions were formulated so that respondents could choose from several options. In addition to the options offered, respondents could also choose the option "other" and express their own opinion or attitude on the issue. An important question was whether the hotel in question had an environmental management concept at all. The questionnaire also asked whether accommodation facilities considered implementing environmental management an advantage and whether they would strive to obtain an environmental management certificate.

Last but not least, the questionnaire asked about how guests are informed about the hotel's environmental activities. All participants were informed about the research and the privacy of the questionnaire; they were willing to participate in the research and had the opportunity to contact the interviewer via the email provided in the questionnaire list and to be informed about the research results. Correspondence analysis was used to analyze the selected data from the questionnaire survey. ArcGIS and STATISTICA 12 were used for graphical representation.

3. Results and Discussion

Hotels found the maximum benefit of environmental management in protecting and improving the environment, confirmed in individual classes and overall (4.29). The second best-rated measure was cost savings (2.48) and hotel guest preferences (2.14). On the contrary, minimal benefits were found in higher satisfaction of current hotel staff (1.64) and increased sales (1.74). Also, many hotel managers and hotel operators did not consider that they would consider a competitive advantage over other accommodation facilities as a benefit of environmental management (1.87; table 2).

Table 2. Benefits of environmental management in the hotels

benefit / class	Tourist *	Economy **	Standard ***	First Class ****	Luxury *****	no stars	weighted average
cost savings	2.75	2.00	2.52	3.26	2.45	2.67	2.48
revenue increase	1.00	1.32	1.68	2.23	1.72	2.00	1.74
higher satisfaction of current staff	1.25	1.16	1.48	2.21	1.97	1.67	1.64
guest preferences	2.00	1.68	2.10	2.49	2.48	1.67	2.14
higher hotel quality	1.75	1.56	1.87	2.19	2.69	3.33	2.00
advertising and hotel promotion	1.50	1.44	1.82	2.08	2.28	3.33	2.19
competitive advantage over others	2.00	1.64	2.08	2.70	2.69	2.00	1.87
envir. protection and improvement	4.50	3.68	4.26	4.56	4.45	5.00	4.29
average	2.09	1.81	2.23	2.72	2.59	2.71	--

Note: 1 – minimum benefit, 5 – maximum benefit
Source: own processing (2025)

Guesthouses, like hotels, found the most significant benefit of environmental management in protecting and improving the environment, confirmed in individual classes and overall. The value achieved using the weighted average was only 0.01 lower than in the case of hotels (4.28). Moreover, the Tourist class recorded the highest value of all pension classes for the aforementioned benefit (4.80). The second best-rated measure, just like in hotels, was cost savings (2.41), followed by hotel guest preferences (2.13) and advertising and promotion of the pension (2.13). On the contrary, the results indicated the minimum benefits according to pensions in higher satisfaction of current employees (1.62) and increased sales (1.73), again almost identical values as in hotels. The semi-structured interview showed that although this is the highest class in the guesthouse category, Czech guests are still not interested in whether the guesthouse is environmentally friendly, but in paying as little as possible for their stay. Guesthouse owners do not know how to respond to this. As for guesthouses that did not have any stars, the smallest benefit was found in higher satisfaction of current employees (1.04; table 3). Accommodation facilities should take a more individual approach to the development of managers and should enable employees to work in an environment characterized by green inclusion.

Table 3. Benefits of environmental management in the guesthouses

benefit / class	Tourist *	Economy **	Standard ***	First Class ****	no stars	weighted average
cost savings	3.40	1.45	1.96	2.43	2.74	2.41
revenue increase	1.00	1.29	1.66	1.94	1.58	1.73
higher satisfaction of current staff	1.00	1.84	1.69	1.89	1.04	1.62
guest preferences	1.80	1.52	1.96	2.51	2.22	2.13
higher hotel quality	2.60	1.71	1.85	2.49	2.30	1.97
advertising and hotel promotion	1.00	1.65	1.80	2.17	1.48	2.13
competitive advantage over others	1.80	1.68	1.99	2.57	2.16	1.84
envir. protection and improvement	4.80	3.84	4.01	4.57	4.24	4.28
average	2.18	1.87	2.12	2.57	2.22	--

Note: 1 – minimum benefit, 5 – maximum benefit
Source: own processing (2025)

As for the financial cost of implementing environmental management, the higher the class of the hotel/guesthouse, the lower the financial cost. The values obtained from the Tourist class for hotels (n = 4; 2.75) and guesthouses (n = 5; 3.40) have minimal informative value due to the small sample size (table 1, 4). The best results were achieved for hotels in the Luxury class (n = 29; 2.38); for guesthouses, this was also the highest, i.e., First class (n = 35; 3.37).

Table 4. Financial requirements in implementing environmental management

category / class	Tourist *	Economy **	Standard ***	First Class ****	Luxury *****	no stars
hotel	2.75	4.40	4.52	4.02	2.38	5.00
guesthouse	3.40	4.32	4.17	3.37	--	3.16

Note: 1 – minimum benefit, 5 – maximum benefit
Source: own processing (2025)

From semi-structured interviews it was found that for some hotels it is tough to apply environmental management… "unrealistic in our hotel, because it is not affordable"… *"I think that environmental management is financially demanding for probably all accommodation facilities, because it is not yet addressed much and it always requires something extra"… "I would like to participate more in being environmentally friendly, I try in my family, but on a guesthouse basis it is demanding mainly financially and timewise"… "it would require more support from the city"… "it is relatively expensive, or the alternatives are cheaper in terms of acquisition costs, maybe it would help to have more information from this field."*

As for the environmental certificate, almost no hotel or guesthouse was interested in this type of certificate. Only eight hotels (1.35%) and two guesthouses (0.58%) showed an effort to obtain an environmental certificate. As the Green Hotel Association (2020) states, having an environmental certificate from a financial and time perspective is not entirely desirable. It is more important that accommodation facilities apply various environmental management elements and measures, thus being environmentally friendly even without an environmental certificate. As we learned from one semi-structured interview, *"it does not matter much how much an accommodation facility relies on an environmental certificate or uses eco-products if it accommodates people who do not know how to behave even at home, let alone in the mountains, by which I mean throwing garbage in the forests, making fires and other such delights."*

Knowledge of environmental certificates did not even achieve average hotel results. Overall, the best results were achieved by the First Class (11.68%) and Luxury (12.41%) classes. On the other hand, hotels in the lowest class, i.e., Tourist, were not aware of any mentioned certificates (0.00%) that were environmentally friendly (table 5).

Table 5. Knowledge of environmental certificates in the hotels (%)

environmental certificates / class	Tourist *	Economy **	Standard ***	First Class ****	Luxury *****	no stars
The Flower	0.00	8.00	9.36	25.26	17.24	0.00
The Green Key	0.00	4.00	3.22	4.74	17.24	33.33
LEED	0.00	0.00	2.05	5.79	10.34	0.00
BREEAM	0.00	4.00	0.29	3.16	3.45	0.00
Eco-Friendly Service	0.00	4.00	8.19	19.47	13.79	0.00
average	0.00	4.00	4.62	11.68	12.41	6.67

Source: own processing (2025)

Guesthouses achieved better results in all classes than hotels in terms of knowledge of environmental certificates. Guesthouses in the Tourist class and hotels in this class did not demonstrate any knowledge or awareness of the selected certificates. As in hotels, very low awareness was recorded for the LEED and BREEAM eco-labels. For all other classes, it was found that the highest knowledge in the area of environmental certificates was found in The Flower and Ecologically Friendly Services (Table 6).

Table 6. Knowledge of environmental certificates in the guesthouses (%)

environmental certificates / class	Tourist *	Economy **	Standard ***	First Class ****	no stars
The Flower	0.00	12.90	10.81	25.71	8.00
The Green Key	0.00	9.68	4.50	14.29	8.00
LEED	0.00	0.00	2.25	5.71	8.00
BREEAM	0.00	3.23	1.35	0.00	0.00
Eco-Friendly Service	0.00	12.90	7.66	28.57	12.00
average	0.00	7.74	5.32	14.86	7.20

Source: own processing (2025)

Hotels achieved below-average results in informing their current and potential guests (table 7). The Economy class (4.00%) provided the least information and the most by the Luxury class (37.93%). Guesthouses were in a similar situation, with the worst results recorded by the Tourist class (0.00%) and Economy (9.68%), while the best results were achieved by the First Class guesthouses (22.86%).

Table 7. Information regarding environmental friendliness (%)

category / class	Tourist *	Economy **	Standard ***	First Class ****	Luxury *****	no stars
hotel	25.00	4.00	10.53	28.95	37.93	33.33
guesthouse	0.00	9.68	11.26	22.86	--	18.00

Source: own processing (2025)

If a hotel informed its loyal and potential guests that it was environmentally friendly, it was most often through information signs or stickers in the bathroom. Since it was possible to provide multiple possible answers (some hotels also provided information in other ways), the sum in the table may not equal 100.00%. Information regarding eco-labeling in the bathroom reached high values in individual classes (except for the Tourist class). Economy class hotels and hotels without any stars received 100.00% regarding eco-labeling in the bathroom, the First Class class was better than the Luxury class (81.82% vs. 72.73%). It is also evidenced by figure 3, in which the Tourist and Economy classes are the furthest away from individual areas (red squares). This is because hotels in these classes used information regarding eco-labeling in only one area (table 8).

Table 8. Location of environmental messages in the hotels (%)

eco-meesages location / class	Tourist *	Economy **	Standard ***	F. Class ****	Luxury *****	no stars
hotel information forms at reception area	0.00	0.00	36.11	29.09	27.27	100.00
hotel website	100.00	0.00	27.78	36.36	63.64	100.00
signs, stickers, eco-labels in bathroom	0.00	100.00	66.67	81.82	72.73	100.00
booking portals	0.00	0.00	8.33	10.91	18.18	0.00

Source: own processing (2025)

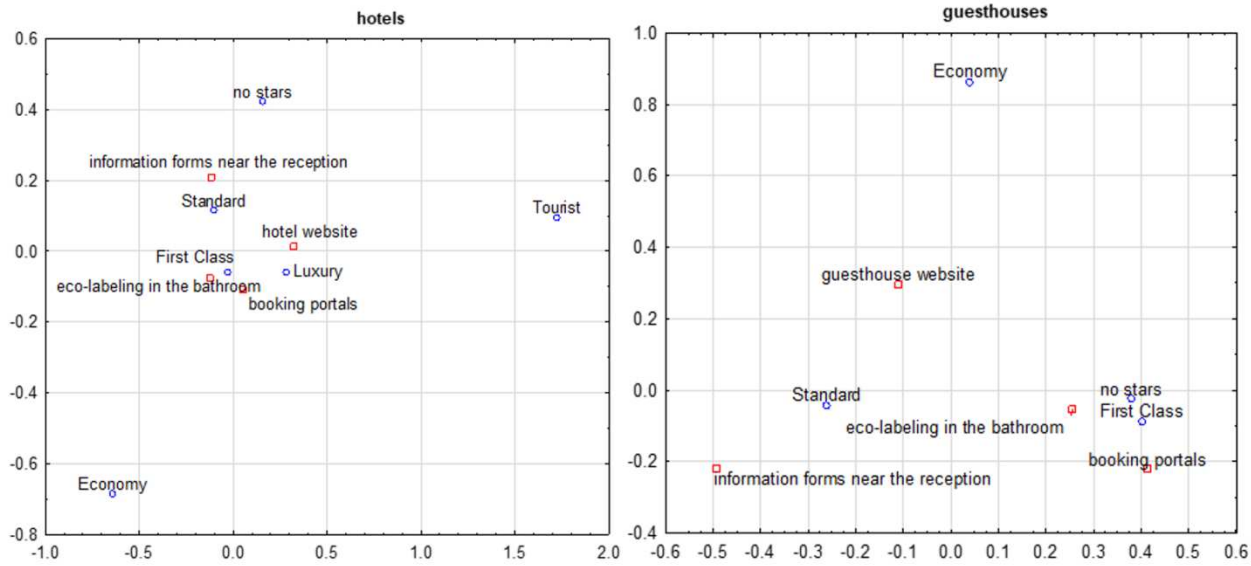

Figure 3. Environmental friendliness in the hotels and the guesthouses
Source: own processing (2025)

Guesthouses in the Tourist class did not inform their guests about their efforts in environmental friendliness (0.00%), which is why they do not appear in figure 2. Guesthouses in the Economy class provided the most information about environmental friendliness via the guesthouse websites (66.67%), the highest value achieved within the individual guesthouse classes. Guesthouses in the Standard class informed guests via the guesthouse websites (40.00%), eco-labels in the bathroom, and guesthouse information forms around the reception (40.00%). The information around the reception received the highest value, both among all guesthouse classes and hotels. Eco-labels achieved the best results in the First Class class (75.00%) and among guesthouses that do not have any stars (55.56%; Table 9).

Table 9. Location of environmental messages in the guesthouses (%)

eco-meesages location / class	Tourist *	Economy **	Standard ***	First Class ****	no stars
hotel information forms at reception area	0,00	0,00	40,00	12,50	11,11
hotel website	0,00	66,67	40,00	25,00	33,33
signs, stickers, eco-labels in bathroom	0,00	33,33	40,00	75,00	55,56
booking portals	0,00	0,00	8,00	12,50	22,22

Source: own processing (2025)

It is precisely non-violent information to guests through signs and stickers in the bathroom, how to make guests think and realize, for example, how to prevent water waste, etc. On the other hand, many accommodation facilities are interested in this issue, believing that they will have better results in terms of sustainability. From the semi-structured interview it was reported that *"the topic of sustainable business interests me quite a lot, but in the guesthouse we have a problem with the fact that clients such as seniors and families with children, or school stays, come to us, and even if we inform them about waste sorting and reducing water flow, they often do not care much about it."*

The hospitality industry's effort to minimize negative impacts on the environment is reflected in the integrated application of elements of sustainable business and environmental management, which is in line with research (Cerchione & Bansal, 2020; Filimonau, 2021). However, the aforementioned drivers are implemented in a particular tool mix, as they are applied in an integrated manner, which aligns with research by Aboramadan et al. (2022). It is more than desirable that not only managers, employees, but also guests are educated in the field of sustainability, which is consistent with research by Diaz-Farina et al. (2023), Vrabcová et al. (2022), Vrabcová & Urbancová (2021). In addition, accommodation facilities should consider incorporating sustainable behavior into their standards and reward and promote their employees in green inclusive leadership (Aboramadan et al., 2022).

Conclusion

The aim of the paper was to evaluate hotel managers' and accommodation owners' perceptions of environmental management and eco-labeling in Czechia. According to the interviews conducted, hotels and guesthouses found the most significant benefit of environmental management in protecting and improving the environment, which was confirmed in individual classes and overall (weighted average 4.29 and 4.28). The interviews and questionnaires also revealed that the topic of sustainable business is interesting, but there was a problem with the clientele in some accommodation facilities. It also emerged that managers are concerned about the outflow of guests due to the promotion of environmental measures, because guests want to relax during their stays and not deal with environmentally friendly behavior. As for the environmental certificate, almost no accommodation facilities expressed interest in obtaining it. Only eight hotels (1.35%) and two guesthouses (0.58%) expressed an effort to obtain an environmental certificate in the future. On the other hand, having an environmental certificate from a financial and time perspective is not entirely desirable. According to the interviews, accommodation facilities apply various elements and measures of environmental management even without having an environmental certificate.

Resources

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Aspects of Digital Nomadism at the Current Travel Market: Preferences of Digital Nomadism Tourists

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Abstract

Research background: Under the influence of many factors, the typical patterns of the labor market and its working conditions are gradually transforming. Not only the methods of management but also the place of work are changing. This has significantly begun under the influence of the pandemic in the case of many professions from the home environment and in online form. This has stimulated the development of the still current trend of digital nomadism, which has a significant connection to the tourism industry and its services.
Purpose of the article: The aim of this paper is the identification of the specific aspect of digital nomadic tourism and its practice at the example of Slovak potential nomadic tourists. It investigated the preferences of a sample of Slovak respondents when changing their place of work from traditional forms to an online environment and in relation to tourism and the consumption of its services.
Methods: The research was based on questionnaire research as the main research method. It mainly investigated the preferences of Slovak potential digital nomads. The collected data from the research were processed using advanced statistical methods.
Findings & Value added: The research results point to public interest in practicing digital nomadic travel as well as differences in preferences when choosing tourism services and the forms of its implementation.

Keywords: Digital nomadism, Digital nomads, Nomadic tourism, Nomadic destinations, Labour market change

JEL classification: P46, J62

1. Introduction

The digital nature of the new millennium has brought changes to the market in many sectors of the global economy. It applies an ever-increasing number of new tools in the sense of the digital advancement of society. In addition to their numerous advantages, these have also begun to shape new development trends that affect all market entities. Not only businesses are adapting to the digital transformation, but also the modern population, which can hardly imagine life without digital tools. Digitization, technological progress and also a change in the perception of work have significantly influenced the way individuals approach travel and, on the other hand, employment and work performance. In the context of current socio-economic and technological transformations, we are increasingly encountering a phenomenon that combines the traditional way of traveling with modern forms of remote work – this is the so-called nomadic tourism. This phenomenon is closely linked to the concept of digital nomadism, which refers to a lifestyle that allows individuals to work independently of a specific location through digital technologies, often migrating between different destinations in order to combine work and leisure activities. Nomadic tourism is essentially a new form of mobility. Its distinctive feature is the overcoming of the traditional dichotomy between work and leisure, stability and mobility, or between home and foreign environments. Unlike conventional tourism, which is usually short-term and oriented towards relaxation and leisure, nomadic tourism is more long-term and productive, as it is linked to the continuity of work duties and integration with the local environment. In many cases, this lifestyle takes on a transnational character, with individuals building a hybrid identity independent of a single state or cultural context. The basis of this lifestyle is the availability of high-quality internet connectivity, the development of coworking and coliving spaces, favorable visa regimes, as well as the growing global infrastructure

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aimed at supporting digital nomads. The result is the formation of a new social group that has a higher degree of time, space and work flexibility. This group also actively contributes to the redefinition of the concepts of mobility, globalization and work, while from the perspective of destination destinations it also plays an important role as an economic stimulus or tool for the diversification of local tourism.

Although the nomadic way of traveling in combination with remote work began to be discussed even before the pandemic period of the long-lasting Covid-19 pandemic, research and in particular has so far received only a small amount of attention. This is the reason for the creation of the paper in question and its research. The main interest was to target the Slovak employees and traveler market and determine their attitude towards nomadic tourism, for the purposes of its potential future development also in an organized form. Since this is a truly specific type of travel consumption of tourism services, this offer was implemented in a significantly dominant individual form. However, the pandemic has stimulated its expansion and therefore there is potential for a possible change, when the offer could also be organized, which could save time in providing nomadic travel and, on the other hand, support the income of tourism businesses by expanding their portfolio of offered packages. Given the above, the main research question was: *What are the specific needs and interests of potential participants in nomadic tourism originating from Slovakia?*

1.1 Rise in popularity of nomadic travel

The enthusiasm around remote and independent working has rapidly gained momentum in the last few years. The digital nomad phenomenon has frequently been portrayed as an exemplar of this pattern and referred to by the media as a highly location-independent form of nomadic work (Nash et al. 2018). The increased mobility of employed knowledge workers allows them to temporarily engage in leisure travel while working remotely, thereby experiencing the digital nomad lifestyle. This phenomenon is gaining traction due to the rising popularity and acceptance of hybrid work (Koll et al. 2025). According to Salmela (2024), independent and Nomadic Travel takes part in identifying and understanding this transformation by providing an extensive account of academic research on backpacking from multiple academic fields, approached from both western and non-western perspectives, and situated in post-pandemic times and futures. This form of mobility brings with it several benefits. The primary benefits and positives include the flexibility of the work environment, the possibility of cultural exchange, personal development and economic benefits for the host destinations, especially in developing countries or outside the main tourist interest. In addition, many companies around the world are now actively offering remote work, which allows regular employees to work outside the typical office environment (Hermann et al. 2020). Secondly, as Ay and Güzel (2025) point out, digital nomads also play an important role in destination marketing and are effective in generating intentions to visit destinations. A targeted approach to promoting destinations with well-known personalities can lead to mutually beneficial and effective results for both nomads and host communities (Kozak et al. 2024). Generally, it is possible to conclude, that the concept of digital nomadism and nomadic tourism represents a dynamic and rapidly developing field that intersects the dimensions of work, leisure, mobility and global connectivity. Digital nomadism understood as a new dimension of remote work has certainly acquired a new meaning at the turn of 2020 and 2021. The outbreak of the COVID-19 pandemic in 2020 significantly accelerated the digitization of work and education areas, which had a valid impact on our socio-economic functioning.

1.2 Digital nomads at nomadic tourism market

Arslan (2024) mentions that digital nomadism brings a new perspective on the nature of travel and tourism mobility, along with a distinct tourist typology characterized by unique features. Its central subject is nomadic tourists. They are characterized, for example, by authors Fikry et al. (2023) , who state that digital nomads are independent workers who choose to work from different locations of their own choosing rather than from a permanent company or office. Digital nomads are characterized, and different from the rest of the sedentary world, by their freedom from time and location constraints (Makimoto, 2013). Holleran (2022), describes digital nomads as (those who work for higher wages in developed countries but live in cheaper locations, most often in the global south) are known for their ability to practice geo-arbitrage, that is, they seek lower living costs by working remotely. Mouratidis (2018) characterizes digital nomads as global nomads. The term digital nomad comes from the words “digital”, which means the use of computing technology, and “nomad”, which refers to members who travel from one place to another without restrictions. They can work practically anywhere. Most digital nomads are self-employed freelancers who work in a variety of fields, including writing, blogging and vlogging, virtual assistant work, social media management, digital marketing, graphic design, and more (Christoph,

2021). They can move freely across borders and without a permanent residence or work address. In practical terms, it may seem difficult for people without a permanent residence or job to cope with everyday financial problems, and therefore, according to the author Milošević (2020), the solution is actually quite simple: as they work online, they also receive payments online. In terms of scientific knowledge, the concept paper by Kozak et al. 2024 examined the digital nomad in detail from a tourism and leisure perspective and sought to provide a broader understanding of the phenomenon. In terms of visa policies targeting digital nomads by 2023, research was conducted by Bednorz (2024). His results illustrate how digital nomad visas can reinforce broader strategic priorities of governments (mostly focused on tourism development), stimulate economic competition between countries, and redefine the concept of "digital nomad" from the host's perspective.

As Holleran (2022) argues, in the future, it can be assumed that digital nomadism will become more attractive with the growing acceptance of remote work and what consequences this could have for destinations in the global south that are already experiencing "transnational gentrification". For this reason, it seems justified to devote deeper scientific attention to the issue for its further conceptual development, based on the specificities and preferences of those working in the current market and those new to the labor market. However, the connection between digital behavior and tourism requires in-depth investigation. Kozak et al. (2024) also argue that the intersection between digital nomadism and leisure and tourism activities remains unclear. Bednorz (2024) argues that while research on digital nomadism is growing exponentially, its implications, including government responses to this emerging class of mobile workers, remain underexplored.

2. Methods

The aim of the research was to identify the specifics of digital nomadic tourism and the preferences of its potential participants in Slovakia. The main research method was a questionnaire survey aimed at examining respondents' attitudes towards the transition from traditional forms of work to an online environment, specifically in the context of tourism and the consumption of its services.

The questionnaire was distributed between October 2024 and February 2025 through both online platforms and in-person methods, ensuring diversity in respondent demographics. To capture attitudes and perceptions, the survey employed scaled questions using a five-point Likert scale (response options: definitely yes; yes; neither yes nor no; no; definitely no). This scale enabled respondents to express the intensity of their agreement or disagreement with the presented statements.

For data analysis, a combination of descriptive and inferential statistical methods was used. The Shapiro-Wilk test was applied to assess the normality of data distribution. Since the data did not meet the assumptions of normality required for parametric tests, non-parametric methods were employed throughout the analysis. Specifically, the Wilcoxon Signed-Rank Test was used to compare paired group differences, the Mann-Whitney U test was applied to assess differences between two independent groups, and the Kruskal-Wallis test was utilized to compare differences among three or more independent groups. Additionally, the Chi-square test of independence was used to examine associations between categorical variables. These non-parametric tests are appropriate for evaluating differences in ordinal data or non-normally distributed interval data, ensuring robust and reliable results. The data were initially processed in Microsoft Excel, while more advanced statistical analyses were conducted using the R programming language, ensuring methodological precision and research replicability.

For the purpose of the study, 2 main hypotheses and several sub-hypotheses were stated:

H1: There is an assumption that preferences for the continent as a digital nomadic destination differ significantly among respondents.

H1.1: There is an assumption that preferences for the continent differ based on the gender of respondents.

H1.2: There is an assumption that preferences for the continent differ based on the age of respondents.

H1.3: There is an assumption that preferences for the continent differ based on the place of residence of respondents.

H1.4: There is an assumption that preferences for the continent differ based on the level of education of respondents.

H1.5: There is an assumption that preferences for the continent differ based on the professional position of respondents.

H1.6: There is an assumption that preferences for the continent differ based on the marital status of respondents.

H2: There is an assumption that the planned duration of a digital nomadic stay is influenced by sociodemographic characteristics.

H2.1: There is an assumption that the planned duration of a nomadic stay differs based on the gender of respondents.

H2.2: There is an assumption that the planned duration of a nomadic stay differs based on the age of respondents.

H2.3: There is an assumption that the planned duration of a nomadic stay differs based on the place of residence of respondents.

H2.4: There is an assumption that the planned duration of a nomadic stay differs based on the level of education of respondents.

H2.5: There is an assumption that the planned duration of a nomadic stay differs based on the professional position of respondents.

H2.6: There is an assumption that the planned duration of a nomadic stay differs based on the marital status of respondents.

3. Results

Interest in digital nomadic tourism was analyzed using data collected through a questionnaire survey. The sample consisted of 204 Slovak respondents categorized by multiple sociodemographic variables including gender, age, place of residence, education, occupation, and marital status. These variables were used to examine differences in preferences related to digital nomadic tourism, such as choice of destination, and lenght of travel. Out of the total respondents, 68 (33.33 %) were men and 136 (66.67 %) were women. The analysis included comparisons across all these demographic factors to identify patterns and preferences within the sample.

The main hypothesis H1, which assumes differences in continent preferences among respondents, **was clearly confirmed**: $\chi^2 = 806.0$, $p \approx 5.8 \times 10^{-172}$, indicating that the differences in the overall distribution of preferences are highly statistically significant, with Europe being the dominant choice. However, among the sub-hypotheses, only the one related to age showed a statistically significant difference. The other sub-hypotheses (concerning gender, place of residence, education level, professional position, and marital status) did not reach statistical significance.

To compare preferences for Europe as a digital nomad destination between men and women, the Mann-Whitney U test was used. This non-parametric test was appropriate due to the ordinal nature of the data and non-normal distribution confirmed by the Shapiro-Wilk test ($p < 0.05$). The result ($U = 2786.5$, $p = 0.978$) showed *no statistically significant difference* between genders in their preference for Europe.

To compare preferences for Europe as a destination among digital nomads across different age groups, we used the Kruskal-Wallis test. This non-parametric test was chosen due to the ordinal nature of the ratings and the violation of the normality assumption, which we verified using the Shapiro-Wilk test ($p < 0.05$). The result of the Kruskal-Wallis test ($H = 8.47$; $p = 0.037$) indicates *statistically significant differences* in preferences for Europe among the different age groups of respondents.

To examine differences in continent preferences between respondents living in urban and rural areas, Pearson's χ^2 test of independence was conducted. This test is appropriate for assessing the relationship between two categorical variables. The analysis ($\chi^2 = 6.56$; $df = 4$; $p = 0.161$) showed no statistically significant differences at the $\alpha = 0.05$ level. Therefore, continent preferences *do not significantly* differ between urban and rural residents.

To investigate whether preferences for continents differ by level of education, Pearson's χ^2 test of independence was applied. The analysis involved a contingency table crossing four education levels with six continents. The results ($\chi^2 = 7.63$; $df = 12$; $p = 0.814$) show *no statistically significant differences* in continent preference based on education level, with a very small effect size.

To assess the relationship between professional position (categorized into five groups) and preferred continent, Pearson's χ^2 test was conducted. The results ($\chi^2 = 3.42$; $df = 16$; $p = 0.999$) indicate *no statistically significan*t association. Preferences for continents do not appear to differ based on respondents' professional status.

To compare continent preferences between single and married participants, Pearson's χ^2 test was applied. The results ($\chi^2 = 5.17$; $df = 4$; $p = 0.270$) indicate *no statistically significant difference* in continent preference based on marital status. Any observed differences are minor and likely due to chance. A detailed summary is presented in Table 1.

Table 1. Overview of statistical analyses testing Hypothesis 1

Hypothesis	Test	Test Statistic	df	p-value	Conclusion
H1 (main)	Pearson's χ^2	806.0	-	$\approx 5.8 \times 10^{-172}$	Significant difference in continent preferences; Europe dominant
H1.1 (gender)	Mann-Whitney U	U = 2786.5	-	0.978	No significant difference
H1.2 (age)	Kruskal-Wallis	H = 8.47	-	0.037	Significant difference by age
H1.3 (place of residence)	Pearson's χ^2	6.56	4	0.161	No significant difference
H1.4 (education)	Pearson's χ^2	7.63	12	0.814	No significant difference
H1.5 (professional position)	Pearson's χ^2	3.42	16	0.999	No significant difference
H1.6 (marital status)	Pearson's χ^2	5.17	4	0.270	No significant difference

Source: own processing (2025)

The main hypothesis H2, assuming that sociodemographic characteristics influence the planned duration of a digital nomadic stay, **was confirmed**. A Kruskal-Wallis test ($H = 22.4$, $p < 0.001$) indicated significant effects across demographic groups. The most common planned duration was "1–3 months", particularly among younger and urban respondents, while older and rural participants preferred shorter stays.

H2.1 was tested using the Mann-Whitney U test. A statistically significant gender difference was found ($U = 2316$, $p = 0.039$): men tended to plan longer digital nomadic stays compared to women. Thus, H2.1 *is supported*.

H2.2 was verified via the Kruskal-Wallis test and showed significant age-related variation ($H = 17.8$, $p = 0.001$). Respondents aged 18–29 most frequently selected stays longer than 3 months, while older respondents (45+) planned shorter durations (less than 1 month). Therefore, H2.2 *is supported*.

H2.3 was tested for place of residence. The Kruskal-Wallis test yielded a significant result ($H = 10.4$, $p = 0.005$): urban residents planned longer stays, whereas rural participants preferred short-term stays. H2.3 *is supported*.

H2.4 was tested using the Kruskal-Wallis test across four education levels and revealed a statistically significant difference ($H = 9.1$, $p = 0.028$). Respondents with higher education (master's or postgraduate) planned longer nomadic experiences. Thus, H2.4 *is supported*.

H2.5 was examined using the Kruskal-Wallis test across five professional groups. The result was significant ($H = 11.6$, $p = 0.020$): freelancers and senior professionals reported longer planned durations than junior or administrative staff. H2.5 *is supported*.

H2.6 was tested using the Kruskal-Wallis test across three marital status groups and did not yield a significant result ($H = 4.3$, $p = 0.117$). Thus, H2.6 *is not supported*. For a full presentation of all results related to H2 and its sub-hypotheses, see Table 2 below.

Table 2. Overview of statistical analyses testing Hypothesis 2

Hypothesis	Test	Test Statistic	df	p-value	Conclusion
H2 (main)	Kruskal-Wallis	H = 22.4	5	< 0.001	Supported; sociodemographic factors influence planned duration
H2.1 (gender)	Mann-Whitney U	U = 2316	—	0.039	Supported; men plan longer stays than women
H2.2 (age)	Kruskal-Wallis	H = 2	2	0.001	Supported; younger respondents plan longer stays
H2.3 (place of residence)	Kruskal-Wallis	H = 10.4	2	0.005	Supported; urban residents plan longer stays
H2.4 (education)	Kruskal-Wallis	H = 9.1	3	0.028	Supported; higher education linked to longer planned duration
H2.5 (professional position)	Kruskal-Wallis	H = 11.6	4	0.020	Supported; freelancers and senior professionals plan longer stays
H2.6 (marital status)	Kruskal-Wallis	H = 4.3	2	0.117	Not supported; no significant difference based on marital status

Source: own processing (2025)

4. Discussion

The findings of this study confirm that sociodemographic factors significantly influence various aspects of digital nomad preferences and behaviors. Europe emerged as the most attractive continent for digital nomads, with a strong consensus across different demographic groups, except for some variation related to age. This suggests that the appeal of Europe as a destination transcends most sociodemographic differences.

The planned duration of digital nomadic stays also varied according to demographic factors. Younger, urban, and higher-educated respondents generally planned longer stays, whereas older, rural, and less-educated participants preferred shorter durations. These differences likely reflect varying life stages, financial flexibility, and lifestyle priorities. Marital status, however, did not appear to have a significant impact on the intended length of stay. These insights have important implications for destination marketers, accommodation providers, and policymakers. By tailoring services to specific demographic groups, stakeholders can enhance satisfaction and encourage longer stays among digital nomads. For example, urban destinations could focus on amenities appealing to younger nomads seeking longer stays, while rural areas might prioritize family-friendly options.

In summary, this research highlights the diverse ways in which sociodemographic characteristics influence digital nomad behaviors and preferences. Recognizing these nuances will help stakeholders better support the digital nomad community and promote sustainable digital nomadism worldwide.

Limitation and suggestions for further research

Limitations of this study include its cross-sectional design and reliance on self-reported data, which may introduce some bias. Future research could benefit from longitudinal designs and qualitative methods to better understand the motivations behind demographic differences.

From a research perspective, it is clear that despite the growing interest, several areas remain unexplored. In particular, a deeper analysis of the long-term socio-economic impacts on local communities, differentiation between different types of digital nomads according to professional background, income and motivations, as well as research on the impact of digital nomadism on the environment are lacking. Similarly, a comparative analysis between countries that actively implement visa regimes for digital nomads and those that take a passive approach to them is lacking. Moreover, in the context of the post-pandemic development of remote work and hybrid employment models, it is necessary to examine the extent to which digital nomadism is changing from an alternative lifestyle to a mainstream trend.

Conclusion

Digital nomadism and nomadic tourism face significant shortcomings and challenges. The most common include legal and administrative uncertainty - the absence of specific visas, a complex tax situation, but also risks associated with social isolation, the absence of a stable social background or psychological pressure from constant environmental change. The author Arslan (2024) also emphasized that while digital nomadism contributes to local economy and cultural change on the one hand, it presents challenges in terms of regulation and taxation on the other. From the perspective of host communities, digital nomads can contribute to increasing housing prices and disrupting local communities, creating the phenomenon of so-called digital gentrification. In conclusion, it can be stated that the digitalized form of mobility represents a significant phenomenon of the current globalized world. Despite its positive aspects, it requires a comprehensive approach in terms of social impacts, political regulation and environmental sustainability. Further research should aim to create balanced policies that allow for the responsible use of the potential of digital nomadism without negative consequences for host communities and the nomads themselves.

This study confirmed that sociodemographic factors significantly influence the planned duration of stay, participation preferences, and accommodation choices of digital nomads. The results show that urban nomads tend to plan longer stays and more often travel alone or with a partner, whereas rural respondents prefer shorter stays. Education level and professional position also play a key role in shaping the length of stay and accommodation preferences. Europe emerged as the clearly dominant preferred destination, with no significant differences across groups. These findings are valuable for policymakers, travel agencies, and service providers, enabling them to better target their offerings and tailor services to different segments of the digital nomad community.

Overall, the results contribute to a deeper understanding of the characteristics of digital nomadism and support more effective development of this growing phenomenon. Future research should explore how emerging global trends, such as remote work policies and technological advancements, continue to shape digital nomad behaviors. Understanding these dynamics will be crucial for adapting strategies to support and sustain the evolving digital nomad lifestyle.

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Analysis of Vacationers' Satisfaction with Air Transport Services in the Context of Tourism

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Abstract

Research background: Tourism plays an important role in the development, attractiveness, and communication of knowledge of the natural, cultural, and social heritage of destinations and countries. To make "must see" sites more accessible, mankind has historically been concerned with the question of appropriate forms of transport. Today, one of the most preferred forms of transport is air transport, which has evolved not only in terms of safety, but has also diversified based on the needs and expectations of travellers. Currently, air transport is reasserting its position as the dominant mode of transport in the choice of holiday destinations.
Purpose of the article: This paper aims to determine the level of passengers satisfaction with the services provided by air carriers in the context of holiday tourism.
Methods: The research was conducted through a questionnaire survey with a sample size of 368 respondents. Several statistical methods were used to process and interpret the data obtained, mainly the Chi-square test, Pearson's correlation coefficient, and Cramer's V coefficient.
Findings & Value added: The research results showed a high level of satisfaction among respondents with airline services, especially in the areas of cabin cleanliness, compliance with hygiene standards, and feeling safe during the flight. These findings contribute to a better understanding of holidaymakers' perceptions of air transport service quality and represent added value for tourism service providers.

Keywords: Tourism, Services, Air Transport, Tourism Participant

JEL classification: Z32, D02, O17, P31

1. Introduction

Transport is a crucial element of the tourism system, and air transport is primarily responsible for international arrivals (Silveira et al., 2023). The impact of air transport on economic growth is significant and multidimensional (Khanal et al., 2023). The importance of aviation lies in connecting people, supporting economic development, and promoting tourism and trade, which provides consumers with choice, creates jobs, and brings socio-economic benefits (Vermooten, 2023). Air transport and tourism are interlinked sectors whose synergistic interaction contributes to stimulating economic activity at both national and international levels. The aviation industry not only generates direct economic benefits through employment, investment, and revenue from air services, but also acts as a catalyst for the development of other economic sectors, especially tourism, trade, and infrastructure (Silveira et al., 2023).

Martín-Domingo et al. (2024) examined articles in the WOS and SCOPUS databases that focused on passengers with specific needs concerning air transport. The analysis showed that interest in studying air passengers with specific accessibility requirements is growing (Figure 1). Although the first articles were published in 1986, greater attention to these passengers began to emerge more seriously in the mid-2000s.

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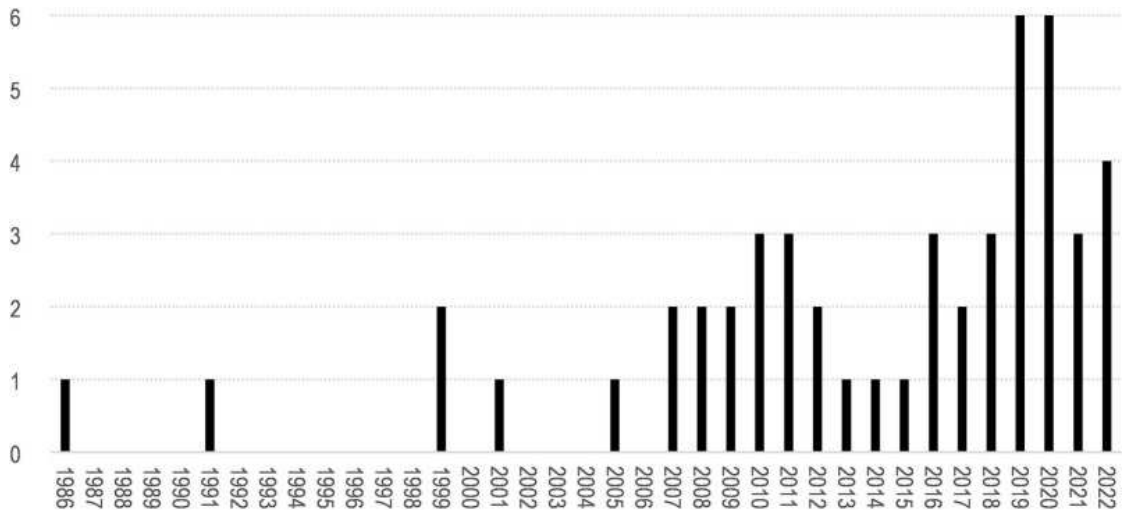

Figure 1. Published Articles in WOS, SCOPUS Databases Focused on Air Passengers
Source: Martín-Domingo et al. (2024)

Airline service evaluation is an important topic for the aviation industry, and due to the varying expectations of passengers, careful monitoring and evaluation of data is necessary (Farzadnia & Vanani, 2022). Findings regarding passengers satisfaction are also important for travel agencies that use the services of air carriers.

Of particular importance is the cooperation between airlines and travel agencies, which is reflected mainly in the offer of so-called air holidays. These integrated products enable more efficient travel organization, reducing costs for the consumer and optimizing the use of capacities in both aviation and tourism infrastructure. Such a connection also strengthens the competitiveness of destinations and supports seasonal and year-round passenger mobility. This complex role of aviation within tourism increases its strategic importance in the context of long-term and sustainable economic growth (Mazzola et al., 2022).

Why is it important to track satisfaction with a sub-service of a package holiday, such as air travel? The authors of the study proceed from the fact that the tourism experience also includes memories during and after the transport, which significantly shape the way the holiday experience is perceived and interpreted. Tourism is characterized by a variety of experiences and memories of travelers, which play a key role in shaping and predicting customer behavior and subsequently the purchase and savings of air travel.

The presented study fills a gap in the study of the satisfaction of vacationers (travel agency clients) when consuming a part of the product (air travel), namely, services associated with air transport.

1.1 The role of air transport in the travel agency product

Aviation safety is a strategic factor for travel agencies, significantly affecting customer satisfaction, brand reputation, legal risks, and overall business performance. Given the above, it is essential for travel agencies to systematically monitor the safety ratings of air carriers, avoid cooperation with risky entities, and ensure transparent and responsible communication with clients (Barnett & Torra, 2024).

When using air transport, holidaymakers come into contact with several stakeholders, such as airports, airlines, or their contractual partners, with whom they communicate directly (e.g., when checking in for a flight, purchasing additional services, etc.) or indirectly (e.g., through digital information systems). The phases before departure are particularly important, when holidaymakers obtain information about their flight, security procedures, check-in, or orientation at the airport. Customer journey analysis helps to identify key touchpoints in this pre-flight phase, which have a fundamental impact on the overall travel experience and satisfaction with the services provided (Martín-Domingo et al., 2024).

Cerdan Chiscano (2021) highlights the need for training related to the provision of services to air passengers, which should be provided mainly to airline and airport employees, but also to other stakeholders such as airport security personnel and baggage handlers.

Agrawal et al. (2023) talk about the need to digitize operations and passenger services. Vieira et al (2022) develop this idea, for example, by proposing the implementation of accessible and smart bus stops to further improve airport accessibility, or to share basic information, but also for entertainment purposes.

Tran (2024) talks about one of the key prerequisites for minimizing passenger dissatisfaction in air transport. This is the timely, accurate, and consistent provision of information before departure and during the flight. Deficiencies in this area (such as incomplete or unclear information about departure time, boarding gate, delays, or reactions to unexpected situations, etc.) can be considered a serious service failure that can negatively affect the overall customer experience. In the context of service restoration, effective provision of information and customer service plays a crucial role. Providing understandable explanations and empathy are basic tools for mitigating negative consequences and restoring passenger satisfaction. A sufficiently informed customer tends to perceive even the inconveniences that have arisen as less serious, which can contribute to maintaining their trust and loyalty. For this reason, systematic and consistent provision of relevant information is not only a prevention of potential service failures, but also an integral part of the recovery strategy in the event of problems.

1.2 Examples of studies

Demand for air transport is analyzed at global, regional, national, and individual levels, with various factors such as sustainability, emissions (Gössling & Humpe, 2020), air safety (Barnett & Torra, 2024), and ultimately customer and partner satisfaction (e.g., travel agencies) and other factors.

Vredenburgh et al. (2015) investigated factors influencing passenger anger during air travel. They found that odor, noise, seat size, hunger, and unwanted contact during air travel influenced passengers' mood. These factors can be considered as assaults on passengers' senses that do not occur in other environments.

Farzadnia & Vanani (2022) studied various factors of air transport services that are preferred by female and male passengers. Passengers were asked to rate their experiences with air carriers in terms of information provision at the airport and during the flight. The study showed a difference in the perception of the importance of information provided at the airport and during the flight between men and women. Men attributed more importance to information provided before departure, while women considered information provided during the flight to be more important.

Masorgo et al. (2022) identified service failures as a major determinant of customer evaluations of airline service quality and profitability. Specifically, service failures were found to be related to mishandled baggage, delayed arrivals, and involuntary denied boarding.

According to Qiu et al. (2024), many tourism-focused companies, such as travel agencies, have recently been providing contactless services, sharing information through new technological services (QR codes sent as flight tickets) and products, and allowing customers to manage tasks independently.

Hyelim et al. (2025) investigated how the satisfaction of travel agents with air travel was influenced by cabin crew, hygiene and safety levels, claustrophobia, rest restrictions, technology, and negative experiences with uncertain situations.

2. Methods

The theoretical basis of the study, based on the method of scientific abstraction, represented a conceptual framework for formulating new knowledge, which subsequently led to the implementation of the author's questionnaire survey. It served as a tool for verifying the set research objectives.

The study's aim was to determine the level of passenger satisfaction with the services provided by air carriers in the context of holiday tourism.

The research conducted is oriented and examines the current requirements of travelers (tourism participants) in the areas of information, luggage, food, and safety. To achieve the goal, an author's questionnaire was compiled. The questions were open-ended, where respondents could state their opinions, and scaled questions were set on a Likert scale (from 1 = absolute agreement to 5 = absolute disagreement). The questionnaire was completed by 351 respondents (personal contacts) who traveled on vacation in the monitored period. The research was conducted at Košice International Airport, in the period May - September 2024 and November 2024 - January 2025.

In connection with the aim of the study, hypotheses were established, which were subsequently verified or refuted using appropriate mathematical and statistical methods at a significance level (alpha) $\alpha = 0.05$, i.e., at 95% probability. Null hypotheses were established for the above hypotheses in Table 1.

H1: The level of agreement with the requirement for baggage care differs between men and women.
H2: Satisfaction with compensation for damage differs between men and women.
H3: Satisfaction with airport check-in services differs between men and women.
H4: Feeling of safety at the airport differs between men and women.
H5: The Feeling of safety on board the aircraft differs between men and women.
H6: Satisfaction with information from the staff during the flight differs between men and women

Based on the results of the ANOVA normality test, it was found that the data did not meet the requirements of a normal distribution. The Mann-Whitney U test was used to test the hypotheses, since a two-categorical variable (gender) and an ordinal variable (Likert scale, 1 – completely agree to 5 – completely disagree) were compared.

Limitations of the study

The study also contains certain limitations, which the authors are aware of. In some questions, there is a high percentage of respondents who cannot/do not want to express their opinion (for example, they had no experience with an insurance claim or compensation - "46.2% of respondents could not express their opinion" on compensation for damage).

Given that the study includes responses in the categories "rather satisfied", "neutral attitude", and "rather disagree", it is necessary to pay attention to why the respondents answered this way, and possibly address these reasons, as they can be inaccurate and interpreted differently.

A certain limitation may also be the location of the study at Košice International Airport, which means that the results may not be transferable to other airports or countries.

3. Results

The study was conducted with 351 respondents, 74.5% of whom were women and 25.5% were men. The number of air travel holidays that respondents took in the last 3 years (i.e., 2024, 2023, and 2022) is shown in Figure 2.

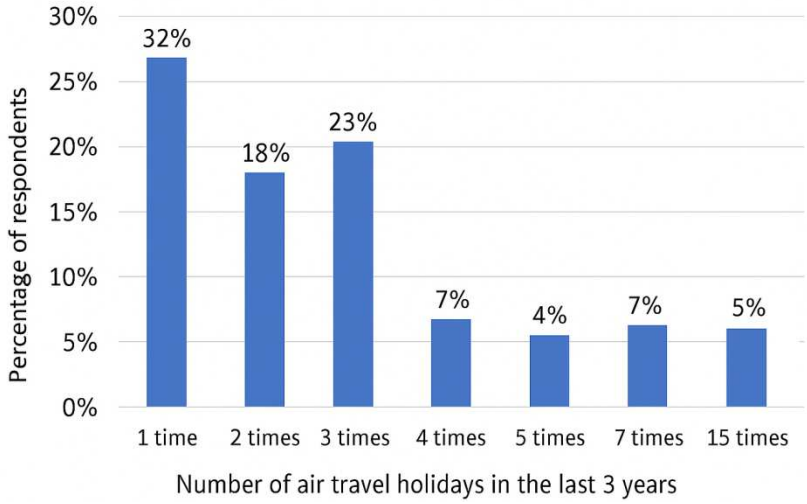

Figure 2. Number of Air Travel Holidays in the Last 3 Years
Source: own processing (2025)

For 40.8% of respondents, it is important which airline the travel agency uses. This information is absolutely important for 28.5% of respondents, rather unimportant for 20% of respondents, and not important at all for 10.7% of respondents.

All respondents stated that they were offered comprehensive travel insurance when purchasing a tour, with each insurance including (in addition to other types of insurance) the services of baggage insurance, documents, and baggage loss. As part of a holiday package, 93.7% of respondents used insurance as a service. Respondents stated that the travel agency fully informed them about the contents of the insured package (48.7%), partially informed them (30.8%), minimally informed them (18.3%), and did not inform them at all (2.2%). The results show that 30.8% of respondents expressed satisfaction with the help of the travel agency in solving the problem (including the insurance claim) with the luggage at the time it was

handed over to the airline. Another 25.6% of respondents somewhat agreed with the statement that the travel agency was willing to help. A neutral position was taken by 35.9% of respondents who could not express an opinion because they had not had an insurance claim. On the contrary, 5.1% of respondents rather disagreed, and only 2.6% clearly disagreed that the travel agency helped solve the problem with luggage.

In the event of damage during transportation to and from vacation, 48.7% were satisfied with compensation for the damage (fully or partially), 46.2% of respondents could not express an opinion (there was no reason for compensation) and 5.1% of respondents were satisfied (of which 3.1% with the amount of compensation and 1.9% with the method of compensation).

In only 50.8% of cases was a travel agency employee present before the respondent's departure. Rather, disagree and absolutely disagree were indicated by 13.1% and 13.1% of respondents. 17.9% absolutely agree, and only 5.1% could not express an opinion on the question.

A travel agency employee solved problems related to air transport (for example, flight delays, etc.). 25.8% of respondents reported a positive experience with solving the problem (possibly by informing them on time), 15.5% of respondents reported that a travel agency employee tried to solve the problem, but they were not completely satisfied with its solution, or the necessary information was received late. 43.3% of respondents did not experience any problems during the trip to and from vacation. Only 15.4% of respondents reported that a travel agency employee did not solve the problems that arose with the airline. This was the response of all respondents who stated above that the employee was not present at the airport (13.1%). The results of the study showed that orientation at Košice International Airport is clear, which was stated by 76.9% of respondents.

Regarding the feeling of safety at Košice International Airport, the majority of respondents (77.20%) expressed an absolute feeling of safety, and 10% of respondents a prevailing feeling of safety. 5% refused to answer the question, and 7.8% stated that there were moments when they did not feel completely safe. None of the respondents felt threatened, or even completely dangerous, at Košice International Airport.

Safety on board the aircraft is in first place on a global scale. Aircraft personnel are trained to handle risky situations. The study agrees with the above statements, as 72% of respondents expressed an absolute feeling of safety on board the aircraft, 20% of respondents could not express their opinion, and only 8% expressed some concerns about safety on board the aircraft.

Satisfaction with the level of service during the flight was expressed by 66.7% of respondents, of which 43.6% were absolutely satisfied and 23.1% were mostly satisfied. Dissatisfaction with the level of service was expressed by 33.3% of respondents, of which 23.3% were rather dissatisfied and 10% were absolutely dissatisfied.

Information from the aircraft crew members during the flight was at a high level for 85% of respondents, and for 10%, it was satisfactory and sufficient. Only 5% of respondents expressed some dissatisfaction and therefore marked the information during the flight by the crew members as rather unsatisfactory.

Based on the questionnaire survey, the established hypotheses were verified..

Table 1. Testing hypotheses with the Mann-Whitney U test

H1-0 There is no difference between men and women in the level of agreement with the requirement to take care of luggage.	
p value = 0.014	U = 315 Z = -2.45
Confirmed H1: *The level of agreement with the requirement for baggage care* ***differs*** *between men and women.*	
H2-0 There is no difference between men and women in satisfaction with compensation for damage.	
p value = 0.06	U = 376 Z = 3.68
Confirmed H2-0: ***There is no difference*** *between men and women in satisfaction with compensation for damage.*	
H3-0 There is no difference between men and women in satisfaction with airport check-in services.	
p value = 0.331	U = 480 Z = -0.97
Confirmed H3-0: ***There is no difference*** *between men and women in satisfaction with airport check-in services.*	

H4-0 There is no difference between men and women in their feelings of safety at the airport.	
p value = 0.006	U = 290 Z = -2.75
Confirmed H4: *Feeling of safety at the airport **differs** between men and women.*	
H5-0 There is no difference between men and women in their feelings of safety on board an airplane.	
p value = 0.001	U = 230 Z = - 3.21
Confirmed H5: *The Feeling of safety on board the aircraft **differs** between men and women.*	
H6-0 There is no difference between men and women in satisfaction with information from the staff during the flight.	
p value = 0.009	U = 275 Z = - 2.60
Confirmed H6: *Satisfaction with information from the staff during the flight **differs** between men and women.*	

Source: own processing (2025)

The results of the Mann-Whitney U test are presented in detail in Figure 3.

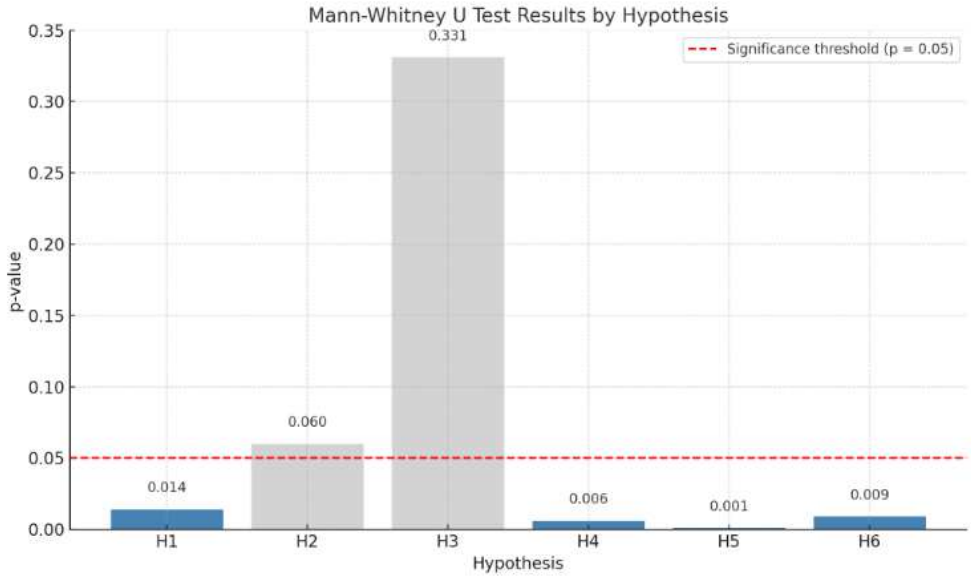

Figure 3. Mann-Whitney U test by hypothesis
Source: own processing (2025)

Where:
Blue bars indicate hypotheses where the difference between men and women was statistically significant ($p < 0.05$)
Gray bars indicate that the difference was not significant ($p \geq 0.05$)
The red dashed line shows the significance level at $p = 0.05$

The results indicate that gender may slightly influence the perception of safety and the need for luggage care as well as satisfaction with on-board information, while the area of satisfaction with check-in and compensation did not show significant differences. A high proportion of passengers appreciated the comprehensive insurance and services provided by travel agencies. Overall, it can be stated that passenger satisfaction is at a high level, although there are areas where there is room for improvement, especially in information and assistance in crisis situations.

4. Discussion

The results of the study are consistent with the findings of Hyelim et al. (2025), who state in the study that systematic training, manuals, and continuous monitoring of cabin crew performance are necessary to increase satisfaction with airlines and improve the quality of services.

Barnett & Torra (2024) point out that security is not only an operational but also a strategic issue for travel agencies. The results of the study confirm this: 77.2% of respondents reported an absolute feeling of security at the airport, and 72% on board the aircraft. At the same time, a statistically significant difference was found between men and women in the perception of security at the airport and on the aircraft. This fact indicates the need for a more targeted approach to different groups of clients in the area of information and support.

Tran (2024) and Martín-Domingo et al. (2024) emphasize the importance of consistent, accurate, and empathetic communication in the pre-flight phase and during the flight. The study shows that 85% of respondents considered the information provided by the cabin crew to be of high quality, which is a positive sign. On the contrary, the respondents reported that the level of information about insurance before the trip was insufficient, as many as 18.3% stated that they were only minimally informed, and 2.2% were not informed at all. This lack confirms the need for better information services from travel agencies.

Tran (2024) and Cerdan Chiscano (2021) state that there is a need for the presence and active involvement of travel agency staff in solving problems. In the study, 25.8% of respondents reported a positive experience with solving air travel problems, but up to 43.3% did not experience any problems and 15.4% of respondents reported that the travel agency staff did not solve the problems that arose - which directly correlates with the fact that in 13.1% of cases the travel agency staff was not present at the airport at all. This situation points to the need for a systematic approach to training and staff readiness, as stated by Cerdan Chiscano (2021).

Agrawal et al. (2023) and Vieira et al. (2022) call for greater digitalization of passenger services. The results of the study show that up to 76.9% of respondents considered the orientation at Košice International Airport to be clear, which can be considered a positive outcome, also in view of the possible digitalization of information systems. However, this data does not include a more detailed analysis of specific digital services, which could be the subject of further research.

Conclusion

The study provided valuable insights into passengers' experiences with air holidays over the past three years, focusing on the services provided by travel agencies, perceptions of safety, and overall satisfaction with services during air travel. Most respondents expressed interest in the quality of air carrier services and comprehensive travel insurance, which points to passengers' growing demands for the level of information and security.

The study showed that travel agency clients are, in most cases, satisfied with the services offered by air carriers, which are part of the travel agency's holiday package. Passengers perceive the airport and onboard environment as safe, which is extremely important for the development of air travel, and they appreciate the comprehensiveness of insurance packages.

The findings show that respondents particularly appreciate the feeling of safety at the airport and on board the aircraft, as well as the quality of communication from the cabin crew. However, the presence of a travel agent before departure and their involvement in solving problems remains variable, which signals room for improving personal service and support in unexpected situations.

The results of statistical testing confirmed that gender plays a significant role in the perception of some aspects of services, especially in the areas of safety and information. These differences indicate the need for a more personalized approach from travel service providers.

Reserves exist mainly in the area of information and some areas of customer support in solving problems. The results provide valuable recommendations for improving the quality of services in the field of organized air travel. In conclusion, it can be stated that although the overall perception of the quality of services during air holidays is mostly positive, there are areas - especially insurance information, assistance with problems, and consistency in providing service at the airport - that require improvement. Emphasis on an individualized approach to the customer and consistent communication can significantly contribute to increasing the satisfaction of travel agents' clients.

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Stakeholders´ Perception of Pilgrimage Tourism Development in the Prešov Region

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Abstract

Research background: Pilgrimage tourism is one of the oldest forms of tourism. Its history dates back to before our era and it is still very relevant today for the development of tourist destinations. The Prešov Self-Governing Region has great potential for developing tourism. In recent years, the development of religious tourism products has become a key focus.
Purpose of the article: The aim of this paper is to present the results of a research focused on the perception of religious tourism on a sample of respondents of selected institutions in the Prešov Self-Governing Region, which are actively involved in the creation of tourism products.
Methods: Primary data were obtained through a questionnaire survey of 277 respondents from various entities and institutions involved in tourism development in the Prešov Self-Governing Region's 13 districts. The established research hypotheses were verified at the $\alpha = 0.05$ level of significance through correlation analysis, specifically through Spearman's correlation coefficient, given a distribution of variables that was not normal. The correlation analysis was performed in the interface of the statistical program R.
Findings & Value added: The results showed that, in terms of its potential, pilgrimage tourism can be considered a significant and promising area for developing tourism in the Prešov Self-Governing Region. The importance of cooperation and partnership between the public, private and church sectors to achieve synergistic effects was also demonstrated. The results and proposals can be used by the various entities involved in creating, managing and marketing tourism products in the region under study.

Keywords: Religious tourism, Pilgrimage tourism, Prešov Self-Governing Region, Stakeholders, Cooperation

JEL classification: L83, Z32

1. Introduction

Although modern tourism is considered a relatively new phenomenon, its roots clearly go back to the ancient tradition of pilgrimage. After all, pilgrimage was the first form of tourism, originating thousands of years ago (Collins-Kreiner, 2020a). Today, religion remains an important incentive for travel, with religious sites attracting large numbers of pilgrims and tourists. Religious tourism accounts for a significant proportion of both domestic and international tourism. It contributes to economic growth and creates cultural, political, religious and social ties between tourists and host communities (Chien-Pang, 2021). In addition, religious tourists tend to adhere to guidelines and regulations, and the nature of such trips fosters social inclusion, enabling people from various social backgrounds to participate. Pilgrims often seek simplicity and travel in groups, which makes logistics easier than for recreational trips. Religious sites often have nearby markets, which provide space for local vendors (Bielikova et al., 2024).

The Prešov Self-Governing Region has great potential for tourism development, and the promotion of pilgrimage tourism is one of its strategic priorities for socio-economic development, as set out in its planning documentation. The Prešov Region has a long-standing tradition of pilgrimage, as evidenced by the numerous pilgrimage sites that attract domestic and foreign pilgrims. To promote the most famous pilgrimage routes, the Prešov Self-Governing Region implemented an international project entitled Svätomariánska púť (Light from the East), financed by the European Union through the Interreg

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V-A Poland-Slovakia 2014-2020 cross-border cooperation programme. The project's primary goal was to promote pilgrimage tourism in the Polish-Slovak border region, drawing inspiration from the route to Santiago de Compostela. The thirteen project partners set strategic objectives focused on creating a comprehensive pilgrimage tourism product. The project involved creating a pilgrimage route passing through sacred sites in Poland and Slovakia, places of Marian worship. As part of the project, virtual panoramas of several dozen such sites were also created (Svätomariánska púť, 2025). The cooperation between the local government and other stakeholders on this project was exemplary. In the near future, the Prešov Self-Governing Region plans to develop a new, comprehensive project to promote pilgrimage tourism. This project will not only focus on pilgrimage sites, but also on other significant cultural and sacred monuments in the region. The aim is to expand the range of pilgrimage routes for hikers, cyclists, and motorists. This will require coordinated cooperation between several interested parties. Pilgrimages play an important role in Slovakia's spiritual landscape, attracting many pilgrims every year. It is highly likely that this trend will continue in the near future (Jesenský et al., 2024). In this context, our research aimed to determine how religious and other forms of tourism are perceived by a sample of respondents from institutions in the Prešov Self-Governing Region that are involved in creating tourism products.

1.1 Pilgrimage tourism

One of the oldest forms of tourism is travel for religious reasons, such as pilgrimages. It has seen significant growth, especially over the last 50 years. It has developed in various contexts and locations, and is becoming an increasingly popular research topic for scholars from a range of disciplines. According to Collins-Kreiner (2020b), most of the research on religious tourism in recent years has been conducted in Eastern European countries and therefore reflects the social and cultural environment in these post-communist countries. In developing regions and remote areas, religious tourism is considered part of economic diversification strategies. Current professional literature on religious tourism highlights the diversification of participants. It distinguishes between individuals who are traditionally religious and those who are not, but who live in societies where traditional religious beliefs are losing their significance, and who are increasingly attracted to religious travel experiences (Choe, 2024). According to Wight &Mabel (2022), there are currently two types of religious tourist. The first type is characterised by tourists whose faith and spiritual beliefs differ from those of the destination. These tourists are often motivated by novel experiences, the opportunity to appreciate heritage and religious buildings as cultural artefacts, and educational opportunities. Religious tourists should also include individuals who travel to religious sites to engage in spiritual practices in specific environments, such as retreats in India and Thailand, or to participate in long pilgrimages along the Caminos. These individuals may not be religiously affiliated and may be seeking self-transformation. The word 'pilgrim' dates back to the Middle Ages, when it referred to someone who travelled to places of worship for religious reasons (Butoracová Sindleryová, Čajková & Šambronská, 2019; Malis et al., 2023). In academic texts and general discourse, the concepts of religious tourism and pilgrimage are often discussed in tandem and considered closely related. As a research concept distinct from other market segments, pilgrimage was virtually non-existent before 1990. The concept has its roots in theories and ideas developed mainly by sociologists and anthropologists in the 1970s and 1980s. These theories focused on the 'visitor experience' and the psychosocial dynamics that drive various types of tourism, including pilgrimages (Collins-Kreiner, 2020a). Nowadays, traditional religious pilgrimages form a significant part of the tourism industry. Religious centres, spiritual places and sacred destinations often become tourist attractions, providing economic benefits for local people and communities, and creating the financial resources needed to preserve cultural heritage. What is now known as 'religious tourism' has evolved from a niche market into one of the most popular forms of tourism.

1.2 Cooperation in the Creation of Religious Tourism Product

Religious and pilgrimage tourism currently contribute to the sustainable development of tourism, as well as to the social and economic growth of tourist destinations in sacred places. This form of tourism plays a key role in creating social and public value within communities by enabling territories and local economies to strengthen collaborative and cooperative processes in the interest of sustainable development (Romanelli et al., 2021). The development of religious tourism hinges on the commitment and cooperation of stakeholders. Without an understanding of the relative importance of these stakeholders and their contributions, it is difficult to manage relationships with them and encourage their engagement. These

factors are essential for the strategic management of religious tourism. To maximise the social and economic impact of religious tourism while balancing the needs of different stakeholders, tourism authorities and operators must recognise the importance of stakeholders. It is important to understand the level of commitment of stakeholders, and to distinguish between primary and secondary stakeholders. In most cases, the needs of churches, temples, pilgrims and host communities should take precedence over those of businesses, government agencies and tourists, in order to secure their involvement and support (Chieng-Pang, 2021). Small and medium-sized enterprises operating in the pilgrimage tourism sector are among the most vulnerable in the post-pandemic period, due to the need to innovate in terms of products and business activities (Setyawati et. al., 2024). The latest example of international cooperation, and a significant event in the development of pilgrimage tourism in the Prešov Self-Governing Region, is the establishment of official ties with the Provence-Alpes-Côte d'Azur region - one of France's most economically powerful and popular tourist destinations. The signing of the cooperation agreement on 9 June 2025 marked the beginning of a new chapter in the partnership, which has existed since 2019. This agreement covers sustainable tourism, national parks, and religious tourism. The signed document aims to strengthen the ties between the regional and local institutions, businesses, civil society organisations, and citizens of both regions. Activities are expected to take place in areas such as environmental protection, climate change adaptation, supporting cooperation between national parks, and promoting tourism, culture, education and university networking (Jeleňová, 2025).

2. Methods

The aim of this paper is to present the results of a research focused on the perception of religious tourism on a sample of respondents of selected institutions in the Prešov region, which are actively involved in the creation of tourism products.

The perception of religious tourism from the point of view of selected institutions and entities involved in the development of tourism within the Prešov Self-Governing Region was surveyed through an original questionnaire survey, which was attended by a total of 277 respondents, including 5 regional tourism organizations (1.80 %), 4 regional tourism organizations (1.44 %), 32 entities of the higher territorial unit (11.55 %), 2 regional development agencies of the Prešov Self-Governing Region (0.72 %), 1 Innovation Partnership Centre (0.36 %), 193 towns/municipalities (69.68 %), 3 religious institutions of the Greek Catholic Church (1,08 %), 5 religious institutions of the Roman Catholic Church (1.80 %), 5 travel agencies (1,80 %), 16 cultural institutions (5.78 %), 1 civic association (0.36 %), 3 non-profit organisations (1.08 %), 4 tourism service enterprises (1.44 %) and 3 unspecified enterprises (1.08 %) active in tourism. The questionnaire survey contained a total of 35 items, but in this paper we present only its main results. Selected items of the questionnaire survey were evaluated through frequency analysis.

To find out the perception of religious tourism, 2 research questions and their associated research hypotheses were set:

RQ 1: Is there a statistically significant correlation between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism in relation to the economic development of the Prešov Self-Governing Region?

H_0: We assume that there is no statistically significant correlation between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism in relation to the economic development of the Prešov Self-Governing Region.

H_1: We assume that there is a statistically significant correlation between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism in relation to the economic development of the Prešov Self-Governing Region.

RQ 2: Is there a statistically significant correlation between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism in relation to the social development of the Prešov Self-Governing Region?

H_0: We assume that there is no statistically significant correlation between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism in relation to the social development of the Prešov Self-Governing Region.

H_1: We assume that there is a statistically significant relationship between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism in relation to the social development of the Prešov Self-Governing Region.

The established research hypotheses were verified at the α = 0.05 level of significance through correlation analysis, specifically through Spearman's correlation coefficient, given a distribution of variables that was not normal. The correlation analysis was performed in the interface of the statistical program R.

3. Results

In this section of the paper, we present the main findings from the questionnaire survey through frequency analysis, which we present in Table 1 below. In the frequency analysis, we present the level of agreement through the number of respondents who expressed their attitude towards selected statements about religious/ pilgrimage tourism within the Prešov Self-Governing Region.

Table 1. Frequency analysis of the level of agreement with the statements about religious/ pilgrimage tourism in the Prešov Self-Governing Region

Claims	Level of agreement (number of respondents)				
	Strongly agree	**Agree**	**Neutral attitude**	**Disagree**	**Strongly disagree**
Thanks to its potential, the Prešov self-governing region has the prerequisites for the development of pilgrimage tourism.	158	85	31	3	0
Pilgrimage tourism contributes to the social development of the Prešov Region.	**125**	106	40	3	3
Pilgrimage tourism contributes to the economic development of the Prešov Region.	**101**	94	68	11	3
Pilgrimage tourism connects the public, religious and private sectors of the Prešov Region.	128	92	45	8	4
I consider the preservation of the spiritual traditions and cultural heritage of the Prešov Self-Governing Region to be very important.	**193**	59	22	2	1
The interest in wandering and pilgrimage tourism within the Prešov Region is minimal among the younger generation.	27	83	**136**	24	7
Pilgrimage tourism should be included in the strategic development plans of the Prešov self-governing region.	94	115	59	7	2
Systematic support for the creation of religious/pilgrimage tourism products by tourism organisations is crucial for the Prešov Self-Governing Region.	67	110	88	10	2
Systematic support for the creation of religious/ pilgrimage tourism products by the Shat is crucial for the Prešov Self-Governing Region.	87	99	78	10	3

Source: own processing (2025)

From Table 1 above, it can be seen that the selected respondents expressed a predominantly agreeing attitude for almost all selected statements about religious/ pilgrimage tourism within the Prešov Self-Governing Region. In particular, the highest level of agreement can be seen in the statement that the preservation of the spiritual traditions and cultural heritage of the Prešov Self-Governing Region is very important, which was marked in agreement by as many as 193 respondents out of a total of 277 (i. e. 69.67 % of the research sample). These results only confirm that respondents consider the preservation of the cultural and spiritual heritage of the destination to be important. After the statement about the importance of preserving the heritage of the destination, the second statement with which the respondents had the second highest level of agreement was the statement that the Prešov Self-Governing Region has sufficient

conditions for the development of pilgrimage tourism, which was agreed by 158 respondents (57.04 % of the research sample). This result thus confirms that the respondents perceive the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism, especially thanks to the many spiritual monuments or sites of pilgrimage tourism that the region has at its disposal. It is also interesting to note that 136 respondents had a neutral attitude when they claimed that the interest in wandering and pilgrimage tourism within the Prešov Self-Governing Region is minimal among the young generation.

In terms of the contribution of pilgrimage tourism to the social and economic development of the Prešov Self-Governing Region, the level of agreement of respondents was also high. 125 respondents (45.13 % of the research sample) strongly agreed with the statement about the contribution of pilgrimage tourism to the social development of the Prešov Self-Governing Region. 101 respondents (36.46 % of the research sample) strongly agreed with the statement about the contribution of pilgrimage tourism to the economic development of the Prešov Self-Governing Region. Considering these results from the frequency analysis (Table 1), it is evident that the respondents perceive the importance and justification of pilgrimage tourism within the Prešov Self-Governing Region, as this form of tourism contributes to the social and economic development of the region. These results were also the basis for the development of research hypotheses, in which we wanted to verify whether there is a statistically significant relationship between the perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism by the respondents with respect to the social and economic development of the Prešov Self-Governing Region. The results of the correlation analysis and verification of the research hypotheses are presented in the following Table 2.

Table 2. Results of verification of research hypotheses through correlation analysis

Correlation analysis parameters	**RQ 1**	**RQ 2**
p-value	0.0000	0.0000
ρs	0.5504	0.7100
The strength of the relationship	medium	strong
Correlation type	direct	direct
Conclusion	The resulting p-value is below the significance level. H_0 rejected. There is a statistically significant relationship between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism with respect to the economic development of the Prešov Self-Governing Region.	The resulting p-value is below the significance level. H_0 rejected. There is a statistically significant association between the respondents' perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism with respect to the social development of the Prešov Self-Governing Region.

Source: own processing (2025)

From the results of the correlation analysis presented in Table 2, it is clear that our assumptions were confirmed and there is a statistically significant relationship between the perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism by the respondents with respect to the economic and social development of the Prešov Self-Governing Region. Both correlations are direct, which means that the perception of the potential for pilgrimage tourism in the Prešov Autonomous Region contributes directly in proportion to the economic and social development of the destination. If we talk about the strength of the relationship, in the case of the perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism by the respondents with respect to the social development of the Prešov Self-Governing Region, the correlation is strong. These results thus confirm that respondents perceive the importance of pilgrimage tourism in the Prešov Self-Govering Region, as this form of tourism is related to the economic and social development of the destination.

4. Discussion

From the results of the survey conducted and the verification of the research hypotheses, we found several significant results. The first significant result is the finding that the preservation of the spiritual

traditions and cultural heritage of the Prešov region is very important from the point of view of our respondents. In particular, this result points to the strong connection of the residents with the regional identity and values. This attitude may be a consequence of the long historical continuity as well as the diversity of cultural expressions that are typical for the region. In the Prešov Self-Governing Region there are many sacral monuments, folklore traditions, linguistic and religious communities, which increases the awareness of the importance of their protection. In the context of regional development, it would therefore be appropriate to focus on creating conditions for preserving and promoting these values through school programmes, community initiatives or grant support from the local government. In addition to the cultural aspect, these traditions also have the potential to strengthen social cohesion, intergenerational dialogue and local pride, as confirmed by the results of the 2020 study (Chien-Pang, 2021).

At the same time, the results of the analysis showed a statistically significant relationship between the perception of the potential of the Prešov Self-Governing Region for the development of pilgrimage tourism and its economic and social development, which is a direct correlation. This means that the higher the respondents rate the potential of pilgrimage tourism in the region, the more they also perceive its positive contribution to the economic and social sphere of the region. The strongest correlation was identified between the perception of pilgrimage tourism and the social development of the Prešov self-governing region, where the correlation reached a strong level. This result confirms that pilgrimage tourism is perceived by the respondents not only as a spiritual activity, but as a complex phenomenon that can increase social cohesion, promote community life, intercultural dialogue and preserve traditional values. From an economic point of view, we can assume that pilgrimage tourism is perceived as a tool for generating income for local entrepreneurs, supporting small and medium-sized businesses, but also creating jobs, especially in marginalised areas where important pilgrimage sites are located. These results also correspond with the research results of some foreign authors (e.g. Choe, 2024; Belucio et al., 2023; Štefko et al., 2015) who argue that religious tourism, especially in developing regions and remote areas, is considered as part of economic diversification strategies. Respondents also implicitly recognise the potential of this form of tourism as one of the long-term and sustainable ways of developing the region.

We are aware of the article´s limitations that should be considered when interpreting the results. The first limitation lies in its focus exclusively on institutional stakeholders active in tourism development within the Prešov Self-Governing Region, thereby excluding the perspective of pilgrims and visitors themselves. Furthermore, the findings are geographically limited to a single region and therefore cannot be generalized to the entire territory of Slovakia. Methodologically, the study relied on a questionnaire survey and correlation analysis, which, while confirming significant relationships between variables, do not allow for the assessment of causality. Another limitation is the temporal scope of the data, which reflect a specific point in time. Finally, the research did not explicitly address environmental aspects of pilgrimage tourism.

From a strategic planning perspective, this result can be an important starting point for the formulation of public policies and development projects that should support places of pilgrimage in the region - for example, through investment in infrastructure, destination marketing, heritage preservation and local community engagement. These findings thus confirm the growing importance of pilgrimage tourism as one of the key factors of development in the Prešov Self-governing Region, and at the same time point to the need for its systematic support and integration into regional development strategies.

Conclusion

The results of this research confirm that pilgrimage tourism is perceived by the respondents as an important factor contributing to the social and economic development of the Prešov Self-Governing Region. The statistically significant direct correlations between the perception of its potential and various aspects of development point to its complex nature, which goes beyond spiritual travel and extends into the broader context of regional development. The particularly strong link between pilgrimage tourism and social development signals its potential to strengthen community ties, preserve cultural heritage and promote social cohesion. The economic dimension is reflected in particular in the potential development of marginalised areas, support for local entrepreneurs and the creation of new jobs, given that religious tourism can be seen as a tool for economic diversification in peripheral regions.

Based on the above findings, it can be concluded that pilgrimage tourism represents one of the sustainable pillars of the region's development. However, its effective use requires purposeful planning, investment in infrastructure and systematic support from both the public and private sectors. In this respect, it is particularly important to develop cooperation between the public and private sectors in the

development of religious/ pilgrimage tourism products. Effective cooperation between these sectors should be based on partnership, mutual communication and a shared vision for the development of the region. The promotion of pilgrimage tourism can thus act as a platform for linking the interests of different actors - local government, religious institutions, businesses and local communities. This model of cooperation has the potential to increase the attractiveness of the region, diversify the economy and at the same time protect its spiritual and cultural value, which is closely linked to sustainable tourism development. Religious and pilgrimage tourism in particular appears to be a form of tourism that can be developed sustainably and in the long term in the future within the Prešov Self-Governing Region. Pilgrimage tourism is characterised by low seasonality, strong links to local communities, respect for nature and cultural values, and these attributes make it a suitable tool for the sustainable development of rural and less developed areas. As well as strengthening regional identity and preserving traditional values, it also provides space for the development of infrastructure, business and local employment.

It follows that pilgrimage tourism should be integrated into the strategic documents and development policies of the Prešov Self-Governing Region, given that it can be developed in the future in a long-term and sustainable manner. At the same time, the results of our research can serve as an impetus for further multidisciplinary research of this phenomenon in the context of regional development.

Based on the findings, we recommend several directions for future research. First, the analysis should be extended to include the perceptions of pilgrims, especially in terms of their motivations, satisfaction, and experiences. Comparative research across regions or countries could uncover specific characteristics and transferable models of pilgrimage tourism development. Longitudinal studies would be valuable to monitor the long-term socio-economic impacts of pilgrimage tourism. Future research should also address environmental issues and the possibilities for sustainable development of pilgrimage sites. Complementing quantitative methods with qualitative approaches could provide a deeper understanding of stakeholder attitudes. In light of increasing digitalization in tourism, future studies could also explore the role of online promotion of pilgrimage sites and virtual pilgrimage experiences.

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7. Green Economy and Sustainable Entrepreneurship

Challenges of Adopting Circular Economy Business Models in Sri Lankan Manufacturing Companies

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Abstract

Research background: The Circular Economy (CE) presents a transformative approach to sustainable development, emphasizing resource efficiency, waste reduction, and closed-loop systems. While global momentum for CE is rising, the transition to Circular Economy Business Models (CEBMs) remains particularly challenging for firms in developing countries. In Sri Lanka, manufacturing companies—critical to the nation's economic output—struggle to integrate CE principles despite increasing sustainability discourse.
Purpose of the article: This study aims to explore the challenges associated with adopting CEBMs in Sri Lankan manufacturing companies, with a specific focus on how management control systems (MCS), viewed through Simons' control framework, influence this process.
Methods: A qualitative research design was employed. The population included all manufacturing companies listed on the Colombo Stock Exchange (CSE), and a purposive sample was selected based on public disclosures related to sustainability. Data gathered through semi-structured interviews with key organizational representatives were analyzed thematically.
Findings & Value added: The findings identify several internal and external challenges: lack of standardized internal systems for CE integration, limited stakeholder engagement, and difficulties in communicating complex CEBM structures. Externally, regulatory pressure, investor expectations, cultural values, and international sustainability standards elevate CE awareness. However, technological limitations, leadership inconsistency, and financial constraints significantly impede adoption. This article adds value by demonstrating how Simons' MCS framework can diagnose key organizational control deficiencies limiting CEBM adoption. It offers practical and theoretical insights for managers and policymakers aiming to foster CE transitions in developing economies. By aligning internal control systems with CE imperatives, firms can better respond to external pressures and sustainability goals.

Keywords: Circular Economy, Management Controls, Manufacturing, Challenges

JEL classification: Q54, Q56, M4

1. Introduction

The transition to sustainable and circular business practices has become a critical priority for many industries, including manufacturing. However, adopting Circular Economy Business Models (CEBMs) faces numerous internal and external barriers. Despite growing research on these challenges, significant gaps remain in our understanding.

One gap is the lack of a precise categorization of internal barriers at different organizational levels (micro, meso, macro) (Urbinati, Chiaroni & Chiesa, 2017). Without this distinction, it is difficult to see how barriers at each level differentially affect operations. Additionally, financial and policy barriers are often acknowledged (Diaz, Reyes & Baumgartner, 2022), but their specific influence on business priorities and strategies has not been deeply explored.

Technological expertise and resource constraints are frequently cited as obstacles, yet their exact contributions to successful CEBM adoption remain underexplored. Collaborative barriers, such as firms' reluctance to share information, also complicate implementation (Bocken, 2023). Furthermore, the quality

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of products under circular models is sometimes questioned; it is not well understood why products from CEBMs are perceived as inferior to those from linear models (Pietrulla, 2022).

Prior studies have identified external barriers such as consumer resistance caused by low awareness (Hina et al., 2022), weak legislation and regulation (Kazançoğlu et al. 2023), and complex supply chain issues (Lieder & Rashid, 2016). However, the mechanisms by which these barriers emerge and strategies to overcome them remain under-researched. The effects of social, cultural, and environmental factors, as well as government policy, on CEBM adoption also need further investigation (Lieder & Rashid, 2016).

Moreover, limited attention has been given to these challenges in developing-country contexts (Nwobodo, 2024; Weerakoon & Thayaparan, 2023). In particular, there is little research on CEBM adoption in Sri Lanka's manufacturing sector. This study aims to fill these gaps by providing a comprehensive analysis of both internal and external barriers to CEBM adoption. It focuses on categorizing internal challenges at multiple organizational levels and examining how financial, technological, and collaborative factors specifically impact business performance in Sri Lankan firms. Hence, this study seeks to understand why it is challenging for manufacturing companies in Sri Lanka to adopt circular economy business models (CEBMs). Specifically, it aims to explore the challenges related to the adoption of CEBMs in Sri Lankan manufacturing companies, with particular attention to the role of management control systems (MCS).

2. Literature Review

In China, researchers have identified persistent barriers to CE adoption. Su et al. (2013) highlighted that Chinese SMEs face a lack of economic incentives, misapplication of environmental taxes, and high initial capital costs for cleaner production. Geng and Doberstein (2008) similarly found obstacles in technology development, public participation, and policy frameworks. Wang et al. (2020) noted that ineffective use of financial instruments and weak environmental legislation further hinder CE practices. Xue et al. (2010) found that only 16.7% of Chinese officials were familiar with CE concepts, indicating a critical policy-level knowledge gap.

Other studies emphasize sector-specific and innovation challenges. Singhal, Tripathy and Jena (2020) identified significant internal difficulties in deploying remanufacturing within China's automotive industry. Ritzén and Sandström (2017) outlined five broad innovation-management challenge categories for CE transition, stressing the need for cross-sector integration and diverse stakeholder perspectives. Kumarasinghe and Sylva (2024) described increasingly strict environmental laws as "green challenges" to developing nations' trade, requiring costly technical overhauls (Geissdoerfer et al., 2017).

In other emerging economies, findings are consistent. Agyemang et al. (2019) found that in Pakistan's automotive sector, profitability, cost reduction, and environmental concern drive CE adoption, while lack of knowledge, limited resources, and insufficient expertise are the main barriers. Dwivedi et al. (2022) reported that in Bangladesh's leather industry, a clear understanding of CE principles is crucial for successful implementation. Soh and Wong (2021) linked CE adoption to Industry 4.0 in Brazil and identified poor communication between public and private sectors, inefficient policies, and insufficient investment in remanufacturing as significant obstacles.

Indian studies also highlight multiple barriers. Govindan and Hasanagic (2018) identified 39 CE implementation challenges, categorizing them into governmental, economic, technological, knowledge and skills, management, cultural and social, and market factors. Sehnem et al. (2019) similarly identified 30 barriers to sustainable production and consumption in supply chains using a fuzzy analytic hierarchy process. Mittal and Sangwan (2014), however, emphasized that India's reliance on nonrenewable energy and waste disposal is a significant sustainability challenge, and noted that previous research had not pinpointed specific CEBM adoption barriers in manufacturing.

Given these gaps, the present study focuses on Sri Lankan manufacturing firms to identify significant CEBM adoption challenges in a developing-economy context. By building on the existing literature, this research seeks to understand how these global findings manifest locally and to uncover any unique factors in Sri Lanka.

3. Methods

This study employed a qualitative design, using in-depth semi-structured interviews to explore CEBM adoption challenges. Six interviews were conducted with heads of sustainability functions in Sri Lankan manufacturing companies. Participants were purposively sampled to include firms with high, medium, and low levels of CEBM adoption (Benson & Monciardini, 2018). This purposive sampling

ensured that respondents had relevant expertise in both CE initiatives and management control. Interviews lasted between 45 and 80 minutes, were recorded and transcribed, and focused on topics derived from the research objectives.

An interview guide was developed based on the conceptual framework of (Luciano et al., 2024) and on preliminary quantitative results. The guide was pilot-tested internally with experts and refined following feedback (Chauhan, Parida & Dhir, 2022). It covered key topics such as business model elements (resources, cost structure, revenue streams, stakeholder engagement, and management control factors, while allowing flexibility for probing. Before each interview, the finalized guide was shared with the respondent so they could prepare.

Data were analyzed using thematic analysis (Hermann et al., 2022). The researcher first familiarized herself with the data by reviewing transcripts multiple times. Initial coding was then performed to identify meaningful units; similar codes were clustered iteratively to form themes and sub-themes aligned with the theoretical framework. This iterative process yielded six main themes and seven sub-themes reflecting the challenges of CEBM adoption among these firms.

To ensure rigor, the study addressed credibility, transferability, dependability, and confirmability (Supanut, Maisak & Ratchatakulpat, 2024). Credibility was enhanced through triangulation (comparing interview data with company reports and quantitative findings) and member checks (participants reviewed interpretations for accuracy). Transferability was supported by providing rich contextual details (company profiles, interview procedures) for comparison in future research. Dependability was established via an audit trail and peer debriefing; the research process and findings were discussed with the supervisor to uncover any bias (Supanut et al., 2024). Confirmability was maintained by documenting decisions in reflexive notes and using triangulation of multiple data sources. Together, these steps ensured that the findings were well-supported and reflective of the participants' perspectives.

4. Results and Discussion

The analysis revealed several interrelated barriers to CEBM adoption in Sri Lankan manufacturing. The most salient finding was the absence of a standardized CE integration process. Five of the six companies acknowledged that, despite recognizing the need for sustainability, no clear internal system exists to guide CE adoption. One sustainability manager noted:

"Our management realized a need to integrate CE and sustainability-related activities into the core business. It is the only option to survive in the current context. However, no clear process has been developed to achieve that in the organization so far." (Manager 4)

Similarly, others commented on this gap:

"CE is not only about the environment or social pillars; it is a holistic approach towards ensuring long-term operation. But the steps taken by top management are not clear." (Manager 5)

"We have very diverse socio-economic and environmental priorities to manage… We are not clear on how to link them with the core business." (Manager 2)

These quotes illustrate that managers feel a social contract to address stakeholder concerns (Ortiz-de-Montellano, Samani & van der Meer, 2023) but lack guidance on implementation. According to Stakeholder Theory, firms seek legitimacy by meeting stakeholder needs (Casalegno et al., 2020; Tapaninaho & Heikkinen, 2022), and CEBMs can enhance value for multiple stakeholders. However, the interviews show that stakeholder engagement is still weak. For example, one manager reflected:

"In our internal and external context… the level of engagement we have developed is not satisfactory. To build better engagement. We must be sustainable in every aspect, including the product and production." (Manager 2)

Another manager added:

"As a corporate entity, we create wealth. It is challenging to distribute the wealth we create appropriately among all our stakeholders." (Manager 4)

A third noted:

"The challenge is the practicality of day-to-day interactions with our stakeholders (shareholders, customers, partners, employees, and society). If we could maintain proper interactions, we could identify all these people… and understand what expectations they have." (Manager 5)

These remarks suggest that companies recognize the importance of addressing stakeholder expectations but struggle to operationalize this broad view. It appears firms often prioritize traditional shareholder interests, consistent with the managerial perspective of stakeholder theory (Gallardo-Vázquez,

Herrador-Alcaide & Matin, 2024). In practice, the complexity of a CEBM makes communication difficult. As one interviewee explained:

"CEBM is very complicated. So we face difficulties in addressing all stakeholders' needs. Comprehending our stakeholders is difficult." (Manager 6)

Another added:

"When you adopt CEBM, matching it to the organizational structure is difficult, and it also makes it difficult for people to understand." (Manager 1)

These comments indicate that the multifaceted language of CE ("goals, targets, processes") complicates aligning the model with existing structures and demonstrating credibility (Bocken et al., 2016). In short, companies have not yet figured out how to communicate and execute CEBMs in a way that satisfies diverse stakeholders.

While internal systems were lacking, external pressures were strong drivers. Most interviewees reported that regulators, industry groups, and investors are increasingly demanding CE-related action. For instance:

"Regulators like the International Organization for Standardization (ISO) are vigilant about social and environmental aspects. They have a separate sustainable roadmap… working on how manufacturing companies can achieve CE." (Manager 5)

"Especially for an export brand, maintaining or increasing brand equity depends on the sustainability policies and regulations practiced in the target markets." (Manager 4)

"We realized early on that investor interest in sustainability was increasing. We realized that investors are not likely to invest in a company without proper governance structures on sustainability." (Manager 2)

"Now there is pressure from investors regarding our CE performance… that has affected us so much, and we have been doing (CE) for years." (Manager 1)

These excerpts show the normative pressures: international standards (ISO, UN goals) and investor demands heighten the urgency to integrate CE. Cultural factors amplify this effect; Sri Lanka's collectivist culture, which values societal welfare (Jenei et al., 2024; Weerasinghe, Gunarathne & Samudrage, 2025; Wijewansha et al., 2021), likely contributes to stakeholder expectations for corporate sustainability. Together, these findings align with Institutional Theory (Arranz & Arroyabe, 2023). Four of the six companies were members of the UN Global Compact (UNGC), and managers emphasized how this affiliation created top-level awareness of CE:

"There was a huge impact from the UNGC to adopt UN-related sustainability targets and initiatives like CE practices. UNGC created top-level awareness to adopt and rethink our actions according to the SDGs… especially for top management, UNGC was influential." (Manager 4)

"We adopted CEBMs when they were introduced in 2015. We have been part of this whole global movement (via UNGC) since 2002." (Manager 2)

These accounts suggest that organizational membership in international initiatives instills the global CE agenda. Interviewees also noted mimetic pressures: seeing peer firms' sustainability initiatives "challenged" them to act:

"Peer organizations challenged us. After seeing others' initiatives, our management believes we can approach CE as a large conglomerate. We benchmark with foreign principals on how they have been doing CE-related projects." (Manager 6)

"We benchmark both international and national organizations for new initiatives. So both aspects are important." (Manager 4)

"By having a culture within our company, we are influencing a culture in other industries. Basically, we are paving the way for them to adopt it as well." (Manager 2)

These examples of isomorphism (Arranz & Arroyabe, 2023) show that firms imitate peers and industry norms to maintain legitimacy (D'Amato & Korhonen, 2021). One manager even took pride in leading CE adoption to influence others. Overall, institutional forces (normative and mimetic) strongly encouraged CE, but companies still faced internal challenges in responding effectively.

Organizational culture and leadership also played roles. Only one manager (Manager 3) cited personal or ethical motivation as a driver, noting that her company's founder had embedded sustainability values. She admitted, however, that not all firms shared this ethos:

"Our company values are weakly rooted in sustainability… starting from the motto itself (sustainability is) a major driver. So we are not self-driven." (Manager 3)

"They (our leaders) believe sustaining the business is enough; sharing (with society) is not something you see. It will be difficult to exist in Sri Lanka for a company like that." (Manager 3)

These comments highlight that leadership and corporate values influence CE adoption. Consistent with case studies (Schöggl, Stumpf & Baumgartner, 2020), lacking leadership commitment or a pro-sustainability culture makes integration difficult. Several interviewees confirmed the importance of management support:

"Leadership is the key to doing everything. When it comes to CE, they (the top managers) are very keen and are driving it." (Manager 4)

"The top management drives CE-related matters. For our companies, the leadership comes from the top." (Manager 2)

Conversely, one manager lamented:

"Our top management has not been providing unbroken guidance, and we have constantly been seeking opportunities and encouragement to look beyond what we have been doing." (Manager 6)

These statements imply that inconsistent management practices and a lack of alignment across departments hinder the effective implementation of circular economy initiatives.

Table 1. Summary of data

Factor	Key Insights	Manager(s)	Theoretical Implications
Internal Systems	- Lack of standardized CE integration process across firms. - No clear internal systems to guide CE adoption.	Manager 4, Manager 5	- **Stakeholder Theory**: Companies recognize the need to meet stakeholder needs but lack a straightforward implementation process.
Stakeholder Engagement	- Engagement with stakeholders is weak and difficult to operationalize. - Companies often prioritize traditional shareholder interests.	Manager 2, Manager 4, Manager 5	- **Stakeholder Theory**: Weak stakeholder engagement complicates CEBM adoption despite its broad value for stakeholders.
Communication of CEBMs	- CEBM complexity makes it challenging to align with existing structures. - Difficulty in demonstrating credibility and comprehending stakeholders' needs.	Manager 6, Manager 1	- **Institutional Theory**: The Complexity of CE makes communication difficult, impacting legitimacy.
External Pressures	- Strong pressures from regulators, investors, and industry groups to adopt CE. - International standards and UNGC membership raise awareness.	Manager 5, Manager 4, Manager 2	- **Institutional Theory**: Normative pressures (regulations, standards, and investors) strongly encourage CE adoption. - **Isomorphism**: Peer influence motivates companies to act.
Cultural Factors	- Sri Lanka's collectivist culture emphasizes societal welfare, influencing stakeholder expectations for sustainability.	Manager 2, Manager 4	- **Cultural Factors**: Collectivist culture drives companies to act in accordance with societal expectations.
Leadership and Organizational Culture	- Leadership is key to CE adoption; lack of commitment or inconsistent guidance stalls progress. - A pro-sustainability culture is crucial for CE integration.	Manager 3, Manager 4, Manager 2, Manager 6	- **Leadership and Culture**: Management's support and commitment play a crucial role in successful CE adoption.
Technological Constraints	- Adoption of CE frameworks (e.g., SDGs) depends heavily on advanced technology and infrastructure. - Lack of technical capacity limits progress.	Manager 4, Manager 2	- **Technology**: Insufficient technical infrastructure hinders CE integration.
Financial Constraints	- Initial cost and uncertain ROI hinder large sustainability projects. - Financial pressures and lack of resources are significant barriers.	Manager 1, Manager 6	- **Financial Constraints**: Upfront investment and uncertain financial returns are key barriers to CE adoption.
Overall Findings	- Strong external pressures, but internal barriers (e.g., lack of systems, leadership, culture, technology, financial resources) limit CE adoption.	All Managers	- **Institutional, Managerial, Financial, and Technological Factors**: CEBM adoption is primarily hindered by internal factors rather than external regulations alone.

Source: own processing (2025)

Conclusion

This study underscores that the most significant challenge to adopting and integrating Circular Economy Business Models (CEBMs) lies at the business ecosystem level, where stakeholder expectations and legitimacy pressures are pivotal. In particular, the involvement of companies with global initiatives such as the United Nations Global Compact (UNGC) exerts considerable pressure for CEBM adoption. At the business level, internal factors—such as company values, management philosophy, and organizational culture—play a vital role in shaping CE integration.

Financial and technological constraints were also identified as significant barriers, particularly in terms of short-term financial trade-offs, the complexity of creating differentiation, and the efforts required to build brand equity around CE principles. Despite these challenges, the findings of this study provide a foundation for various stakeholders—including corporate managers, policymakers, accounting professionals, and academics—to evaluate and enhance the corporate contribution to CE.

Given the current low levels of CEBM adoption, corporate managers are encouraged to revisit and realign their business strategies to embed CE more deeply. A more substantial commitment at the corporate level could unlock economic benefits and long-term competitive advantages. Professional accounting bodies can play a pivotal role in promoting corporate engagement with CE by embedding sustainability-oriented practices into accounting standards and guidelines. Simultaneously, policymakers should consider developing a national-level corporate agenda to institutionalize CE practices and motivate broader industry participation. Moreover, academic institutions are urged to incorporate CE principles into curricula to cultivate awareness and foster a sustainability-oriented mindset among future professionals. As revealed in the qualitative inquiry, awareness and team cohesion are essential for advancing sustainability objectives within organizations.

For academics and researchers, this study contributes to the growing body of knowledge on CE and provides a basis for further research. However, the study has several limitations. It focused exclusively on listed companies adhering to sustainability reporting standards, excluding the contributions of unlisted companies and those not reporting under frameworks such as GRI. This may have led to an incomplete representation of the broader CE landscape. Furthermore, the use of CEBM phases as a proxy for adoption levels, along with the reliance on a limited set of management control systems (MCS) indicators, presents potential measurement biases. The qualitative insights, while rich and context-specific, may not be generalizable due to the inherent limitations of semi-structured interviews.

Future research should broaden the scope to include non-GRI-reporting manufacturing companies and explore more comprehensive MCS constructs, such as the management control package proposed by Malmi and Brown (2013). In addition, adopting alternative theoretical lenses—such as Fashion Theory—may offer nuanced perspectives on how MCS and CEBM interrelate. Further investigation into the attitudes and decision-making processes around MCS integration, as well as a deeper examination of the factors influencing the prioritization of adoption challenges, would significantly enhance understanding in this area.

Ultimately, a collaborative, multi-stakeholder approach will be essential to overcoming the barriers and fully realizing the potential of Circular Economy Business Models in practice.

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When Values Meet Knowledge: Mediating and Moderating Effects of University-Sourced Knowledge on Sustainability Performance

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Abstract

Research background: Organizational sustainability efforts increasingly rely on both leaders' competencies and external knowledge. Yet research often treats these separately, viewing competence and university-sourced knowledge as distinct predictors of sustainability. Less explored is how these factors interact, specifically, whether university knowledge not only mediates the impact of leaders' competencies but also moderates their strength.
Purpose of the article: This study examines how university-sourced knowledge both mediates and moderates the relationship between leaders' action-normative competencies and sustainable performance.
Methods: The study employed Partial Least Squares Structural Equation Modeling (PLS-SEM). Data were collected from 600 organizations across the V4 countries. Bootstrapping (5,000 samples) was applied to estimate path significance.
Findings & Value added: The study reveals that university-sourced knowledge plays a dual role in shaping sustainable performance. It functions as a partial mediator between leaders' Competencies (normative and action) and sustainability performance, as evidenced by significant path coefficients from competence to knowledge ($\beta = 0.463$, $t = 5.123$, $p < 0.001$) and from knowledge to performance ($\beta = 0.115$, $t = 3.334$, $p = 0.001$). It also acts as a moderator, amplifying the competence–performance link (interaction term: $\beta = 0.151$, $t = 4.069$, $p < 0.001$; $f^2 = 0.130$). Specifically, university knowledge has a greater impact in firms with lower internal competence, while highly competent firms rely less on external input. These findings extend existing research by integrating knowledge management and competence-based perspectives, enriching sustainability competency theory and leadership models through a competence-dependent knowledge sourcing lens.

Keywords: Normative competence, Action competece, University-sourced knowledge, Sustainable performance

JEL classification: M14, O32, I23

1. Introduction

Given limited resources, small and medium-sized enterprises (SMEs) face growing challenges in implementing sustainability principles. Addressing these challenges requires effective knowledge management that systematically identifies, acquires, and applies relevant knowledge (Chen et al., 2024; Kumar et al., 2025; Sedlák et al., 2025).

Universities, with their expertise, research infrastructure, and access to advanced technologies, are well-positioned to enhance SMEs' sustainability capacity (Forés et al., 2023; González-Ramos et al., 2023; Szczepanska-Woszczyna et al., 2024; Xu et al., 2024), providing innovation impulses that drive sustainable solutions (Bäumle et al., 2023; Umar et al., 2025).

The impact of such collaboration depends on SME leaders' ability to align strategic decisions with sustainability values (normative competencies) and convert them into concrete actions (action competencies) (Bansal et al., 2023; Laasch et al., 2023). Yet, most studies examine external knowledge separately from leadership competencies (Edeh et al., 2024; Hakeem et al., 2025) or focus on specific

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leadership types (Alqatan et al., 2025; Pett et al., 2025; Umar et al., 2025; Van et al., 2025), neglecting their interaction and potential interdependence.

It therefore remains unclear whether external knowledge, particularly from universities, can both mediate and amplify (moderate) the influence of managerial competencies on sustainable performance. Addressing this gap is essential for understanding how SMEs can meet escalating sustainability demands effectively (Chen & Zhang, 2024; Kumar et al., 2025; Razminiene et al., 2024).

This study examines how university-sourced knowledge both mediates and moderates the relationship between leaders' competencies (normative and action) and sustainable performance. The study thus develops sustainability competency theory by integrating the concept of university knowledge as a dual-role factor in the context of managerial competencies and sustainable performance. It combines knowledge management and competency-based views, taking into account the dynamic interaction between competencies and knowledge.

From a practical perspective, in the context of the V4 countries, where connections between universities and businesses are often not systematically developed, understanding these interactions can inform more effective policies for supporting knowledge transfer and strengthening SMEs' innovation capacity. It can also provide businesses with a framework for more targeted competency development and for optimizing cooperation with academia, ensuring that investments in sustainability translate into measurable environmental, economic, and social outcomes.

The first part of the study presents a theoretical framework in which key concepts are defined and the links between normative and action competencies of leaders, university knowledge, and sustainability performance are explained. The second part describes the data collection and the measurement method, and the verification of the variables' reliability and validity, as well as the specification and adjustments of the measurement and structural model used in the PLS-SEM analysis. The third part presents the results of the PLS-SEM analysis and interprets the theoretical and practical implications of the findings. The fourth part summarizes the main findings and offers recommendations for future research.

2. Theoretical background

Competencies can be defined as the knowledge, skills, and attitudes that enable managers to successfully perform tasks, solve problems, and respond effectively to real-world challenges (Barth et al., 2007; Mulder, 2014). They include the ability to apply acquired knowledge in a specific context, adapt to changes, and purposefully achieve set goals (Ploum et al., 2017; Soare, 2015). In the area of sustainability, they enable managers to take effective steps towards long-term environmental, economic, and social goals, in particular by minimizing environmental impact (Coelho et al., 2024; Ibidunni et al., 2025), maintaining long-term value (Forés et al., 2024; Rubio-Andrés et al., 2025), and improving the quality of life and strengthening social justice and community relations (Aksu et al., 2023; Azapagic et al., 2000; Benn et al., 2014).

Consequently, in the context of sustainability competency theory, normative competencies represent the manager's ability to identify, evaluate and align sustainability values, principles and objectives with the perspectives of various stakeholders, and action competencies refer to the ability to actively and responsibly engage in initiatives and measures that lead to improved sustainability, combining motivation with the practical implementation of concrete steps (Knight et al., 2018; Laasch et al., 2023; Moratis et al., 2022; Wiek et al., 2011). Together, they create a synergy in which normative competencies provide value and ethical direction, while action competencies ensure their transformation into concrete and practical actions that enable organizations to effectively implement sustainability principles and achieve measurable improvements in environmental, economic, and social indicators: **H1:** Competencies (normative and action) → Sustainable performance.

From a knowledge management perspective, knowledge is a strategic resource and a critical driver of performance when it is effectively acquired, shared, and applied (Ferreira et al., 2016; Grant, 1996; Nonaka, 2009). Managers with strong normative competence are more likely to deepen their knowledge of sustainability as a value-based concept, while those with strong action competence are better able to translate knowledge into concrete solutions (Belas et al., 2018; Durst et al., 2012; Pett et al., 2025; Rozsa et al., 2022). University knowledge can thus act as a mediator that increases the effectiveness of both types of competences. Thanks to a more profound and scientifically based understanding of sustainability issues, managers can design and implement initiatives that lead to measurable improvements in environmental, economic, and social indicators: **H2:** Competencies (normative and action) → University knowledge → Sustainable performance.

Finally, the competency-based perspective (Prahalad et al., 2009; Sanchez et al., 1997; Soare, 2015) emphasizes that organizational performance depends not only on resources (such as knowledge) but also on the capabilities to integrate, deploy, and renew them in dynamic contexts. In this view, competencies represent strategic capabilities, but their impact is contingent on complementary resources (Ativetin et al., 2025; Masek et al., 2024; Psurny et al., 2024). University knowledge can therefore also act as a moderator, strengthening the relationship between competencies and sustainable performance. While normative and action competencies provide motivation, ethical direction, and the ability to act, without sufficient domain-specific knowledge, individuals may mis-set priorities, underestimate the complexity of the system, or implement less effective solutions. Therefore, a higher level of university knowledge increases the effectiveness of competencies and leads to a stronger positive impact on sustainability performance. Conversely, with low availability of university knowledge, even managers with high levels of normative and action competencies may be significantly limited in achieving measurable improvement: **H3:** University knowledge × Competencies (normative and action) → Sustainable performance.

3. Methods

Data were collected in 2024 in the V4 countries (Czech Republic, Slovakia, Poland, Hungary) using the Computer-Assisted Web Interviewing (CAWI) method by the MNFORCE research agency, which handled questionnaire distribution and quality control. The required sample size was determined ex-ante with G*Power 3.1 for multiple regression with three predictors (including an interaction), assuming a medium effect size ($f^2 = 0.10$), $\alpha = 0.05$, and power $(1–\beta) = 0.95$, resulting in a minimum of 119 respondents (Faul et al., 2007). The final sample comprised 600 SMEs.

Micro-enterprises (1–9 employees) represented 43% of the sample, followed by small (10–49; 29%) and medium-sized enterprises (50–249; 28%). The largest sectoral group operated in manufacturing and industry, followed by trade/retail and IT/technology, with additional representation from healthcare, education, services, energy, and tourism. Limited liability companies comprised nearly half of the respondents, sole proprietors over one-third, and the rest were joint-stock or other legal forms. Most firms had operated for more than 10 years, followed by those with 3–10 years in business, and a minority with less than 3 years of operation.

The questionnaire targeted SME representatives in decision-making or management roles, with respondents split almost evenly between owners/co-owners (48.50%) and managers (51.50%), ensuring strategic insight into organizational operations. Most had secondary education with a high school diploma (35.83%) or a 2nd-level university degree (30.83%), followed by 1st-level university graduates (19.67%) and those with a higher academic degree (7.00%). Only 5.50% had secondary education without a diploma and 1.17% had primary education, indicating a relatively high educational level.

The largest age groups were those born in 1981–1996 (44.83%) and 1965–1980 (38.50%), followed by 1946–1964 (9.00%) and after 1997 (7.00%); respondents born before 1945 were minimal. Men comprised 56.50% of the sample, women 42.33%, while 0.50% identified differently and 0.67% declined to answer.

Normative competence (MCFN01_04_A–C) and Action competence (MFAC01_05_A–D) were measured using the Competence Framework for Sustainable Entrepreneurship questionnaire (Ploum et al., 2017). Principal component analysis (PCA) of the eight items, initially expected to load on two factors, yielded a single factor explaining 67.65% of the variance, indicating a strong interconnection between competencies. This unified construct (8 items) showed high internal consistency (Cronbach's $\alpha = 0.931$) and acceptable multicollinearity (VIF = 2.213–3.144), justifying further analysis using a single-factor model.

Sustainable performance (Aksu & Akman, 2023) comprised Environmental (SPEE01_07_A-G), Economic (SPEC01_05_A-E), and Social (SPES_01_04_A-D) performance items. Based on empirical evidence, we tested it as a one-dimensional construct. Factor analysis of 31 eco-innovation–related items yielded a single factor explaining 51.73% of the variance, with excellent sampling adequacy (KMO = 0.963) and significant Bartlett's test ($\chi^2(378) = 7097.037$, $p < 0.001$). All items loaded strongly (≈0.55–0.77), internal consistency was high (Cronbach's $\alpha = 0.942$), and VIF values (1.814–4.740) indicated acceptable to moderate multicollinearity. These results support using a reliable one-factor model for further analysis.

University knowledge (EIKS01_05_A) as a source of eco-innovation information was measured with a single item: "When implementing eco-innovations in our company, information, insights, and knowledge resources from universities and research organizations are important to us."

All responses were recorded on a 5-point Likert scale (1 = totally agree, 5 = totally disagree), enabling a direct assessment of the perceived importance of academic and research institutions in eco-innovation processes.

The original measurement model demonstrated excellent internal consistency (Cronbach's $\alpha = 0.932$ and 0.942; composite reliability > 0.94) but exhibited moderate multicollinearity, with several indicators exceeding the recommended Variance Inflation Factor (VIF) threshold of 3. Notably, the highest VIF reached 4.740 for SPEC01_05_A, suggesting potential redundancy among items within specific constructs.

To test the proposed model, we used Partial Least Squares Structural Equation Modeling (PLS-SEM), suitable for prediction-oriented research with complex relationships, including interactions and mediations, as well as for relatively small samples and without strict normality assumptions (Hair, 2014). First, we assessed the measurement model (reliability, convergent, and discriminant validity), followed by the structural model, focusing on explained variance (R^2), effect sizes (f^2), the significance of structural paths via bootstrapping (5,000 resamples), moderation of the interaction effect, and predictive power (Q^2_predict). This multi-level approach provides a comprehensive and robust evaluation of the hypotheses and the model's practical applicability.

To improve model parsimony and reduce multicollinearity, all items with VIF values above three were excluded, resulting in a reduced measurement model (Table 1). This re-specification produced the following improvements: 1. Multicollinearity reduction: Maximum VIF decreased from 4.740 to 2.878, falling well within the conservative threshold of <3. 2. Reliability and validity maintained: Internal consistency remained excellent: Cronbach's $\alpha = 0.920$ and 0.908; composite reliability > 0.92 for both constructs. Average variance extracted (AVE) remained above the 0.50 threshold (0.675 and 0.523), preserving convergent validity. HTMT ratios for all construct pairs remained well below the 0.90 threshold, confirming discriminant validity. 3. Structural model integrity: R^2 values, path coefficients, and effect sizes (f^2) were highly consistent with the original model. All hypothesised paths remained statistically significant ($p < 0.01$), with negligible changes in magnitude. Predictive relevance (Q^2predict) remained positive for all indicators, confirming that predictive capability was not compromised. 4. Model parsimony: The reduced model retains theoretical coverage while eliminating redundant measurement items, producing a more efficient and interpretable instrument.

Analyses were performed in SPSS 29 and SmartPLS 4.

Table 1. Individual items descriptive statistics

Item	Mean		Skewness		Kurtosis	
	Statistic	Std. Deviation	Statistic	Std. Error	Statistic	Std. Error
MCFAC01_05_A I know how to explain the decisions a company has made concerning sustainability	1,910	0,843	1,037	0,100	1,504	0,199
MCFAC01_05_B I challenge not sustainable ways of working in a company	2,050	0,951	0,920	0,100	0,791	0,199
MCFAC01_05_C 20. I know how social, environmental, or societal challenges can be turned into opportunities for an company	2,080	0,877	0,644	0,100	0,269	0,199
MCFAC01_05_E 21. I am able to motivate higher management in a company to invest in sustainability	2,120	0,997	0,864	0,100	0,485	0,199
MCFN01_04_A I am willing to take the initiative to improve my activities based on standards, values, goals and sustainability principles	1,950	0,900	0,970	0,100	0,997	0,199
MCFN01_04_B I know what is seen as "good sustainable practice" in my field	2,010	0,887	0,921	0,100	1,017	0,199
MCFN01_04_C I am able to apply norms, values, targets, and principles of sustainability to my own practice	2,000	0,903	1,073	0,100	1,472	0,199
SPEC01_05_E By introducing eco-innovations in our company, we have gained a competitive advantage	2,250	1,029	0,558	0,132	-0,360	0,263
SPEE01_07_A By introducing eco-innovations in our company, we record positive development of environmental sustainability awareness	1,790	0,710	0,518	0,132	-0,186	0,263
SPEE01_07_B The introduction of eco-innovations in our company has a decline in accidents that pollute the environment	1,950	0,867	0,752	0,132	0,264	0,263
SPEE01_07_C By introducing eco-innovations in our company, material consumption has been reduced	1,850	0,839	1,087	0,132	1,421	0,263
SPEE01_07_D By introducing eco-innovations in our company, energy consumption has been reduced	1,880	0,841	0,940	0,132	0,852	0,263
SPEE01_07_E By introducing eco-innovations in our company, water consumption has been reduced	2,100	0,974	0,678	0,132	-0,066	0,263

SPEE01_07_F The introduction of eco-innovations in our company has reduced emissions of liquid, gaseous, solid pollutants or waste products	2,040	0,934	0,844	0,132	0,550	0,263
SPEE01_07_G By introducing eco-innovations in our company, the use of harmful chemicals has been reduced	2,010	0,955	0,859	0,132	0,428	0,263
SPES01_04_B The introduction of eco-innovations in our company has improved the company image	1,900	0,862	1,030	0,132	1,494	0,263
SPES01_04_C By introducing eco-innovations in our company, employees' satisfaction with work has increased	2,070	0,951	0,819	0,132	0,569	0,263
SPES01_04_D The introduction of eco-innovations in our company has improved awareness and protection of people's rights in the community	2,070	0,926	0,788	0,132	0,697	0,263
EIKS01_05_A When introducing eco-innovations in our company, we are important information, knowledge and sources of knowledge from universities and research organizations	2,190	0,992	0,722	0,100	0,235	0,199

Limitations. The study used the CAWI method, which, while efficient, depends on self-reported and voluntary responses that may be influenced by response bias or social desirability (Rózsa et al., 2024). Its cross-sectional design limits causal inference and captures relationships only at a single time point. Additionally, some constructs, such as University knowledge, were measured with a single item, reducing the ability to test internal consistency and fully capture the construct's complexity.

4. Results and discussion

The Figure 1 presents a structural model that illustrates the relationships between the investigated latent variables within the framework of Partial Least Squares Structural Equation Modeling (PLS-SEM). The model comprises three main constructs: Competencies (normative and action), University knowledge, and Sustainable performance.

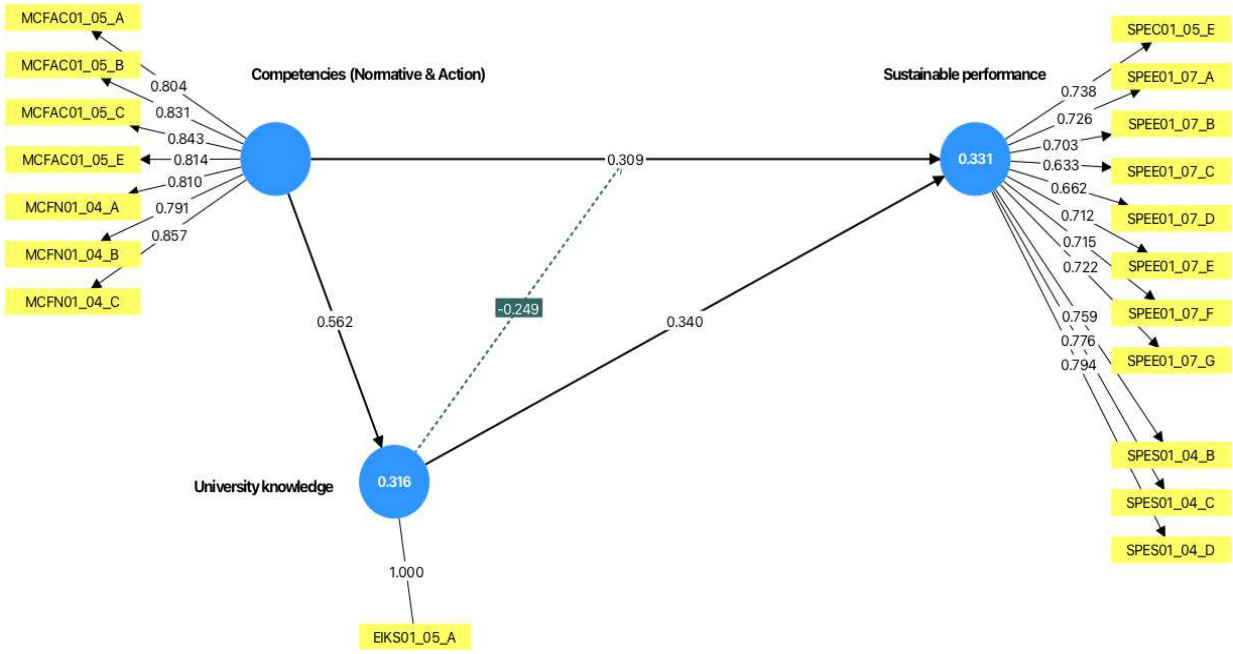

Figure 1. PLS-SEM model
Source: own processing (2025)

The model explains 32.7% of the variability in the construct Sustainable performance ($R^2 = 0.327$) and 31.5% of the variability in the construct University knowledge ($R^2 = 0.315$). These values represent a weak to moderate explanation, which is acceptable in the context of social science research (Hair, 2014).

Structural relationships (path coefficients). All hypothesized relationships between latent variables were statistically significant ($p < 0.01$): Competencies (normative and action) → Sustainable performance: $\beta = 0.096$, $t = 3.095$, $p = 0.002$; Competencies (normative and action) → University knowledge: $\beta = 0.463$, $t = 5.123$, $p < 0.001$; University knowledge → Sustainable performance: $\beta = 0.115$, $t = 3.334$, $p = 0.001$. Moderation (University knowledge × Competencies (normative and action) → Sustainable performance): $\beta = 0.151$, $t = 4.069$, $p < 0.001$.

The interpretation of the effect sizes (f^2), which express the relative contribution of individual exogenous variables to the explained variability of the target constructs, showed that even though the effects are mostly small, their significance and direction confirm the justification for their inclusion in the model: Competencies (normative and action) → Sustainable performance: $f^2 = 0.096$ (small effect). Competencies (normative and action) → University knowledge: $f^2 = 0.277$ (medium effect). University knowledge → Sustainable performance: $f^2 = 0.102$ (small effect). Moderation (interaction): $f^2 = 0.130$ (small to medium effect).

The moderating effect analysis revealed that the interaction between University knowledge and Competencies (both normative and action-oriented) has a positive and statistically significant impact on Sustainable performance ($\beta = 0.151$; $p < 0.001$). This indicates that a higher level of university knowledge enhances the positive influence of action-normative competencies on sustainable performance.

The interaction visualization (Figure 2) shows three regression lines that illustrate the relationship between Competencies (normative and action) and Sustainable performance at different levels of University knowledge: The red line represents a low level of knowledge (–1 SD). In this case, the relationship is weak and significantly lower, which means that at low knowledge, even high competencies translate into lower sustainable performance. The blue line shows the relationship at an average level of knowledge (Mean). The relationship is positive and moderate. The green line shows the situation at a high level of knowledge (+1 SD), where the relationship is most pronounced - i.e., the combination of high competencies and high knowledge leads to the highest expected sustainable performance.

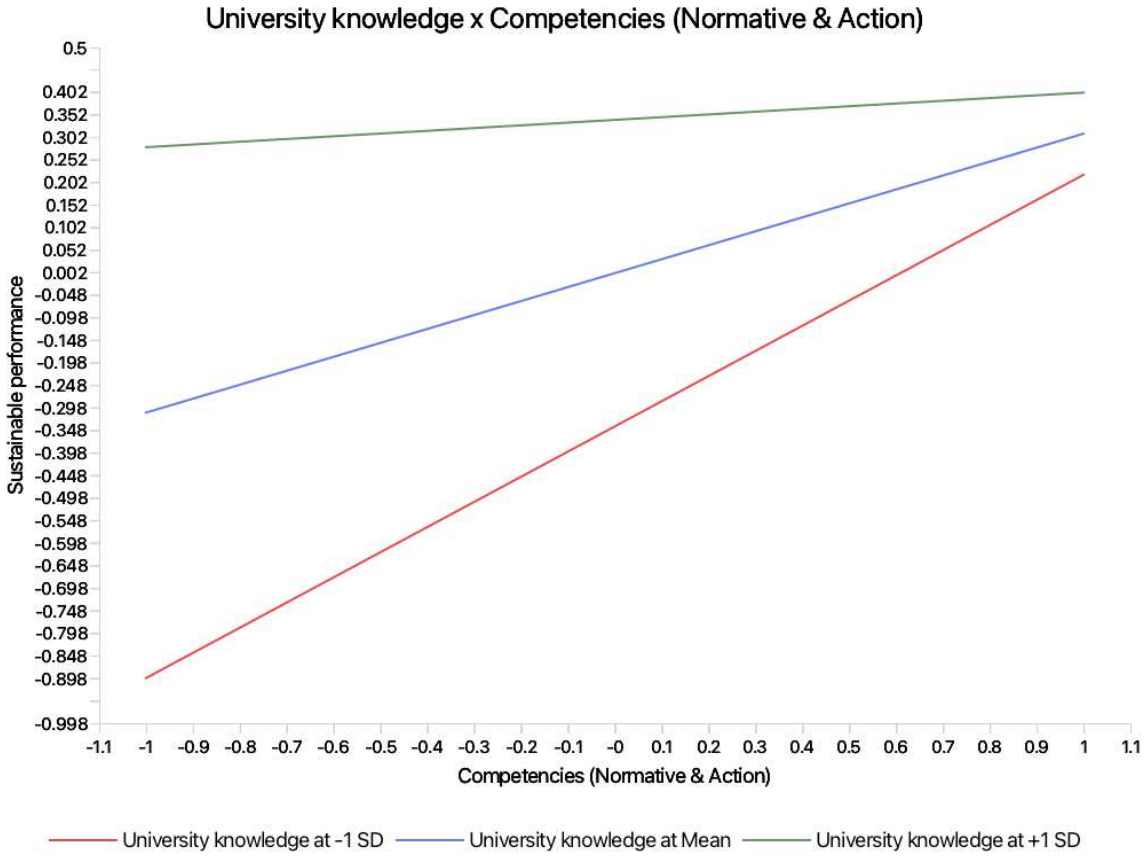

Figure 2. Simple slope analysis
Source: own processing (2025)

Predictive relevance (Q^2_predict). The predictive ability of the model was assessed using the Q^2_predict metric, which is based on a comparison of the PLS-SEM model predictions with the results of benchmark models: linear regression (LM) and naive model (IA). All monitored indicators showed Q^2_predict values higher than zero (e.g., EIKS01_05_A = 0.311; SPEE01_07_A = 0.166), which indicates that the model has predictive relevance. At the same time, in most cases, the RMSE values in the PLS model were lower compared to both benchmark models (e.g., SPEE01_07_A: RMSE_PLS = 0.490 < RMSE_LM = 0.503 < RMSE_IA = 0.537), which confirms the medium to high predictive accuracy of the model.

Based on the assessment of R^2, f^2, regression coefficients, moderation and predictive accuracy, it can be concluded that the structural model has solid explanatory and predictive properties, with all structural relationships being empirically confirmed (H1: $\beta = 0.096$; $t = 3.095$; $p = 0.002$; H2: $\beta = 0.463$; $t = 5.123$; $p < 0.001$; $\beta = 0.115$; $t = 3.334$; $p = 0.001$; H3: $\beta = 0.151$; $t = 4.069$; $p < 0.001$).

Although our results are generally consistent with previous research that highlights the positive role of external knowledge in achieving sustainability outcomes (Chen & Zhang, 2024; Hakeem et al., 2025; Umar et al., 2025), they also suggest that university knowledge has a greater impact in firms with lower levels of internal competencies, while in firms with higher levels of managerial competencies (normative and action) its importance is not as pronounced.

This study contributes to the development of sustainability competency theory by integrating the concept of university knowledge as a dual-role factor, mediating and amplifying the effect of managerial competencies on sustainable performance. In contrast to most previous works that have examined these variables in isolation, our results show that their combination is synergistic: leaders' value- and action-oriented competencies translate more effectively into measurable environmental, economic, and social outcomes when supported by scientifically sound academic knowledge. The results further reveal that the effect of university knowledge is competency-conditioned – stronger in companies with lower internal competencies and less pronounced in highly competent organizations. This pattern supports the competency-contingent knowledge sourcing lens, which integrates the knowledge management and competency-based views and shifts the understanding of sustainable leadership towards models that take into account the dynamic interaction between capabilities and external resources.

From a practical perspective, the results suggest that companies should adapt their external knowledge acquisition strategies to the level of internal competencies. Firms with lower normative and action competencies should invest in targeted collaboration with universities and research organizations to strengthen their ability to translate value-oriented intentions into effective sustainable solutions. Conversely, organizations with high levels of normative and action competencies can use university knowledge more selectively and focus on deepening their own knowledge integration and adaptation capabilities. For policymakers, this means that support programs should differentiate between companies according to their level of competencies and offer differentiated forms of knowledge transfer support that take into account their specific needs and absorptive capacity.

Conclusion

In an environment characterized by rapid technological change, growing sustainability demands, and global competition, the ability of organizations to effectively leverage external knowledge sources is becoming a key prerequisite for long-term sustainability performance. External knowledge, including that from universities, allows companies to exceed their internal capacities, accelerate the emergence of breakthrough innovations, and strengthen their ability to adapt to changing market conditions and societal expectations.

This study empirically confirmed that university knowledge plays a dual role in the relationship between managerial competencies (normative and action) and sustainable organizational performance. On the one hand, it mediates part of the effect of competencies, helping to translate leaders' value-oriented capabilities into concrete environmental, economic, and social outcomes. On the other hand, this knowledge amplifies the effect of competencies, with its contribution being more pronounced in enterprises with lower internal competency levels than in highly competent organizations.

As this study has a cross-sectional design, we recommend that longitudinal approaches be used in the future to more accurately capture the causal relationships and dynamics of interactions between competencies, external knowledge, and sustainable performance over time. In addition to universities, it would also be useful to examine how other sources of external knowledge are included in the model. It would be particularly useful to address one of the study's limitations by developing multi-item scales to measure university knowledge, capturing different dimensions of knowledge transfer (e.g., intensity, form of collaboration, quality, absorptive capacity).

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The Role of Quality Management in Supporting the Circular Economy Transition: A Case Study of Closed-Loop Production in the Polish Textile Industry

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Abstract

Research background: The textile industry is among the most environmentally polluted sector, contributing significantly to global waste and resource consumption. Hence, circular economy (CE) transition is increasingly recognized in this sector as a strategic necessity. Quality management (QM) practices may serve as a potential enabler of this transition by supporting sustainable production through improved process efficiency, waste reduction, and operational reliability.
Purpose of the article: The aim of the paper is to explore the role of QM practices in supporting the CE transition, using the case of closed-loop production in Polish textile companies.
Methods: The study employed a mixed-methods research design, combining two embedded qualitative case studies with a complementary quantitative survey. The qualitative component included semi-structured interviews (N=21), participant observation, and documentation analysis in medium and large textile manufacturing companies. The quantitative survey (N=128) targeted employees across various organizational levels and enterprise sizes, focusing on QM practices, CE awareness, and their interrelations. Descriptive statistics, independent t-tests, and linear regression were used to analyze survey responses, while thematic analysis guided the qualitative interpretation.
Findings & Value added: The study demonstrates that QM practices can support CE transitions through both structured and adaptive pathways, depending on organizational context. Case studies show that structured, ISO-based systems with centralized quality control foster procedural discipline and support CE through practices like defect reuse and waste reduction, while decentralized, agile models integrate CE via innovations such as print-on-demand and strong employee engagement across all organizational levels. Survey data confirm significantly higher adoption of QM and CE practices in large firms compared to SMEs ($p<0.05$). A strong positive correlation ($r=0.94$) and regression analysis ($R^2=0.89$) indicate that QM maturity is a key driver of CE engagement. The findings emphasize that leveraging existing QM frameworks offers a scalable pathway to circularity, particularly for resource-constrained SMEs.

Keywords: Sustainablity, Resource efficiency, Textaile sector, Process improvement, Organizational improvement

JEL classification: M11, Q56, L67, D22, O32

1. Introduction

The textile industry, one of the world's most resource-intensive sectors, faces significant environmental challenges due to its high water consumption, greenhouse gas emissions, and waste generation throughout complex supply chains (Kazancoglu et al., 2020; Ellen MacArthur Foundation, 2017). Traditional linear production models, centered on extraction, production, consumption, and disposal, have led to increasing environmental degradation and resource depletion. In response, the circular economy (CE) has emerged as a promising paradigm for sustainable transformation, especially in industries like textiles, where material recovery and process redesign can substantially reduce environmental footprints (Barros et al., 2021; Kazancoglu et al., 2020).

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CE models emphasize closing resource loops through strategies such as reuse, recycling, remanufacturing, and eco-design. These practices are particularly relevant for the textile sector, which produces 93 billion cubic meters of wastewater annually and generates massive amounts of microplastic pollution and textile waste (Kazancoglu et al., 2020). Implementing CE in this industry has the potential to reduce environmental impacts, conserve resources, and create economic and social value through new business models and reverse logistics systems (Barros et al., 2021).

Within this transformation, quality management (QM) systems can act as enablers for circular strategies by ensuring consistent standards in recycled inputs, monitoring processes, and facilitating the adoption of circular principles at the organizational level (Barros et al., 2021). The role of QM in sustainability transitions has gained recognition, as it offers structured methodologies for enhancing process efficiency, minimizing waste, and fostering continuous improvement. Building on this perspective, Wei et al. (2024) emphasize that sustainable quality management practices, which embed environmental objectives within core quality routines, are essential for operationalizing circular strategies in practice, particularly in resource-intensive sectors like textile where internal organizational barriers hinder circular transformation.

The Polish textile industry is one of the most dynamic and economically significant sectors in Central and Eastern Europe, comprising over 36,000 entities and generating approx. EUR 11.6 billion in revenue in 2022. According to the Polish Agency for Enterprise Development, a key challenge for the industry is adaptimg manufacturing processes to tight environmental regulations and sustainability expectations, with 43% of firms planning to introduce new circular offerings in response (Kargul et al., 2023).

Despite growing interest in circularity, empirical research examining how QM supports closed-loop production, remains limited. Previous studies have predominantly focused on either technological innovation or macroeconomic policy, often neglecting the operational practices and internal capabilities that influence a firm's ability to transition toward circular models. Therefore, the aim of this paper is to explore the role of QM practices in supporting the CE transition, using the case of closed-loop production in Polish textile companies.

1.1 Quality management practices in the textile industry

Modern textile firms increasingly adopt a hybrid approach to QM, integrating ISO frameworks with real-time monitoring, environmental certifications, and industry-specific tools. QM practices, encompassing systems, philosophies, methods, and tools, form the backbone of this approach. Among these, the ISO 9001 norm is the most widely implemented, providing a standardized framework for quality assurance, process efficiency, and continual improvement. Studies show that ISO 9001 adoption in textile SMEs leads to measurable gains in procurement accuracy, supplier performance, and internal coordination (Zimon et al., 2018). When paired with ISO 14001, which emphasizes environmental management, the combined approach extends these benefits to include resource efficiency, reduced environmental impact, and support for eco-design and reverse logistics, aligning quality and sustainability goals within a cohesive strategy (Zimon et al., 2020).

Recent studies deepen this understanding by applying data-driven models. For instance, Sithi et al. (2025) employ SWARA-TOPSIS, a structured multi-criteria method, to prioritize suppliers based on quality, cost, and environmental standards, supporting better sourcing aligned with ISO principles. Additionally, methods such as FMEA combined with fuzzy logic (Kodaloğlu et al., 2025) are applied to assess quality and safety risks in spinning operations. This hybrid method enhances traditional risk evaluation by accommodating uncertainty in real-world textile settings. The integration of machine learning in production monitoring (Trankov et al., 2024) further automates quality checks, enabling real-time feedback loops and proactive defect prevention.

Beyond ISO systems, many textile companies now pursue industry-specific certifications to satisfy increasingly conscious consumers. Standards like OEKO-TEX® Standard 100, STeP by OEKO-TEX®, and the Bluesign® system guarantee chemical safety and transparency in production. The Global Organic Textile Standard (GOTS) ensures compliance with environmental and social norms throughout the lifecycle of textile products (Roy Choudhury, 2015). These certifications are further strengthened by digital traceability technologies and lean practices that reduce waste and improve transparency (Bilancia et al., 2025). Innovative frameworks are also emerging. Le et al. (2025) developed a data mining-based prediction model for defect detection in knitwear, aligning with DMAIC's analytical stages. Similarly, Dahule and Gunde (2025) promote digital documentation and real-time data dashboards to drive operational excellence in spinning mills. This integrated approach to quality not only enhances efficiency and compliance but also sets the stage for circular practices.

1.2 Closed-loop production cycles and circular economy

The CE in the textile sector aims to move away from the traditional linear "take-make-dispose" model to one that is regenerative by design, minimizing waste and maximizing resource utilization (e.g., Chen et al., 2021; Roy et al., 2022). This transition is driven by the urgent need to mitigate the environmental degradation caused by conventional textile manufacturing, which is a major contributor to greenhouse gas emissions, water consumption, and chemical pollution. A core principle of CE is the recovery of materials to make processes more energy-efficient and prevent waste, leading to economic benefits and optimized material recycling (Murray et al., 2017). De Felice et al. (2025) have suggested key CE strategies for closed-loop production consisting of 1) effective waste collection and management; 2) the R-strategies (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover); 3) green manufacturing integrating sustainable practices to minimize waste, conserve resources, and reduce emissions; and 4) sustainable supply chain management. Furthermore, digital innovations such as blockchain and digital product passports are increasingly utilized to enhance transparency, traceability, and efficiency within CLP systems (Schöggl et al., 2023). However, the successful implementation of such systems requires more than technical innovations; it necessitates robust organizational processes and a culture of continuous improvement.

Recent studies suggest that QM practices, such as systematic process control, stakeholder engagement, and continuous feedback mechanisms, may play a pivotal role in supporting this transition. For instance, Kazancoglu et al. (2020) emphasize the importance of integrated supply chain coordination and systemic process alignment to enable effective collection, sorting, and reprocessing of materials within circular textile supply chains. Abdelmeguid et al. (2022) further highlight that addressing both hard aspects (e.g., business model redesign, regulatory alignment) and soft aspects (e.g., consumer awareness, organizational behavior) is critical to overcoming barriers to CE implementation in the fashion sector. From a QM perspective, these insights align closely with the principles of continuous quality improvement and stakeholder-driven value creation. Moreover, Furferi et al. (2022) advocate for lifecycle-oriented strategies, including eco-design and traceability, which resonate with QM frameworks focused on process standardization and outcome measurement. Therefore, evaluating the influence of QM practices on CE performance may provide valuable insights into how structured management systems can enhance the effectiveness and scalability of closed-loop production models in the textile industry.

2. Methods

This study employed a mixed-methods strategy embedded within a single-case study design, following the typology proposed by Yin (2018). In this design, the Polish textile industry is treated as the overarching case, while two selected manufacturing enterprises serve as embedded units of analysis. This approach is particularly suited for studying complex organizational processes in real-life settings, enabling the integration of multiple data sources. The use of qualitative and quantitative methods provided a comprehensive view of how QM practices support the development of closed-loop production within the context of Poland’s CE transition.

Firstly, two embedded case studies were conducted within manufacturing organizations referred to as Company X and Company Y. Data collection involved semi-structured interviews and participant observation. The interview questions were organized into two thematic areas: (1) QM practices and (2) CE and closed-loop production. A summary of the key characteristics of both cases is presented in Table 1.

Table 1. Summary of key characteristics of the embedded units of analysis

Aspect	Company X	Company Y
Dates of data collection	March 15–16, 2024	April 2–4, 2024
Number of participants	12	9
Positions represented	CEO, production managers, quality controller, production workers	CEO, production managers, digital quality controller, production workers
Methods used	Semi-structured interviews, participant observation, field notes	Semi-structured interviews, participant observation, administrative immersion
Thematic area covered	QM practices, CE and closed-loop production	QM practices, CE and closed-loop production

Source: own research.

Secondly, the quantitative component complemented the qualitative findings through a structured survey distributed to textile enterprises. The survey sample was selected using purposive sampling, targeting companies within the Polish textile sector that are actively engaged in QM practices. Selection was based on available industry reports and expert recommendations. The survey consisted of 12 questions grouped into three thematic sections: practices of quality management, implementation of closed-loop production, and the influence of QM on CE transition. Closed-ended questions were used, that applied a 5-point Likert scale to assess familiarity, implementation level, and correlation between quality and circularity aspects. The questionnaire was pilot-tested prior to distribution to ensure clarity and relevance. The survey was administered electronically between March 11 and 19, 2024, with follow-up reminders sent to increase the response rate. Responses were anonymous, and all data were processed with respect to ethical standards, including informed consent and full anonymization.

The analysis followed Yin's (2018) guidelines for embedded case study research, where each unit of analysis was examined individually before drawing cross-unit conclusions within the broader context. The qualitative data were analyzed using thematic analysis. The material was coded according to two predefined thematic areas. Emerging insights were noted and compared within and across the two organizations. Observational notes and reflections were used to contextualize and triangulate findings. The quantitative data were analyzed using descriptive statistics in SPSS. Mean values, standard deviations, medians, and frequency distributions were calculated for each question and stratified by enterprise size (large, medium, small). The differences between groups were explored through independent t-tests with statistically significant differences at the level of $p<0.05$. Prior to conducting the t-tests, assumptions of normality and homogeneity of variances were verified. Additionally, to investigate the relationship between QM and CE practices, a linear regression analysis was performend. The analyses were conducted using validated procedures to ensure the reliability and robustness of the results.

3. Results

3.1 Case Study Analysis

Company X is a long-established textile manufacturer with production facilities in three Polish cities. Data were collected through seven interviews and direct observation at the Kamienna Góra site, which specializes in linen, cotton, and hemp textiles. The company applies a highly structured QM approach grounded in ISO 9001, with dedicated quality control positions embedded in all nine stages of production. During interviews, managers emphasized the routine use of quality boards, production plans, and control procedures, which collectively ensure high process discipline and standardization. Observational data confirmed these practices, revealing visible signage, quality checkpoints, and documented procedures at workstations.

In terms of circularity, Company X has integrated several CE-oriented practices, most notably the reuse of defective textiles through a factory outlet store. This initiative not only diverts material from waste streams but also aligns with the company's broader zero-waste philosophy. As noted by the weaving department manager, process changes, such as restructuring departments to include quality controllers, have significantly reduced material losses. However, while office-based employees and managers demonstrated a clear understanding of CE objectives, this awareness was noticeably lower among production workers. Interviews with shop-floor staff revealed a more task-oriented perspective, with limited understanding of how their roles contribute to broader sustainability goals.

Company Y represents a younger, dynamic textile firm that evolved from a micro-enterprise into a mid-sized company integrated into an international textile group. Fieldwork at Company Y took place in early April 2024 and involved eight interviews, participant observation, and administrative immersion in the firm's production and logistics departments. Unlike Company X, which emphasizes formal process stability, Company Y's approach to QM is built on agility and responsiveness. The firm uses the Quick Response Manufacturing (QRM) strategy, whereby each production department operates as a semi-autonomous unit comprising planners, graphic designers, buyers, customer service, and quality staff. This structure allows for real-time coordination and rapid execution, particularly in the digital printing division.

Quality assurance is integrated into daily operations through mandatory quality control cards, signed by employees at each production stage. Interviewees, particularly in the digital department, emphasized how this system has enhanced traceability and reduced the incidence of errors. Moreover, Company Y has made strategic investments in certifications such as GOTS and ISO standards, which required substantial internal reforms but have yielded operational and reputational benefits.

The company's alignment with CE principles is most visible in its adoption of the print-on-demand (POD) model. This approach, implemented in the digital printing unit, enables textile products to be produced only upon receiving customer orders, typically within 24 hours, eliminating excess inventory and significantly reducing waste. The CEO explicitly linked this model to the need for more sustainable production in an industry known for overproduction. Further efforts are underway to extend POD capabilities to other departments, such as embroidery and transfer printing.

Employee engagement with CE principles appeared notably stronger in Company Y than in Company X. This can be attributed to deliberate internal communication strategies, such as CE-themed posters, reuse of textile remnants for office decoration, and quarterly meetings to discuss sustainability goals. Even production workers demonstrated an understanding of recycling and reuse policies, indicating that sustainability has become part of the organizational culture, not just a strategic objective.

While both Company X and Company Y exhibit practices that support the integration of QM and CE principles, they do so through different organizational pathways. Company X represents a model of traditional, hierarchical quality control, where process optimization and reuse initiatives are centrally driven. Company Y, by contrast, exemplifies a more flexible, innovation-driven model in which QM and CE are embedded into the organizational structure and culture, supported by rapid production cycles and high employee engagement. Both cases confirm the theoretical expectation that QM can act as a strategic enabler of closed-loop production, though their approaches reflect varying degrees of scale and internal alignment. This supports literal replication logic, in terms of Yin (2018), showing that mature QM systems facilitate CE transition, but through different mechanisms. Table 2 presents the results of cross-case sythesis results in the form of comparative analysis of Company X and Company Y.

Table 2. Cross-case synthesis results of Company X and Company Y

Theme	Company X	Company Y
QM Maturity	High; formal ISO-based; control at each production stage	High; QRM cells and ISO + GOTS certifications
Closed-Loop Integration	Reuse via store; structured quality control	POD production; creative reuse; proactive certifications
CE Awareness (All Levels)	High in offices, low in production	High across organization due to active communication
Employee Engagement Mechanisms	Limited to visuals (posters, displays)	Visuals, team meetings, direct involvement
Learning and Adaptability	Strong process but limited feedback diffusion	Agile, feedback-rich, learning-focused

Source: own work.

3.2 Survey results

To complement the qualitative case study analysis, a structured survey was conducted with 128 respondents representing various organizational levels within the Polish textile industry. Analysis of respondent characteristics revealed that the majority of participants were employed in large enterprises (N=66; 51.6%), followed by medium-sized enterprises (N=43; 33.6%) and small enterprises (N=19; 14.8%). None of the respondents represented micro-enterprises.

The results of descriptive analysis, as shown in Table 3, indicate a clear distinction between enterprise sizes in the extent to which QM and sustainability-related practices are applied. Large enterprises consistently reported higher mean values across all survey items, suggesting more advanced implementation of both QM practices and circular production principles. For instance, the highest average rating among large enterprises was observed for the implementation of closed-loop production practicies (Q5: M=4.20, SD=1.00), followed closely by the application of QM practices in the production process (Q1: M=4.15, SD =0.77). Medium-sized enterprises reported moderate levels of QM and sustainability activities, with mean scores slightly lower than those of large firms across most questions. Their highest ratings were also associated with closed-loop practices (Q5: M=3.79, SD=1.08) and general QM implementation in production (Q1: M=4.02, SD=0.86). Small enterprises demonstrated the lowest levels of implementation overall. Particularly low scores were recorded for the integration of QM practices across the entire production area (Q2: M=2.05, SD =0.71) and the use of recycling methods (Q7: M=2.42, SD=1.22). However, slightly higher values were noted for actions related to sustainable material consumption (Q6: M=3.32, SD=1.16).

Table 3. Extent of QM and CE related practice implementation across companies sizes in the Polish textile industry

	Large			Medium			Small		
Question	**M**	**Mdn**	**Std**	**M**	**Mdn**	**Std**	**M**	**Mdn**	**Std**
Q1. To what extent are formalized QM practices (e.g., ISO 9001, QM tools) implemented within your company's production processes?	4.15	4	0.77	4.02	4	0.86	2.84	3	1.01
Q2. To what extent does your organization's QM system span the entire value chain (from raw material procurement through manufacturing to final product delivery?	3.42	3.5	1.12	3.07	3	1.35	2.05	2	0.71
Q3. To what extent does the implementation of QM contribute to improving operational efficiency in your company?	3.74	4	0.90	3.42	4	1.28	2.84	3	0.83
Q4. To what extent do the quality management practices applied in your company influence or promote sustainable development (e.g., resource optimization)?	3.89	4	1.04	3.60	3	1.07	3.11	3	1.29
Q5. To what extent has your company adopted circular production principles (e.g., closed-loop systems, product life cycle design, reuse of raw materials, and industrial symbiosis)?	4.20	4	1.00	3.79	4	1.08	2.89	3	1.49
Q6. To what extent does your company reduce material consumption in line with sustainable resource management?	3.79	4	1.21	3.23	4	1.25	3.32	4	1.16
Q7. To what extent are post-production materials reintegrated into production through recycling or reprocessing?	3.68	4	1.13	3.05	3	1.15	2.42	2	1.22
Q8. To what extent has the integration of quality management systems facilitated the implementation of circular economy practices (e.g., recycling, reuse, and closed-loop resource flows) in your company?	3.79	4	1.02	3.65	4	0.87	2.89	3	1.10

Source: own work.

In the next, independent samples t-test was performed. To enhance the comparability of group sizes in the statistical analysis, responses from medium-sized and small enterprises were combined into a single group labeled SME (N=62), while large enterprises were analyzed separately (N=66). The results, as presented in Table 4, indicate statistically significant differences ($p<0.05$) between the two groups for all eight questions. Large enterprises consistently reported higher mean values, indicating a greater extent of implementation of both QM practices and circular practicies. The largest difference was observed in Q7, concerning the application of recycling practices ($M_{Large}=3.68$, $SD=1.13$; $M_{SM}=2.86$, $SD=1.20$; $t=4.017$, $p<0.001$).

Table 4. Results of t-test across survey questions between large and small-medium enterprises

Question	**M_Large**	**Std_Large**	**M_SME**	**Std_SME**	**T-Statistic**	**p-Value**	**Significance Level**
Q1	4.152	0.769	3.661	1.055	2.988	0.003	$p < 0.01$
Q2	3.424	1.124	2.758	1.276	3.126	0.002	$p < 0.01$
Q3	3.742	0.900	3.242	1.183	2.681	0.008	$p < 0.01$
Q4	3.894	1.040	3.452	1.155	2.272	0.025	$p < 0.05$
Q5	4.197	0.996	3.516	1.277	3.349	0.001	$p < 0.01$
Q6	3.788	1.209	3.258	1.214	2.473	0.015	$p < 0.05$
Q7	3.682	1.125	2.855	1.199	4.017	0.000	$p < 0.001$
Q8	3.788	1.015	3.419	1.001	2.067	0.041	$p < 0.05$

Source: own work.

Finally, the data was analysed to investigate the relationship betweem QM and CE practices. For that reason, two composite indexes were developed. The QM Index was computed as the average of responses to questions Q1–Q3. The CE Index was based on the average of questions Q5–Q7, addressing closed-loop production, material consumption reduction, and recycling practices. The Pearson correlation between the two indices was r=0.94, indicating a very strong positive relationship. A simple linear regression further confirmed this link (R^2=0.89, $p<0.001$), showing that approximately 89% of the variance in CE Index scores can be explained by the level of QM implementation. The regression coefficient for the QM Index was 1.07, indicating that each one-point increase in QM corresponds to a 1.07-point increase in CE engagement.

4. Discussion

The findings from this study confirm that QM practices significantly support the transition toward circular CE models in the Polish textile industry. The very strong positive correlation between the QM and CE Indexes reinforces the notion that mature QM systems provide an enabling infrastructure for circular transformation. These results align with recent literature that emphasizes the synergetic relationship between QM and CE. As highlighted by Nguyen et al. (2023), integrating Quality Management 4.0 with Industry 4.0 technologies enhances sustainable supply chain performance through improved input management, waste handling, and preservation strategies. The emphasis on strategic QM also resonates with the case study of Manteco S.p.A., where a structured approach combining eco-design, traceability, and end-of-life planning was used to successfully implement circular practices in textile production (Furferi et al., 2022). Furthermore, the widespread perception among industry professionals that QM supports CE goals suggests growing awareness of circular principles across operational levels. This is crucial, as past studies have identified insufficient knowledge and managerial commitment as persistent barriers to CE implementation (Kazancoglu et al., 2020) The current results suggest a cultural shift within Polish SMEs, where CE is increasingly perceived not only as a regulatory requirement but also as a quality-driven innovation opportunity.

However, challenges remain. Many organizations, particularly SMEs, still lack systemic tools for evaluating environmental performance or integrating CE into strategic decision-making. This is consistent with prior observations that the transition to CE requires long-term investments, complex supply chain coordination, and often poses significant economic constraints. Jabłońska et al. (2020) highlight that many Polish textile enterprises, particularly SMEs, still face limitations in innovation capacity and resource access, which may hinder their ability to fully leverage QMS for sustainability. In line with Furferi et al. (2022), operationalizing CE in the textile sector demands process innovations such as recycled input optimization, design for disassembly, and sustainability reporting, all of which require robust QM systems to be effectively implemented. Moreover, the implementation of traceability systems and digital infrastructure (e.g., RFID, blockchain, IoT) is essential to support closed-loop logistics and enable data-driven decisions (Nguyen et al., 2023). The alignment of these findings with the broader European guidelines on sustainable industrial transformation (Kargul et al., 2023) further validates the importance of integrating QM and CE strategies in policy and practices.

Conclusion

This study demonstrates that QM play an important role in enabling the circular transition of the textile industry. The case study analysis revealed two distinct but effective approaches to integrating QM and CE practices. Company X followed a traditional, ISO 9001-based model with high procedural discipline and reuse strategies, though CE awareness was largely limited to office staff. In contrast, Company Y adopted a decentralized, agile system based on QRM, embedding CE principles into its operations through innovations like print-on-demand and fostering organization-wide engagement. These cases illustrate that QM can support CE transition through both structured and adaptive pathways, depending on organizational context. The survey data confirmed the observations from the case studies and revealed statistically significant differences between large enterprises and SMEs. Large companies consistently scored higher across all surveyed items related to QM and CE practices. These results highlight a clear maturity gap and underline the scalability challenge faced by SMEs, which often lack the resources and systems needed to fully implement CE strategies. The findings underscore that QM is not only compatible with CE assumptions but can actively drive their implementation when strategically utilized. Leveraging existing QM practices, rather than developing new systems detached from established

managerial frameworks, offers a realistic and scalable pathway to circularity in the textile industry, especially for resource-constrained SMEs.

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Forecasting of the Energy Intensity in Agricultural Sector

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Abstract

Research background: The energy intensity of agriculture is a key indicator of the sustainability of the agricultural sector, reflecting the amount of energy required per unit of agricultural production. Higher energy intensity indicates that more energy input is required to achieve the same volume of output, which may indicate inefficiencies in production processes, dependence on external energy sources or a lack of technological sophistication.
Purpose of the article: The aim of this analysis is to assess the evolution of the energy intensity of agriculture to date and to identify possible future scenarios of its evolution in the context of environmental and economic impacts.
Methods: The subject of the research are emissions of the main greenhouse gases - methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) - in agriculture in the Slovak Republic in the period 2000 to 2022. The object of the research is sectoral disaggregated emissions data from FAOSTAT databases, which were subjected to quantitative analysis to calculate the indicator Energy Intensity of Agriculture (measured in gigajoules per hectare, GJ/ha).
Findings & Value added: Model projections of emissions trends to 2030 suggest three possible scenarios. In the conservative scenario, based on the ETS model, emissions are expected to fall to between 5.1 and 5.2 kg CO_2 per hectare. The medium scenario, which assumes a 2% reduction in emissions each year, estimates a decrease to around 4.6 kg CO_2/ha. The most ambitious scenario foresees a reduction of 4% per year, leading to a level of 3.8 to 3.9 kg CO_2/ha. Slovakia was one of the countries with the largest decrease in energy intensity in the EU between 2005 and 2010.

Keywords: Energy intensity of agriculture, CO_2, CH_4, N_2O emissions, Emission scenarios, Emission prediction

JEL classification: Q15, C53

1. Introduction

Agriculture is directly responsible for approximately 10–12% of current global anthropogenic greenhouse gas (GHG) emissions, mainly originating from livestock production. However, such percentage estimates are based on Global Warming Potentials (GWPs), which do not measure the actual warming caused by emissions and ignore the fact that methane does not accumulate in the atmosphere in the same way as CO_2. The importance of livestock emissions for future warming strongly depends on global actions aimed at reducing emissions from other sectors. Reisinger (2010) noted that expanding mitigation potential and achieving substantial reductions in non-CO_2 direct emissions from livestock through both demand- and supply-side measures could significantly contribute to meeting the stringent mitigation targets set out in the Paris Agreement.

In recent years, several environmental policies have been implemented worldwide to reduce the levels of minerals and nitrogen excreted by livestock (Oenema, 2004). The greatest attention is given to GHG emissions, particularly from ruminants, since methane emissions from enteric fermentation are responsible for 21% of anthropogenic methane emissions in the United States (EPA, 2011). In efforts to balance increased food production with environmental protection, more sustainable livestock production scenarios are being explored. These are based on the prediction of methane emissions at the individual animal level, as direct daily emission measurements require specialized equipment and can be costly (Johnson at al., 2008).

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One of the most important global frameworks is the Paris Agreement (2016), which commits countries to submitting Nationally Determined Contributions (NDCs) to reduce GHG emissions. Many countries have already included measures in their NDCs to reduce CH_4 emissions (e.g., enteric fermentation, manure management), N_2O (e.g., optimized fertilizer use), and CO_2 (e.g., protection and restoration of organic soils) (Taibi et al., 2020).

At the European Union level, agricultural emissions are addressed within the Common Agricultural Policy (CAP), which promotes low-emission technologies, improved soil management, and precision farming. Precision fertilization systems and soil nitrogen retention measures are supported to reduce N_2O emissions, while the protection of organic soils contributes to lowering CO_2 emissions (European Commission, 2023).

Although the Global Methane Pledge according to Cael (2023) specifically targets CH_4, it sets a precedent for targeted reductions of individual greenhouse gases in sectors where they dominate – including agriculture. The initiative aims to reduce global methane emissions by 30% by 2030 compared to 2020 levels through measures in the energy, agriculture, and waste sectors (European Commission, 2022).

CO_2 emissions in agriculture originate from several sources associated with farming activities. The main components include:

1. Fossil fuel consumption – emissions from burning diesel, gasoline, and other fossil fuels in tractors, machinery, and transport.
2. Fertilizer production and application – emissions of CO_2 and N_2O from the manufacture of fertilizers and their decomposition in soil.
3. Waste and biological activity – CO_2 released during the decomposition of organic materials and crop residues.
4. Transport – emissions related to transporting inputs to the farm and outputs to the market.
5. Land operations and mechanization – emissions resulting from the use of equipment for soil management.
6. Respiration of plants and soil – direct CO_2 emissions from biological and physical soil processes, which are less significant compared to other sources.

Currently, the focus in agriculture is on reducing emissions through sustainable technologies, improved fertilizer efficiency, enhanced farming practices, and the use of alternative energy sources.

Energy intensity in agriculture is a key indicator of the sustainability of the agri-food sector, expressing the amount of energy required per unit of agricultural output. Higher energy intensity implies that more energy input is needed to achieve the same production volume, which may indicate inefficient production processes, dependence on external energy sources, or low technological advancement.

The aim of this analysis is to evaluate past trends in agricultural energy intensity and identify potential future scenarios of its development in the context of environmental and economic impacts. Increasing energy intensity has significant environmental implications, such as higher GHG emissions, increased carbon footprint of agricultural production, and more intensive use of fossil and non-renewable energy sources.

From the perspective of economic policy and planning, it is important to understand the drivers of agricultural energy intensity and the consequences of its increase or decrease for sectoral competitiveness, resilience to external shocks (e.g., energy prices), and achieving environmental targets, including climate neutrality.

Three alternative scenarios for the future development of agricultural energy intensity are constructed, reflecting different assumptions regarding technological progress, policy interventions, and farm behavior:

- Scenario A – Business-as-usual (BAU) represents the reference scenario with no major changes in policy, technology, or farm practices. It assumes that current trends will continue in the coming years, and the development of energy intensity (e.g., energy use per hectare) and related emissions is extrapolated using time series models such as ETS or ARIMA. This scenario serves as a benchmark for assessing the effectiveness of other interventions.
- Scenario B – Low-carbon scenario assumes a significant technological shift in the sector, particularly through the large-scale adoption of renewable energy sources, precision agriculture, and digitalization of production processes. These changes are expected to increase energy efficiency and reduce GHG emissions. This scenario assumes a 2% annual reduction in energy intensity (in GJ/ha) and a 2.5% annual decrease in CO_2 emissions from agricultural production (in CO_2/ha).

- Scenario C – Policy-regulatory scenario is based on active public policy intervention through a combination of environmental subsidies and carbon taxes. Subsidies support investments in energy efficiency, while a carbon tax creates economic pressure to reduce emissions and energy use. The expected outcome is a 3% annual reduction in energy intensity and a 4% annual decrease in CO_2 emissions.

These scenarios serve to quantify potential environmental and economic impacts and to support the design of effective measures to reduce the energy and emission burden in agriculture.

2. Methods

The subject of the research are emissions of the main greenhouse gases - methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) - in agriculture in the Slovak Republic in the period 2000 to 2022. The object of the research is sectoral disaggregated emissions data from FAOSTAT databases, which were subjected to quantitative analysis to calculate the indicator Agricultural Energy Intensity (measured in gigajoules per hectare, GJ/ha). This indicator refers to the total energy consumption per unit of agricultural area.

The data collection took the form of downloading publicly available datasets from the official portals of the above-mentioned organisations. The data were then processed using R software (dplyr, forecast, ggplot2 libraries), producing descriptive statistics, boxplots and trend models.

Based on the nature of the data, the annual time series, and the theory of the forecasting method, we concluded that exponential smoothing models were the most appropriate models for predicting future values. Exponential smoothing is generally an accurate forecasting method for short-term forecasts. This technique assigns greater weights to more recent observations, while assigning exponentially decreasing weights as observations move further away. This method produces slightly unreliable long-term forecasts. Exponential smoothing may be most effective when time series parameters change slowly over time.

Simple exponential smoothing

Simple or simple exponential smoothing (SES) is a time series forecasting method used with univariate data without trend and seasonal pattern. It requires a single parameter called alpha (a), also known as the smoothing factor. Alpha controls the rate at which the influence of past observations declines exponentially. The parameter is often set to a value between 0 and 1. A simple exponential smoothing formula is set as follows:

$$y_t = \alpha x_t + (1-\alpha)s_{t-1} = s_{t-1} + \alpha(x_t - s_{t-1})$$

explained as follows,
y_t = smoothed statistic (simple weighted average of the current observation xt)
s_{t-1} = previous smoothed statistic
α = data smoothing factor; $0 < \alpha < 1$
t = time period

To predict the future development of energy intensity in agriculture in the Slovak Republic, we used the ARIMA (Autoregressive Integrated Moving Average) model, which is one of the classical approaches to time series modelling. This model is particularly suitable in cases when the analysed time series exhibits non-linear trends, seasonality or autocorrelations, which can be expressed by a combination of autoregressive, differencing and moving averages.

The optimal model structure was identified using the automated auto.arima() function in R software, which selects the most appropriate combination of parameters based on information criteria (in particular, the AIC - Akaike Information Criterion). The selected models were further diagnosed using residual analysis (Ljung-Box test) and graphical autocorrelation checking (ACF/PACF) to verify their goodness of fit and independence of errors.

3. Results

In the last decade, regulatory measures and climate policies have increasingly focused on reducing greenhouse gas (GHG) emissions from agriculture, which is a major emitter of CH_4, N_2O and CO_2. This sector accounts for approximately 14% of global anthropogenic emissions (FAO, 2016) and has therefore become an integral part of national and international climate strategies. Policies focus on promoting

sustainable agricultural systems that simultaneously reduce carbon footprints and increase production efficiency. We have chosen to describe the different types of emissions in agriculture in Slovakia and their evolution.

The figure shows the long-term trend of emissions of three key greenhouse gases - methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2 in kt) - expressed in carbon dioxide equivalent (CO_2eq), together with the sum of these emissions (Total). The data covers the period1993-2022 and captures the gradual decline in greenhouse gas emissions.

The most significant decrease is seen in methane (CH_4), where emissions have fallen from over 3197 kt CO_2 eq. to around 1112 kt CO_2 eq. in 2022. This decrease can be attributed to changes in livestock production (e.g. fewer ruminants or more efficient feeding practices), improved manure management, or other innovative measures to reduce methane.

Nitrous oxide (N_2O) emissions were 935 kt CO_2 eq. in 1993 and have fallen to around 844 kt CO_2 eq. by 2022. Although this is a less dramatic decrease than for CH_4, it still suggests partial improvements in nitrogen input management (e.g. fertilizer management, optimization of manure rates), although elevated values in some years (e.g. 2016-2018) point to a continued need to control nitrogen sources

Carbon dioxide (CO_2) is in a relatively narrow range (about 64-69 kt). This figure indicates that CO_2 emissions from the sources concerned (e.g. fossil fuel combustion in agricultural technology or oxidation of organic soils) remain relatively stable. The slight decrease from over 68 kt in 1993 to 64.44 kt in 2022 may reflect changes in land use or a slight improvement in the efficiency of energy inputs.

Total emissions, Figure 1 (sum of CH_4, N_2O and CO_2) decreased from 4200.86 kt CO_2 eq. in 1993 to 2020.58 kt CO_2 eq. in 2022, a reduction of more than 50%. This long-term trend highlights the success of the various environmental and technological measures being implemented in agriculture, while also emphasising that continued emission reductions - particularly in the livestock sector and nitrogen input management - are key to a more sustainable future.

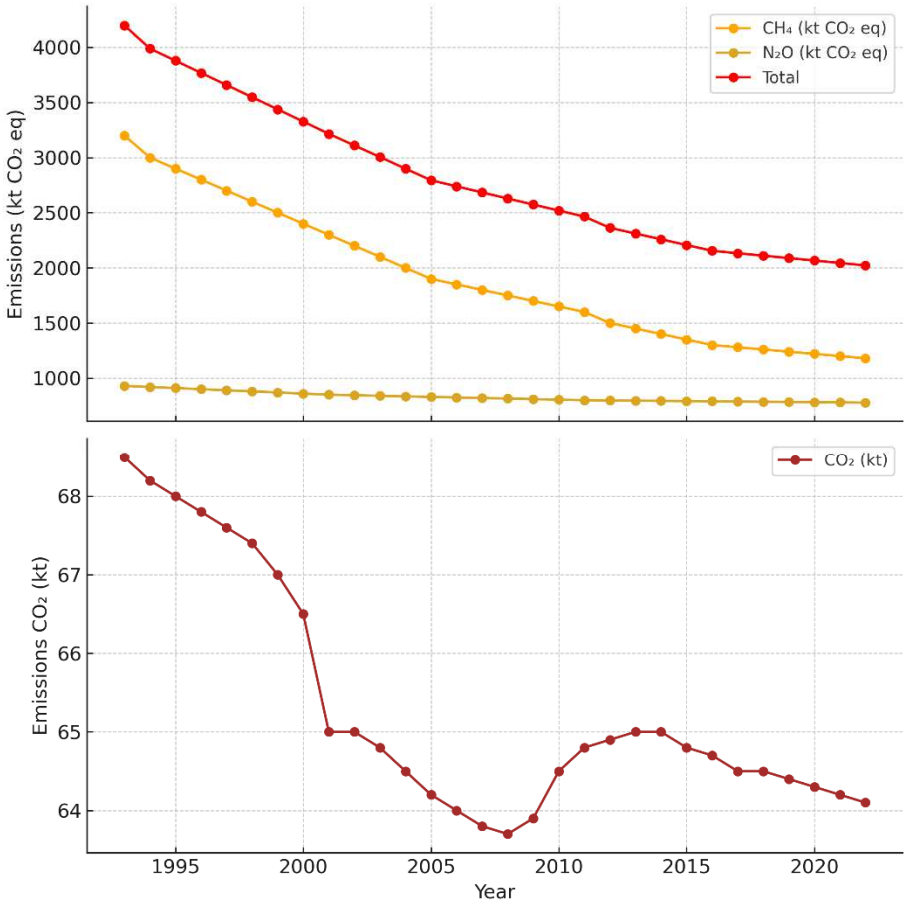

Figure 1. Trend of greenhouse gas emissions in agriculture 1993 - 2022
Source: own processing in R

The descriptive statistics in Figure 2 show the evolution of carbon dioxide (CO_2) emissions from drained organic soils, expressed in kilotons (kt). The mean (average) value is around 65.35 kt CO_2, with a standard deviation of approximately 1.43 indicating a relatively low variability of emissions over the study period. The boxplot shows that most of the values are in the range of approximately 64.53 to 65.19 kt (interquartile range), with the median (50th percentile) at 64.87 kt CO_2.

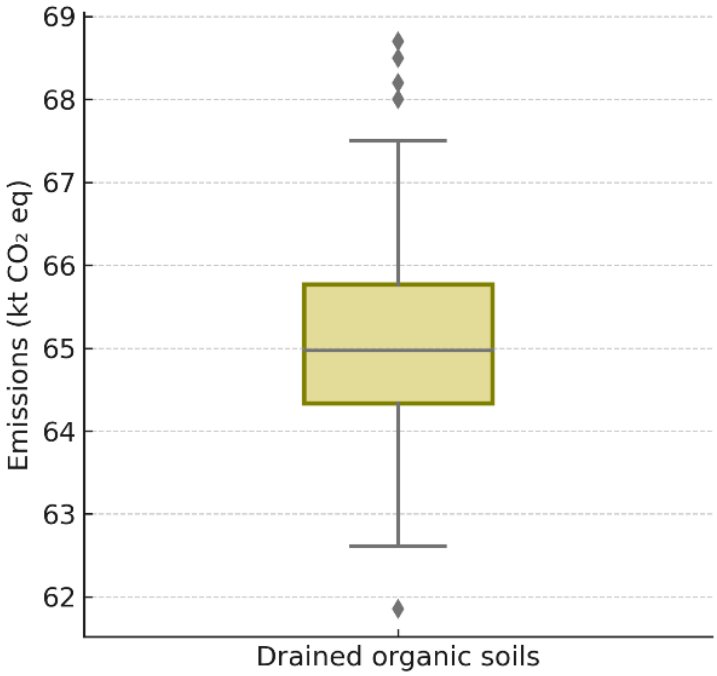

Figure 2. Boxplot of CO2 emissions from selected agricultural sector
Source: own processing in R

A few higher values (above 68 kt CO_2) appear as outliers, indicating less frequent but more significant episodes of elevated emissions. These outlier years or situations may be due to local changes in hydrological conditions, increased drainage rates or other factors affecting the decomposition of soil organic matter.

Overall, it is apparent from the boxplot that under normal conditions emissions fluctuate only within a narrow range; however, the presence of outliers suggests that more substantial CO_2 releases may occur at certain times.

The energy intensity of agriculture (measured in gigajoules per hectare, GJ/ha) is an indicator that indicates the total energy consumption per unit of agricultural area. This indicator includes all energy used for agricultural activities such as:

- mechanised work (tractors, machinery)
- production and use of fertilisers and pesticides
- irrigation
- harvesting and processing

The aim is to assess the energy intensity of agriculture and its impact on the environment. Higher energy intensity indicates that more energy is used to produce the same amount of agricultural products, which may have environmental consequences such as higher greenhouse gas emissions or greater resource depletion.

This metric is important in assessing the sustainability of agricultural production and planning measures to reduce it through more efficient technologies, optimising production processes or switching to more environmentally friendly methods.

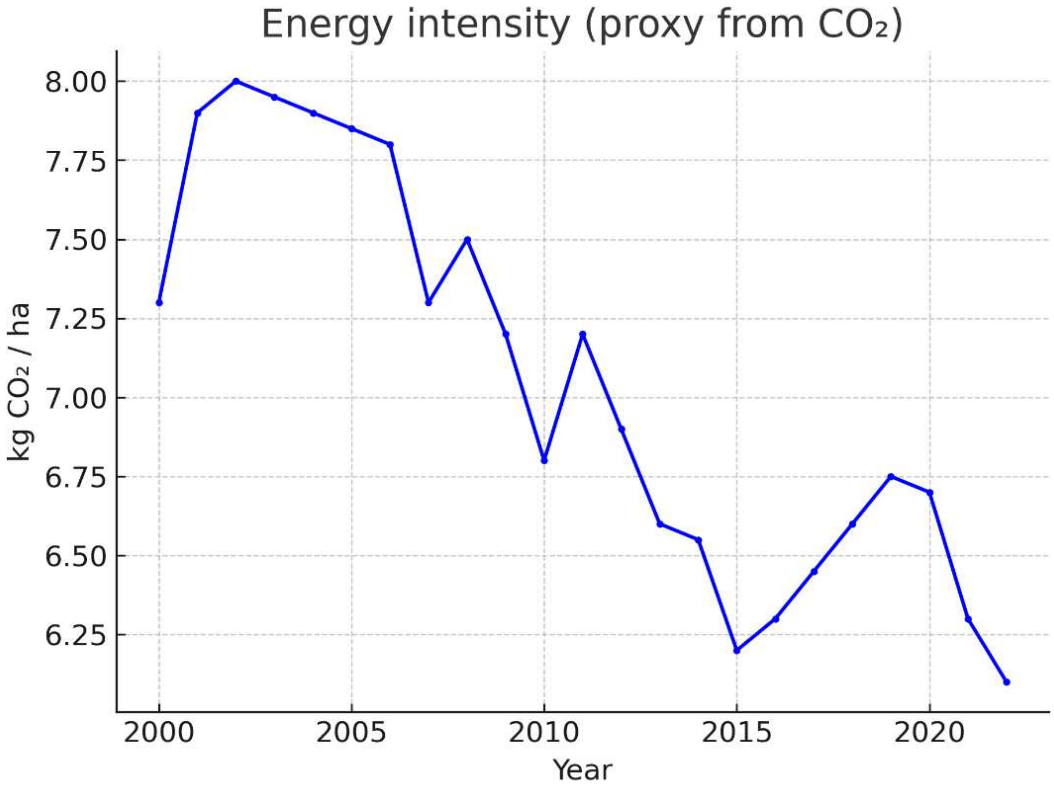

Figure 3. Development of energy intensity in agriculture in Slovakia 2000-2022
Source: own processing (2025)

Figure 3 shows the evolution of energy intensity in agriculture in Slovakia in the period 2000-2022, using the proxy indicator CO_2 emissions per hectare (kg CO_2/ha). It is therefore an indirect indicator where CO_2 emissions are assumed to correlate with energy consumption (e.g. use of fossil fuels in agricultural activities).

The evolution of energy intensity in Slovak agriculture over the period 2000-2022, expressed in terms of CO_2 emissions per hectare, shows a long-term slightly decreasing trend. Between 2000 and 2008, intensity remained relatively stable at around 7.8-8.0 kg CO_2/ha, indicating consistent energy consumption per unit of agricultural land. After 2008, however, there was a clear reversal, with a decline in energy intensity. This development can be attributed to a number of factors, notably the effects of the global economic crisis of 2008-2009, which led to production and input constraints, as well as the progressive modernisation of technologies, which reduced fossil fuel consumption and increased overall efficiency.

In the period 2010-2015, the downward trend continued with slight year-to-year fluctuations, with intensity values falling below the 7 kg CO_2/ha threshold. There was a temporary increase in intensity between 2016 and 2019, which may be related to increased mechanisation, intensification of production or changes in the area and structure of agricultural land use. This was followed by a significant decrease again after 2019, peaking around 2021 at a low of around 6.3 kg CO_2/ha. This development may have been influenced by the reduction in economic activity during the COVID-19 pandemic, the diffusion of more energy-efficient technologies, as well as the introduction of environmental subsidies and regulatory measures promoting more sustainable agriculture.

Overall, it can be concluded that Slovak agriculture has become more energy efficient during the period under review, which is reflected in a decrease in CO_2 emissions per unit of land. However, this decline has not been linear - the development has been marked by cyclical fluctuations, probably reflecting a combination of economic, political and environmental factors, as well as inter-annual climatic and production variations

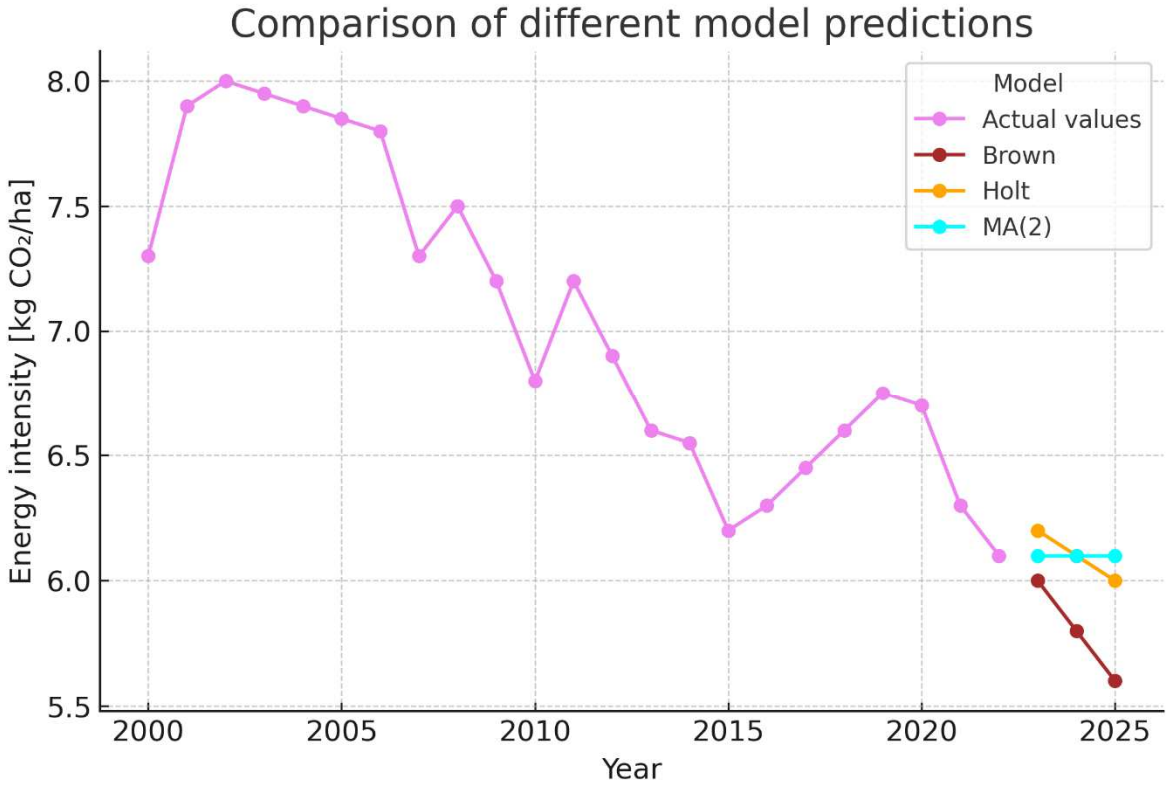

Figure 4. Prediction of energy intensity in agriculture in Slovakia, comparison of models
Source: own processing (2025)

Figure 4 shows a comparison of predictions of agricultural energy intensity in Slovakia (expressed in kg CO_2/ha) using different time series models. The purple line represents the actual values over the period 2000 to approximately 2022, with an overall decreasing trend characterised by the presence of year-to-year fluctuations.

Three different models have been applied to predict future developments. The Brownian model (red line), based on exponential smoothing with a trend, assumes a rapid decline in energy intensity until 2025. However, it is highly sensitive to recent observations and thus may overestimate the decline, especially if recent years have been exceptionally low.

The Holt model (orange line) uses double exponential smoothing that takes into account both level and trend. The forecast under this model indicates a continued decline in intensity, but with a more moderate slope compared to the Brown model. Given its balance and stability, this model can be considered a suitable baseline scenario for continued technology improvement.

In contrast, the second-order moving average model - MA(2) (turquoise line) does not predict any trend. It keeps the predicted values at the average of the last two years, thus creating a horizontal trajectory. It is therefore a conservative forecast, based on the assumption that there will be no major changes in policy or technology in the future.

The comparison shows that different models provide different predictions: while Brown and Holt assume a continued decline in energy intensity, the MA(2) model expects stagnation. Brown's model represents an optimistic extreme, but its use requires caution. Holt's model offers a more realistic view of future developments and may be most appropriate for policy planning. The MA(2) model can serve as a pessimistic reference scenario, especially in the absence of new policy interventions.

It is therefore important to consider current and expected changes in technology, environmental legislation and the structure of agricultural production when choosing the most appropriate forecasting approach. For scenario analysis, the Holt model can be used as a baseline trajectory, while Brown and MA(2) can serve as alternative extremes in terms of optimistic and conservative developments.

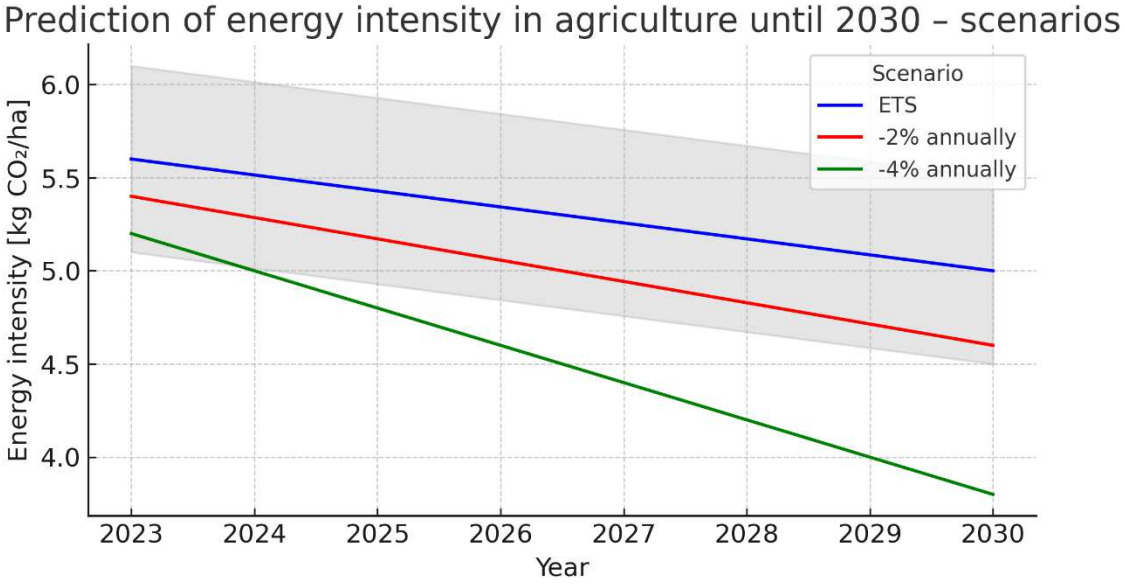

Figure 5. Prediction of energy intensity in agriculture in Slovakia until 2030 – scenarios
Source: own processing (2025)

Figure 5 shows the prediction of the energy intensity of Slovak agriculture (expressed in kg CO_2 per hectare) by 2030 using an exponential smoothing model (ETS) and compares this baseline trajectory with two alternative scenarios of emissions decline.

The blue line represents the projection based on the ETS model, which considers the historical evolution of energy intensity. This approach assumes a moderate, linear decline, with energy intensity falling to around 5.1 to 5.2 kg CO_2/ha by 2030. The grey band around the ETS line represents the confidence interval of the prediction, with its width reflecting the uncertainty of the estimate - the wider the band, the higher the prediction uncertainty.

The alternative scenarios simulate situations in which policy measures or technological changes would lead to faster reductions in the energy burden. The red line represents a scenario with an intensity reduction of 2% per year, which corresponds to a continuing trend of efficiency with moderate implementation of green measures. In this case, energy intensity would be reduced to around 4.6 kg CO_2/ha by 2030.

The Green Line represents an ambitious scenario in which energy intensity is reduced at a rate of 4% per year. Such a development would require significant changes in the form of technology modernisation, the introduction of renewable energy sources, precision agriculture and environmental regulations. Under this scenario, energy intensity could fall to around 3.8 to 3.9 kg CO_2/ha by 2030.

The comparison shows that the potential for emission reductions in agriculture exists and that the choice of policy and technology strategies will be crucial for achieving climate goals. While the ETS model serves as a conservative projection based on historical developments, alternative scenarios allow to quantify the effect of interventions in the system - from modest progress to a transformation towards low-carbon agriculture.

4. Discussion

The energy intensity of the Slovak economy, including agriculture, has declined significantly since 2005. Between 2005 and 2022, total energy intensity decreased by 46.9%, with a 41% decrease by 2021 compared to the baseline period. This trend has been one of the strongest within the European Union countries - for example, between 2005 and 2010, energy intensity fell by more than 21%, the highest in the EU over that period. Rybárova (2021)

The main reason for this decline has been the restructuring and modernisation of production, which has taken place across both industrial sectors and in agriculture. Low-energy production processes, more efficient technologies have been introduced, and work operations have been optimised. In agriculture, less energy-intensive technologies such as minimum tillage, direct drilling, combining work operations and the use of more powerful machinery have been introduced.

Another important factor has been increasing energy efficiency. Emphasis was placed on more efficient use of energy in technological processes, including rationalising the use of fertilisers and pesticides, saving fuel and reducing the number of passes through the field. Promotion of energy conservation and improved energy efficiency were also stimulated by legislation and investment in upgrading equipment and technology. Dokupilova (2024)

The transition to renewable energy and low-carbon technologies also played an important role, assessed Drotár (2020). The strategic documents of the Slovak Republic and the European Union emphasised the development of renewable energy sources, as well as the use of nuclear energy and the gradual phasing out of coal-fired power generation. Investments in alternative energy sources in agriculture have contributed to stabilising the energy market and reducing dependence on fossil fuels.

Legislative and strategic measures, such as the Integrated National Energy and Climate Plan and Slovakia's Low Carbon Development Strategy 2030, have set targets for reducing emissions and increasing energy efficiency. The promotion of precision agriculture and more energy-efficient production methods was part of these strategies. Marisova et al (2015)

Conclusion

Between 1993 and 2022, the agricultural sector in the Slovak Republic has experienced a significant decline in GHG emissions (CH_4, N_2O, CO_2). Total emissions have fallen from 4200.86 kt CO_2eq. in 1993 to 2020.58 kt CO_2eq. in 2022, a reduction of more than 50%. The most significant decrease was observed for methane (CH_4), which decreased from more than 3197 kt CO_2 eq. to 1112 kt CO_2 eq. in 2022. This development was mainly driven by changes in livestock production and the introduction of more efficient manure management.

The energy intensity of agriculture, expressed as CO_2 emissions per hectare of agricultural land, was stable between 2000 and 2008 (7.8-8.0 kg CO_2/ha). After 2008, however, there was a gradual decline, peaking around 2021 when the intensity reached around 6.3 kg CO_2/ha. This trend reflects modernisation of technology, more efficient use of energy and the impact of environmental policies.

Model projections to 2030 (ETS, Holt, Brown, MA(2)) suggest that agricultural energy intensity could fall to 5.1-5.2 kg CO_2/ha (according to the ETS model) if current trends continue. Ambitious scenarios, which assume significant technological and policy changes, estimate a decrease of up to 3.8-3.9 kg CO_2/ha. In contrast, conservative scenarios (e.g. the MA(2) model) assume stagnation at the level of recent years.

The main factors for reducing the energy intensity of the sector have been restructuring and modernisation of production, introduction of more efficient technologies, optimisation of work operations, switching to renewable energy sources, legislative measures and investment in energy savings. As a result of these changes, Slovakia was one of the EU countries with the most significant decrease in the energy intensity of agriculture between 2005 and 2010.

EU environmental policies such as the Common Agricultural Policy, the Paris Agreement and the Global Methane Pledge have also played a key role in reducing emissions and the energy burden. These policies promote low-emission technologies, precision farming, the conservation of organic soils and the transition to renewable energy sources, thus contributing to further reducing the environmental impact of agriculture.

Acknowledgements

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Digital Challenges Shaping a New Generation of Entrepreneurs

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Abstract

Research background: Digital transformation has a significant impact on business and the entrepreneurial environment, generating both new opportunities and challenges for the current and future generations of entrepreneurs. Digital technologies such as artificial intelligence (AI), big data, blockchain, cloud computing, IoT (Internet of things), etc. are fundamentally changing the way businesses operate, produce, deliver services and interact with customer.
Purpose of the article: This article reviews key digital trends in relation to entrepreneurship and the creation of the business environment, with a particular focus on the perceptions and expectations and future entrepreneurs and managers in relation to the integration of digital technologies.
Methods: The aim of the paper is to explore the expectations and attitudes of student - future entrepreneurs and managers towards digital transformation and the integration of digitalization into entrepreneurial activities. A questionnaire survey was conducted among students of the Faculty of Management and Business (FMB) at the University of Prešov, representing potential future entrepreneurs and managers. Data were analyzed using descriptive statistics and exploratory factor analysis (EFA).
Findings & Value added: Based on the analysis of survey data, the paper provides recommendations for enhancing entrepreneurial competencies in the field of digital technologies, including artificial intelligence. Furthermore, it underscores the critical role of education and institutional support in facilitating the effective adoption of advanced technological solutions.

Keywords: Digital transformation, Digital challenges, Entrepreneurship, Entrepreneurs

JEL classification: O30, L28

1. Introduction

Information systems are at the core of all businesses and cover almost all aspects of organizational life. Using technologies in organizations within the context of digital transformation requires an exercise in understanding how to demonstrate their usefulness in relation to the creation, access and sharing of contents and information systems improvements in a safe way. (Moreira, Ferreira & Seruca, 2018) According to Limsarun (2015) adopting of digital technologies and Information Technology is increasingly vital for Small and Medium-Sized Enterprises (SMEs). These tools boost efficiency, innovation, and productivity, opening new market opportunities and strengthening SMEs' role as key economic drivers. While many new entrepreneurs benefit from these digital advancements and shifting consumer behaviors, SMEs still struggle with digitizing core business functions like finance, marketing, human resources, and international collaboration. Digital transformation profoundly influences the business landscape and entrepreneurial environment, presenting both opportunities and challenges for present and future generations of entrepreneurs.

Digital transformation is profoundly transforming SMEs' business activities, bringing about comparative advantages and associated risks. (Skare, de Obesso & Ribeiro-Navarrete, 2023) The rapid pace of change in the technology has forced the business organizations to think out of box and align their operational mechanism accordingly. The need for the sustainable digital innovation is a major need of the

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current decade for meeting the increasing demands of the society in a sustainable way. Organizations, especially SMEs, should be able to deal with these challenges and rapid technological transformations through cost effective frugal business models. (Yousaf, Radulescu, Sinisi, Serbanescu & Păunescu, 2021)

Eller et al. (2020) state that digitalization significantly relates to performance, mediating the effect of information technology on performanceSmall and medium-sized enterprises (SMEs) lag behind larger firms when it comes to digitalization. This has negative impacts on firm performance.

Digital technologies such as artificial intelligence, big data, blockchain, cloud computing, IoT (Internet of things), etc. are fundamentally changing the way businesses operate, produce, deliver services and interact with customer. Also the study conducted by Zhao, Hönigsberg & Mandviwalla (2025) reveals that technologies enhancing dynamic capabilities, like analytics, mobile, IoT, platforms, and cloud, consistently improve performance. Seizing opportunities and transforming them into strategies emerge as key to translating digitalization into gains.

Digitalization, defined as the process of moving to a digital business, is no longer a choice but an imperative for all businesses across all industries and regions. (Oswald & Kleinemeier, 2017) Skare, de Obesso & Ribeiro-Navarrete (2023) find that digital transformation strengthens SMEs' ability and flexibility to address main business issues. Furthermore, findings reveal that digitally transformed SMEs have fewer concerns about access to new and traditional customers, competition changes, access to finance, increasing input costs, external shocks, and regulatory changes.

The digital economy positively enhances enterprise digital transformation, and enterprise digital transformation has a significant positive effect on enterprise innovation. (Li, Rao & Wan, 2022) The growing need for digitalization in enterprises is closely linked to the introduction of green innovations. Digital technologies enable more efficient management of resources, reduced environmental burdens and better process traceability, creating room for sustainable solutions. Through digitalization, businesses can not only improve their performance but also actively contribute to environmental goals through environmentally friendly innovations. Vo-Thai & Tran (2025) link the impact of knowledge management and digitalization on green inovation, especially in the area of sustainable competitive advantage.

Many companies digitally transform their business models, processes, and services. (Möhring, Keller, Schmidt, Sandkuhl & Zimmermann, 2023) Digitalization enables the creation of new, sustainable business models, streamlines processes, and expands access to global market. It also has a significant impact on the labor market, as automation and artificial intelligence are transforming not only the required skills but also the very nature of entrepreneurship. However, digital transformation also brings risks, such as the shortage of skilled labor and experienced managers and loss of inherent competitiveness. (Skare, de Obesso & Ribeiro-Navarrete, 2023) The digital transformation also brings other challenges, in particular related to protection and cybersecurity, regulatory requirements, lifelong learning, mentoring, supporting the entrepreneurial ecosystem, technological adaptability and rapidly changing consumer behaviour.

The role of managers has changed from managing physical assets and people to managing knowledge assets in digital enterprise environments. Therefore, it has become critical to look into the management function and the role of managers in the so-called 'digital enterprise' environment. (Gunasekaran & Ngai, 2007) The need to increase both green and digital skills of future managers (in the conditions of FMB) and the processes of adaptation of educational content to global challenges and changes are also addressed by Huttmanová, Chovancová & Mikča (2024).

2. Material and Methods

The aim of the paper is to explore the expectations and attitudes of students - future entrepreneurs and managers, towards digital transformation and the integration of digitalization into entrepreneurial activities.

A questionnaire survey was conducted among students of the Faculty of Management and Business at the University of Prešov, representing potential future entrepreneurs and managers. The survey involved 90 respondents: students enrolled in the second year of the bachelor's degree programs in Management (56 respondents) and Business Management and Marketing (34 respondents). These respondents were selected due to their potential future roles as entrepreneurs or managers, which made them a relevant group for examining attitudes toward digitalization in the entrepreneurial context. The selection of respondents was conducted using purposive sampling; participation in the survey was voluntary and anonymous, and the questionnaire was distributed digitally.

The questionnaire included both closed-ended and multiple-choice questions, focusing on several thematic areas: general attitudes toward digital technologies in business, preferred fields for their

application, self-assessment of digital competencies, sources of knowledge acquisition, and perceived digital challenges and barriers in entrepreneurship.The data collected were analyzed using descriptive statistical methods, primarily frequency analysis, to identify trends, preferences, and gaps in knowledge or competencies, and exploratory factor analysis (EFA) to identify latent factors in students' attitudes, preparedness, and digital ambitions. Six key variables were included in the EFA: digital technology adoption propensity, theoretical awareness versus practical preparedness, preference for interactive forms of learning, number of areas of digital technology use, number of perceived digitalization barriers, and number of preferred digital tools. Before applying EFA, data suitability was verified using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity, with factor extraction performed according to Kaiser's criterion and Varimax rotation.

3. Results

The results of the questionnaire survey indicate that up to 98% of respondents expressed a positive attitude towards the use of digital technologies (e.g. AI, automation, cloud solutions) in business (Figure 1). 58% of students consider digital technologies as a key tool for the future of business and 40% of respondents said that digital technologies can help but are not essential. Notably, none of the respondents expressed a negative attitude towards the need to use digital technologies in business and they do not perceive digitalizion as a risk. Thus, we can conclude that students perceive digitalization as part of business activities (58%), while they perceive its use as optional (40%).

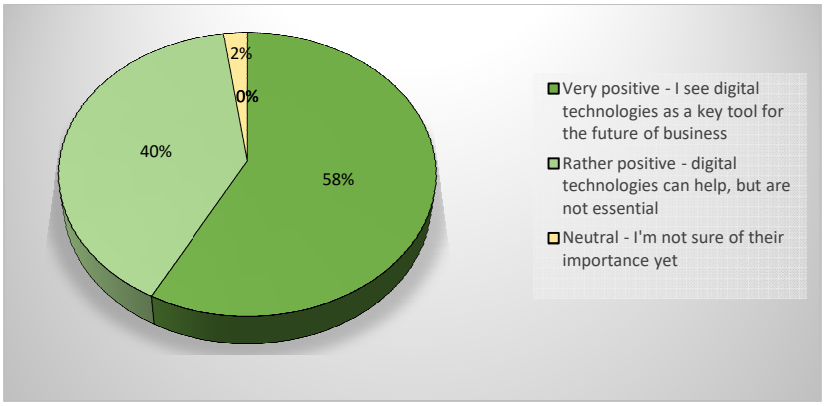

Figure 1. The findings based on the answers to the question: What is your attitude towards the use of digital technologies (e.g. AI, automation, cloud solutions) in business?
Source: own processing (2025)

In the next question (Figure 2), we focused on identifying the areas in which respondents would like to use digital technologies.

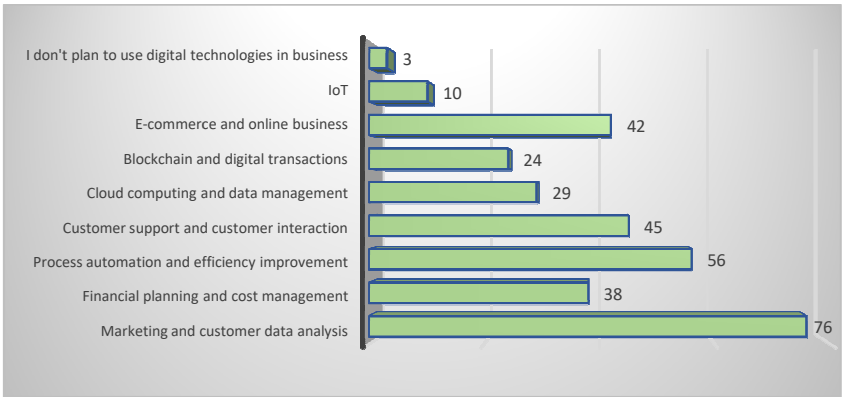

Figure 2. The findings based on the answers to the question: In which areas of business would you like to use digital technology? (multiple choice)
Source: own processing (2025)

Respondents see the greatest potential of digital technologies in the areas of marketing and customer data analytics, indicating that they recognise the importance of understanding customer needs and buying behaviour and targeted marketing. Other activities that respondents identified as potential for the use of digital technologies are process automation, customer support but they also see a wide application in the areas of e-commerce and online trading. On a positive note, only 3 respondents indicated that they do not plan to use digital technologies, which indicates a high level of digitalization and interest in it.

The results of the survey, presented in Figure 3, demonstated that there is an overwhelmingly positive attitude of the respondents towards their own knowledge in the field of digital technologies.

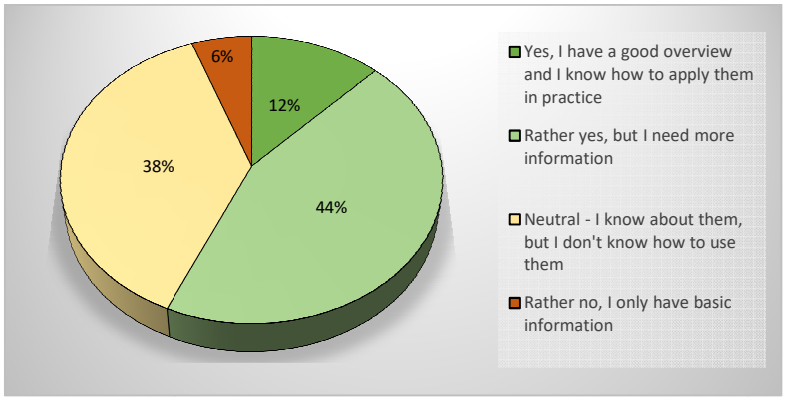

Figure 3. The findings based on the answers to the question: Do you consider your knowledge of digital technologies in business to be sufficient?
Source: own processing (2025)

As presents Figure 3, there are 11 respondents stated that they know how to use this knowledge in practice and consider it to be good. A larger group of respondents are knowledgeable about digital technologies but would need more information (40 respondents), or know about the opportunities presented by digital technologies but are unable to make full use of them (34 respondents). This neutral attitude demonstrates the creation of a gap between theoretical knowledge and practical skills. We see this as an opportunity and a challenge to implement and support the use of digital technologies more widely in the educational process, not only on the theoretical level but also by introducing students to the practical possibilities of using technologies in business. 5 of the respondents interviewed expressed that they have only basic information about the use of digital technologies in business.

When asked about their preferences in gaining knowledge about the use of AI in business (Figure 4), respondents would like to see more examples from practice, but also courses and training delivered directly at the faculty, online courses and webinars as well as face-to-face facilitation of information and the opportunity to consult and interact with AI experts. Only a very small group of students would prefer traditional sources of information such as professional publications. This reflects that practical examples and mediation of experience, or active forms of learning, are important in making AI knowledge and opportunities accessible.

Figure 4. The findings based on the answers to the question: What sources of information would you prefer for gaining knowledge about AI in business? (multiple choice)
Source: own processing (2025)

Respondents identified cybersecurity and data protection issues, as well as a lack of expertise in digital technologies, as the biggest barriers to doing business (Figure 5).

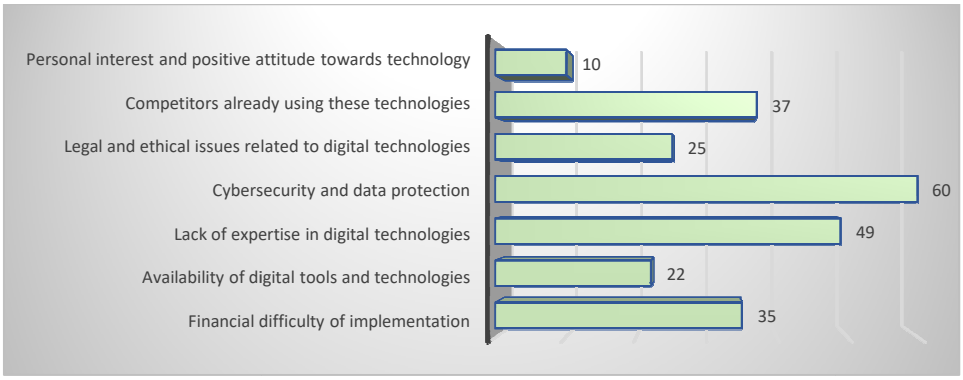

Figure 5. The findings based on the answers to the question: What digital challenges do you consider to be the biggest barriers to doing business? (multiple choice)
Source: own processing (2025)

This finding only underscores the need for deeper implementation of such topics in educational content, but also the need to disseminate the latest knowledge related to e.g. cybersecurity in the business environment, but also to make it more accessible to the wider public. Building digital awareness seems essential in today's information-dependent world. An interesting finding was that 37 respondents, said that competitors who are already able to use digital technologies are a barrier to business development. The results (Figure 5) indicate that respondents perceive the use of digital technology as a significant competitive advantage.

Responses to the question (Figure 6) about what digital tools students would like to know indicate that they were most interested in knowledge related to social networks and digital marketing tools and AI and machine learning. They indicate increased interest in the topics of Big Data Analysis, the topic of cyber security, e-commerce and online business.

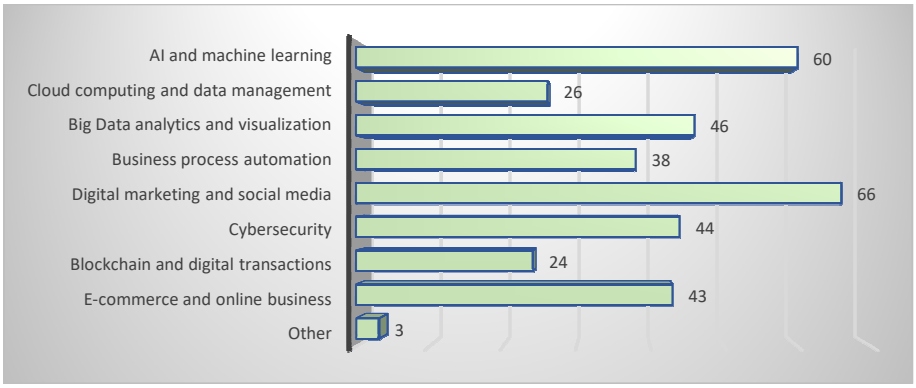

Figure 6. The findings based on the answers to the question: What digital tools would you like to master for effective business? (multiple choice)
Source: own processing (2025)

The survey provided us with answers on what direction to take in updating and modernizing the educational content and which topics need more attention in the future. There was also room for organizing complementary workshops, discussions, or expert seminars and for reaching out to practitioners who would present the topics to students in a clear but attractive way in the form of case studies, best practices, or business stories.

29 of the respondents also provided us with a response to an open-ended question about the concerns and challenges associated with the use of digital technologies today. Data security and cyber security concerns were the most common responses, particularly around the possibility of personal data misuse and hacking attacks, as well as technical failures of hardware and software. Other frequently recurring concerns included: the loss of ethical values and humane aspects of decision-making (in the case of the

use of profit-maximising AI), the replacement of attractive jobs by artificial intelligence, lack of information, funding for digitalization, Some respondents also pointed to the rapid pace of technological change and the need for employees to adapt, which may put increased pressure on the education system and the business environment.

Exploratory factor analysis was conducted to identify latent factors explaining patterns of student responses in the area of digital competencies and attitudes toward business digitalization, with six key variables included in the analysis: technological openness and attitude toward digitalization, theoretical awareness versus practical preparedness, preference for interactive learning forms, number of areas of digital technology use, number of perceived digitalization barriers, and number of preferred digital tools. The suitability of the data was verified using the Kaiser-Meyer-Olkin test (KMO = 0.60) and Bartlett's Test of Sphericity ($\chi^2 = 80.96$; $p < 0.001$), confirming a sufficient degree of correlation between variables and justifying the use of factor analysis. The basic statistics of the analyzed variables are presented in Table 1, which provides an overview of the mean values, standard deviations, and the range of each variable used in the EFA.

Table 1. Basic Statistics of Variables Used in EFA

Variable	Mean	Standard Deviation	Minimum	Maximum
Digital technology adoption propensity	2,97	0,62	1	4
Perceived Digital Competence (theory/practice)	2,63	0,77	1	4
Interactive learning preference	2,47	1,09	1	5
Areas of digital technology use	3,59	1,63	1	8
Digitalization barriers	2,64	1,23	1	7
Preferred digital tools	3,89	1,74	1	8

Source: own processing (2025)

Based on Kaiser's criterion, two main factors were extracted, which together explain 35.2% of the variability in responses (the first factor 26.5%, the second factor 8.7%). The first factor represents students' practical orientation and digital ambition - those who plan to use digital technologies in multiple business areas, want to master a broader spectrum of digital tools, prefer interactive forms of education, and perceive more barriers, which may be related to their higher engagement and awareness of digitalization complexity. The second factor captures internal disposition, positive attitude toward digitalization, and subjective assessment of readiness to use digital technologies. The EFA results show that students' digital readiness is influenced by two main dimensions - practical orientation and digital ambition on one side, and attitude and subjective readiness on the other. These findings indicate the need to support the development of digital competencies through practical opportunities, interactive forms of education, and simultaneously strengthen students' positive attitudes and self-confidence in the field of digital technologies.

Discussion and Conclusion

The findings of this paper highlight the growing relevance of digital transformation in the mindset and expectations of future entrepreneurs and managers.

The overwhelmingly positive attitude of students toward the use of digital technologies in business indicates a strong awareness of their importance in shaping modern entrepreneurial strategies. Students primarily associate digital tools with marketing, customer data analysis, and automation, which they consider essential for maintaining a competitive edge.

However, our survey also revealed a gap between theoretical knowledge and practical application, emphasizing the need to strengthen digital competencies through hands-on educational methods. The respondents' opinions can provide a realistic perspective on students' preferences regarding the expected forms of education delivery, educational approaches, and content gaps in the curriculum for future economists, managers, and entrepreneurs. These should reflect current trends and emerging challenges.

Respondents, students at Faculty of Managment and Business, expressed a preference for interactive, participative and practice-oriented learning approaches such as workshops and expert consultations, rather than traditional academic approaches. This reflects that integrating active learning approaches into educational curriculum is essential for effective digital skills development. Furthermore, issues such as cybersecurity, lack of expertise, and fear of technological obsolescence were identified as main barriers to digital adoption in business. These concerns point to the need for greater emphasis on digital risk management and the cultivation of a digitally resilient mindset among future entrepreneurs and managers.

The exploratory factor analysis revealed two principal factors underlying students' digital readiness: the first factor reflects practical orientation and digital ambition - students who plan to apply digital technologies in multiple business areas, prefer interactive learning, and wish to master a broad spectrum of tools, but also perceive more barriers, likely due to their higher engagement and awareness of digitalization complexity; the second factor captures positive attitude and subjective readiness to use digital technologies, highlighting the importance of internal motivation and confidence for future entrepreneurs and managers. These findings emphasize that effective development of digital competencies requires supporting both practical experience and the cultivation of positive attitudes toward digital transformation.

Our findings are consistent with the results of Barboutidis & Stiakakis (2023), who investigated the factors influencing the level of digital competencies among students in vocational education institutions. They concluded that educational institutions need to update their curricula to meet the current demands of the digital era, specifically through the development of tailor-made courses aimed at strengthening digital skills and addressing specific challenges such as age differences and varying levels of technology usage. This aligns with our observation of a gap between theoretical knowledge and practical digital skills among students, as well as their preference for pratice-oriented, interactive learning approaches. This need to address gaps between perceived and actual digital competence is further underscored by the study of Sciumbata (2020), who explored digital skills among Italian university students in humanities. Despite identifying themselves as confident and competent digital users, participants demonstrated significant knowledge deficits in key areas such as information literacy, cybersecurity, and problem solving. The study highlights a tendency among students to overestimate their skills, which in turn weakens their motivation to improve and may lead educators to wrongly assume that basic digital training is no longer needed. These insights are relevant beyond humanities, as our own data confirm similar differences between students' self-assessment and actual readiness to apply digital tools effectively. Similarly, Tzafilkou, Perifanou & Economides (2022) highlight differences in students' digital skills across age groups, gender, fields of study, and levels of computer experience. They propose a comprehensive model for measuring digital competencies in higher education using the SDiCoS (Students' Digital Competence Scale), which covers areas such as online learning and collaboration, use of social media, mobile and smart devices, safety, and data protection. This model could also be used to complement and validate our findings in future research phases conducted at the Faculty of Management and Business, particularly if we pursue an in-depth analysis of differences in students' digital readiness. In line with these insights, Sánchez-Caballé, Gisbert-Cervera & Esteve-Mon (2020) emphasizes that digital competence is a key requirement for students in the 21st century. This study, conducted at a Catalan university with over 11,000 undergraduate students, revealed significant variations in how digital competence is integrated into the curricula across different fields of study. These findings underscore the responsibility of educational institutions to actively support students in developing digital competence, not only through isolated courses but by embedding relevant skills across the curriculum. In the Slovak context, a similar effort to map the current ways of acquiring digital skills was carried out through a questionnaire survey among students at the University of Žilina, by Misik, Stofkova & Stalmasekova (2018). The study identified several restraints within the educational process, particularly regarding the alignment of learning outcomes with employers' expectations. The findings pointed not only to the insufficient development of digital competencies but also to a lack of focus on analytical, creative, and other advanced skills increasingly required by the labor market. These insights emphasize the importance of integrating both digital and higher-order cognitive skills into curricula to ensure students' employability and readiness for a rapidly evolving work environment.

Our results also confirm that students of Faculty of Management and Business view the use of digital technologies as a significant source of competitive advantage and have an interest in acquiring proficiency in advanced tools such as AI, big data analytics, and digital marketing systems. The outcomes of this survey offer guidance for universities and educators in adapting and enhancing educational programs to

align with the evolving expectations of future entrepreneurs. Moreover, the findings highlight the critical need for institutional backing, modern digital infrastructure, and closer collaboration with industry stakeholders to ensure the delivery of relevant, future-ready education.

A limitation of our survey was the relatively small sample size, as well as the fact that not all respondents have a preference for pursuing entrepreneurship. Their perception of the need to implement digitalization in business activities may also vary between the educational (preparatory) phase and real entrepreneurial practice. Despite these limitations, our goal is to expand the respondent sample and continue the research in order to verify potential changes in respondents' attitudes over time.

In conclusion, equipping students with both the knowledge and confidence to use digital tools effectively is not just a matter of educational innovation; it is a prerequisite for entrepreneurial success in the digital economy. Ensuring that graduates are prepared to meet the challenges of digitalization will be key to fostering innovation, competitiveness, and sustainable growth in the years to come. The results of our survey can be used mainly in the process of updating and improving the content, but also in the process of greater adjustment and adaptation of education as well as in the process of evaluating the quality of study programs, (not only) at the Faculty of Management and Business, University of Prešov.

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Regional Disparities in the Green Transformation Process across the European Union

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Abstract

Research background: Environmental sustainability has become a strategic priority for EU countries, yet their performance varies significantly across key environmental indicators. Comprehensive cross-country comparisons remain crucial for identifying policy strengths, weaknesses, and shared challenges in the green transformation process.
Purpose of the article: The aim of this article is to construct a composite Green Score index for EU member states based on five standardized indicators: municipal waste recycling, environmental taxation, renewable energy usage, greenhouse gas emissions, and energy productivity. This index serves as a tool to assess and interpret the environmental performance of countries and to explore its connection with economic development.
Methods: The analysis uses standardized z-scores to harmonize indicator scales, followed by the construction of a composite index. Principal Component Analysis (PCA) is applied to identify dominant patterns in environmental performance and cluster countries according to shared characteristics. Spearman's correlation test is used to examine the relationship between the Green Score and real GDP per capita.
Findings & Value added: The results reveal strong disparities in environmental performance across the EU, with Sweden, Slovenia, and Austria emerging as leaders, while Malta, Luxembourg, and the Czech Republic lag. PCA identified two main dimensions of environmental behavior: emission-energy efficiency and material transformation. A statistically significant positive correlation between the Green Score and real GDP per capita suggests that economic strength supports environmental progress. The study provides a data-driven framework for policymakers to benchmark sustainability efforts and design targeted strategies for green transition.

Keywords: Sustainability, Environmental indicators, Economic performance, Composite green performance index

JEL classification: Q01, Q56, O44

1. Introduction

In academic literature, transformation strategies are increasingly referred to as pathways to sustainability. They are defined as strategies aimed at achieving a desired future, based on a specific framework of sustainable thinking and practice, and supported by a clearly identifiable group of researchers and experts (Helseth et al., 2025).

In view of recent climate challenges, we need to understand the reasons behind environmental degradation. Globalization, driven by stronger connections between countries through trade, technology, and culture, has boosted economic growth but also caused environmental problems. The depletion of natural resources, pollution, and ecological degradation associated with globalization raise serious questions about their impact on sustainability (Girlovan et al., 2025).

The green transition in the EU is supported by specific targets and extensive investments. The EU has committed to reducing greenhouse gas emissions by at least 55% compared to 1990 levels by 2030. As part of the European Green Deal, it plans to invest around €1 trillion in sustainable projects and green

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technologies over the next decade. The commitments also include increasing the share of renewable energy sources to at least 32% by 2030, with wind and solar energy potentially covering up to 60% of the EU's electricity consumption by 2050. To ensure a fair transition, a “Just Transition Mechanism” has been created to mobilize at least €100 billion to support the most affected regions and sectors (Soto et al., 2025).

Ambitious climate policies, technological progress, and promoting a less resource-intensive lifestyle are key pillars in achieving the UN's sustainable development goals. The growing importance of green transformation is a response to global challenges such as climate change and environmental degradation. Environmental degradation (including deforestation, pollution, and biodiversity loss) is the result of human activity and unsustainable growth. In this context, there is a growing emphasis on the need to analyze the connections between economic growth, the use of renewable energy sources, and ecological innovations, which are essential for effectively addressing environmental problems (Li et al., 2025).

The transition to a green economy requires extensive innovation across all sectors. Regulatory frameworks that motivate industry to adopt sustainable practices play a key role, but their effectiveness depends on parallel support for science, research, and technological development. Without sufficient investment in innovation, regulation may be insufficient to ensure long-term sustainability (Kwilinski et al., 2025).

Assessing sustainable development at the district level is an important but still under-researched topic in the context of achieving the UN goals. Current research focuses either on specific regions or on selected areas of sustainability, such as poverty or the environment, which means that a holistic view is missing. The current UN framework is designed for states and municipalities, which does not provide sufficient methodological guidance for districts. The application of urban goals may be possible, but it is not always appropriate. Therefore, it is necessary to develop an assessment system adaptable to the specific characteristics of districts (Lengyel et al., 2024).

Our collective development is seriously threatened without fundamental change across the social, economic, and environmental spheres. Within the framework of globalized governance, it is necessary to strengthen local initiatives and promote horizontal cooperation between different actor groups. Effective participation of stakeholders leads to synergies and enables better connections between communities and higher levels of decision-making. Local governments are key players in this process, connecting national and global strategies with local realities, increasing public engagement, and contributing to more effective implementation of sustainability policies (Zhan et al., 2025).

When assessing sustainable economic development, it is essential to consider the interrelationships between energy, environmental protection, and the economy. These interconnections are also key to the 2030 Agenda, particularly SDG7, SDG8, and SDG13. Current professional literature increasingly points to the complex relationships between technological development, environmental sustainability, and the transition to new energy models in the context of sustainable development goals (Alvi et al., 2025).

In recent decades, green innovation has grown in importance as a tool for promoting sustainable economic development. Ecological innovation plays a key role in reducing waste and pollution and building a more sustainable economy. The theory of endogenous growth emphasizes that technological progress and innovation are the result of targeted policies and investments that lead to long-term growth. The introduction of green technologies and renewable energy sources increases productivity, promotes research and development, and contributes to GDP growth. Strict environmental policies and optimal taxation of fossil fuels motivate companies to adopt cleaner technologies and energy-efficient solutions. These measures also reduce environmental damage and increase competitiveness. Porter's hypothesis argues that environmental regulations can be a driver of innovation and economic growth. Investments in renewable energy sources increase energy security, reduce CO_2 emissions, and promote technological progress. Effective environmental policies can thus correct market failures and accelerate the transition to a cleaner and more sustainable economy (Khan et al., 2025).

Green economic initiatives are key to reducing emissions and promoting sustainable growth. Experience in various countries shows that investments in green technologies bring measurable results. The transition to a green economy requires policy reforms with an emphasis on sustainability and efficient use of resources. The main tools include green taxes, logistics, and financing that support green behavior and innovation. Green technologies, such as renewable resources and energy-efficient systems, are essential for transforming production and consumption towards sustainability (Rahman and Hossain, 2025).

Growing environmental awareness is increasing pressure on countries to adopt ambitious environmental policies. This shift is supported by education, legislation, and public interest in sustainability. However, financial investment is not enough. Political will and the ability of leaders to design and implement effective strategies are key. Successful environmental management requires clear action plans, strategic planning, and perseverance. Leaders must have not only professional skills but also intrinsic motivation and vision to guide society toward long-term sustainable solutions (Adil et al., 2025).

Although governments and institutions are stepping up their efforts towards sustainable development, the consequences of climate change on human well-being remain unclear and coordination between countries is weak. The excessive use of fossil fuels contributes significantly to the deterioration of the climate situation and weakens the stability of ecosystems and economies. Despite growing pressure to reduce emissions, global energy balances are deteriorating. Research increasingly points to the need to link energy policy with sustainable development goals, with an emphasis on renewable sources and minimizing irreversible environmental damage. However, current policy responses often encounter institutional inertia and ambiguous results (Kaymaz et al., 2025).

Despite growing efforts towards sustainable development, coordination between countries remains weak and the impacts of climate change on people are unclear. Therefore, there is an increasing emphasis on the need for "green transformational leadership" at the national level as well. This approach involves integrating sustainability into political strategies, supporting innovation, and inspiring the public to behave in an environmentally friendly manner. With growing global environmental awareness, the importance of strong leaders who shape corporate strategies towards sustainable production processes is increasing. These leaders support a deeper connection between companies and the natural environment by implementing sustainability into corporate values, motivating employees, and setting long-term environmental goals. Leaders should look beyond short-term economic goals and create conditions for long-term environmental and social stability. Such leadership is key to the transition to a low-carbon economy and the achievement of the SDGs (Suieubayeva et al., 2025).

2. Methods

This paper employs a combination of quantitative analytical approaches to assess the environmental performance of EU member states over the period 2014–2023. The dataset is derived from publicly available Eurostat statistics and includes five key environmental indicators. To ensure cross-country comparability, all indicators were standardized using z-scores. A composite environmental performance index, termed the Green Score, was then constructed as the unweighted average of these standardized indicators, reflecting each country's aggregated sustainability level.

To uncover latent patterns in the data and reduce dimensionality, Principal Component Analysis (PCA) was applied. The results were complemented by K-means clustering to group countries into typological clusters based on similar environmental profiles. To verify the robustness of the index construction, a sensitivity analysis was performed by adjusting the weights of individual indicators. Finally, descriptive statistics and Spearman's rank correlation coefficient were employed to explore the relationship between the Green Score and average real GDP per capita, accounting for the non-normal distribution of economic data.

All statistical analyses and visualizations were conducted using the R programming environment.

3. Results

For each country, average values of five environmental indicators *(Environmental tax revenues (% of GDP), Municipal waste recycling rate (%), Share of renewable sources in gross final energy consumption (%), Greenhouse gas emissions per capita (kg), Energy productivity (PPS/kg of oil equivalent))* were calculated for the entire period under review (2014–2023), thereby eliminating the impact of year-on-year fluctuations and promote the stability of the analysis.

To combine indicators with different units and scales, we used standardization using z-scores. For each indicator, the z-score was calculated according to the form:

$$z = \frac{x - \bar{x}}{\sigma} \tag{1}$$

(x = country average, $\bar{x}$ = average of all countries, σ = standard deviation of all countries)

Table 1. Standardized scores (z-scores) of environmental indicators by country (2014–2023)

Country	*Recycling rate*	*Environmental tax*	*Renewable energy*	*Greenhouse gases*	*Energy productivity*
Belgium	1.085	-0.147	-1.013	-0.299	-0.801
Bulgaria	-0.591	0.669	-0.226	0.221	-1.040
Czechia	-0.348	-1.059	-0.545	-0.553	-0.687
Denmark	0.709	0.925	1.124	-2.136	1.296
Germany	2.055	-0.384	-0.447	-0.447	0.383
Estonia	-0.514	0.391	0.818	-1.373	-0.972
Ireland	0.055	-1.628	-0.930	-1.909	3.839
Greece	-1.469	2.361	-0.284	-0.029	-0.118
Spain	-0.105	-1.216	-0.316	0.790	0.246
France	0.170	-0.686	-0.440	0.775	-0.148
Croatia	-0.858	1.908	0.517	0.968	0.115
Italy	0.701	0.855	-0.362	0.632	0.788
Cyprus	-1.606	0.286	-0.718	-0.287	-0.062
Latvia	-0.327	0.854	1.517	0.901	-0.315
Lithuania	0.443	-1.019	0.349	0.127	0.075
Luxembourg	0.878	-1.487	-1.175	-2.406	0.905
Hungary	-0.340	-0.534	-0.719	0.737	-0.288
Malta	-1.883	-0.631	-1.151	1.074	-1.196
Netherlands	1.185	1.164	-1.086	-0.766	-0.333
Austria	1.444	-0.305	1.030	0.320	0.304
Poland	-0.307	0.025	-0.730	-0.550	-0.292
Portugal	-0.641	-0.392	0.798	0.956	0.392
Romania	-1.857	-0.416	0.162	1.041	1.044
Slovenia	1.253	1.554	0.049	0.430	-0.297
Slovakia	-0.282	-0.296	-0.688	0.588	-0.687
Finland	0.172	0.187	1.709	-0.288	-1.268
Sweden	0.386	-0.784	2.968	1.290	-0.575
EU average	0.589	-0.194	-0.209	0.191	-0.307

Source: own processing (2025)

In the greenhouse gas emissions indicator, which has a negative direction of meaning, the z-score was reversed (multiplied by -1) so that higher values always represent a more favorable environmental status. Based on these standardized values, a composite Green Score index was compiled as a simple average of the five z-scores of the indicators. Each indicator was assigned the same weight (0.2), ensuring equal representation of all environmental aspects:

$$Green\ score = \frac{1}{5}\ (Z_{E_{tax}} + Z_{Recycling} + Z_{Renewable} + Z_{Energy_{productivity}} + (-Z_{Emissions})) \quad (2)$$

To verify the robustness of the index construction, a sensitivity analysis of the weights was performed. Alternative calculation scenarios were created in which the weight of one indicator was increased (to 0.4), while the others were proportionally reduced (to 0.15) so that the sum of the weight remained equal to one. The correlations between the resulting scores in the individual scenarios were highly consistent. Most correlations exceeded 0.80, with several reaching 1.00 (e.g., between Tax focus and Recycling focus). The lowest correlation was with Renewables focus (around 0.72), which still indicates significant stability in the ranking of countries.

The results demonstrated that changing weights does not fundamentally alter the ranking of countries or the scores themselves, confirming the methodological robustness and consistency of the index. Sensitivity analysis confirmed that Green Score is a methodologically stable index, resistant to purposeful adjustments of weights. It therefore provides a reliable and comparable view of countries' environmental performance, which can be used as a basis for further analysis or environmental policymaking.

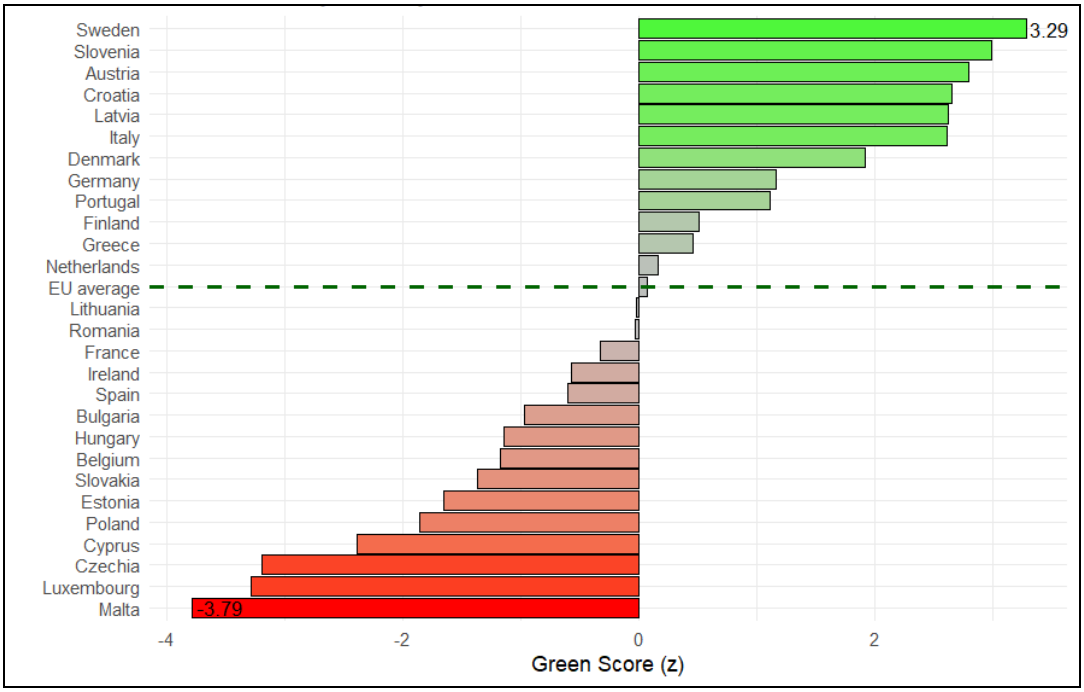

Figure 1. Green Score index (Mean of z-scores, 2014–2023)
Source: own processing (2025)

After constructing the Green Score composite index, we proceeded to the next analytical phase with the aim of identifying hidden structures and dominant patterns among individual environmental indicators. For this purpose, we used Principal Component Analysis (PCA), which allows us to reduce the complexity of the data while preserving as much of its original variability as possible. PCA transforms the original five standardized indicators (z-scores) into a smaller number of new, artificially created dimensions, the so-called principal components (PC). Each principal component represents a linear combination of the original indicators and captures a certain common pattern in the data. Based on the scree plot, two principal components were identified as the most significant: *PC1 (35.5 % of explained variability)*: This axis has the highest weight coefficients (loadings) for the variables Greenhouse_gases (0.581) and Energy_productivity (-0.541), indicating that it represents the emission-energy profile of countries. *PC2 (21.7 % of explained variability)*: This is dominated by the indicators Recycling_rate (0.701) and Renewable_energy (0.634) and is therefore an axis related to material and green transformation. Together, PC1 and PC2 capture 57.2 % of the variability in the data, which is a sufficient basis for visual and interpretative analysis of the spatial distribution of countries according to their environmental characteristics. While the PCA captures the dominant variance structure, it is acknowledged that some unobserved or less prominent environmental factors may remain beyond the scope of this two-component model.

Table 2. Loading coefficients of original indicators on the first two principal components (PCA)

Indicator	PC1	PC2
Recycling_rate_zscore	-0.346	0.701
E_tax_zscore	0.373	0.280
Renewable_energy_zscore	0.333	0.634
Greenhouse_gases_zscore	0.581	-0.162
Energy_productivity_zscore	-0.541	-0.039

Source: own processing (2025)

Each indicator contributes to these axes to varying degrees and in different directions; the loadings reveal what type of environmental behavior a given component combines. A country's position in the PCA graph (e.g., upper right quadrant) therefore reflects how strong its environmental performance is in the given dimensions: Right - strong emissions and energy performance (PC1), Top - strong performance in recycling and renewable energy sources (PC2).

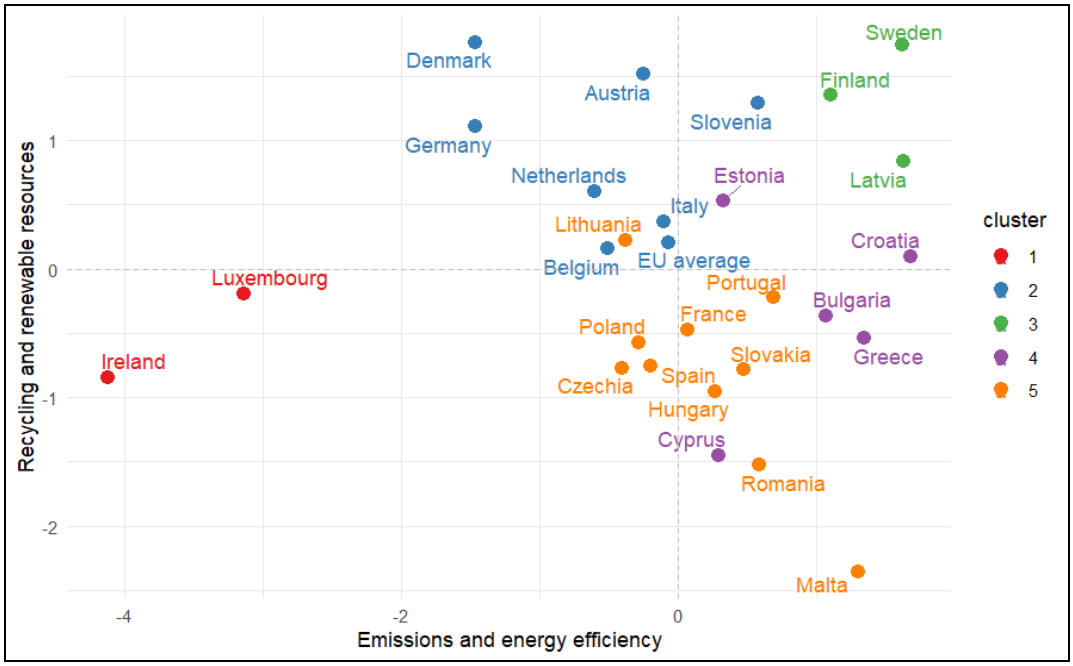

Figure 2. PCA plot of environmental indicators with K-means cluster classification of countries
Source: own processing (2025)

At the end, we looked at the relationship between the Green Score environmental index and countries economic performance, shown as average real GDP per capita from 2014 to 2023. Since real GDP did not show a normal distribution (Shapiro-Wilk $p < 0.05$), we chose the non-parametric Spearman correlation coefficient. We found a moderately strong and statistically significant positive correlation between Green Score and real GDP per capita according to Spearman's test (*rho* = 0.553, $p = 0.0027$), which, according to our analysis, indicates that economically stronger countries tend to perform better in green transformation.

4. Discussion - summary of results

In the first phase of the analysis, we focused on comparing countries based on five selected environmental indicators. Standardized values (z-scores) made it possible to identify countries with above-average and below-average performance in individual areas of environmental policy.

Municipal waste recycling: Germany (2.055), Austria (1.444) and the Netherlands (1.185) achieved the highest scores, confirming their long-term focus on waste sorting and the circular economy. Slovenia (1.253) is another positive example, having improved significantly in recent years. In contrast, Slovakia (-0.282) is slightly below the EU average. *Environmental taxes*: The countries with the highest revenues from environmental taxes were Greece (2.361), Croatia (1.908) and Slovenia (1.554). These countries use tax instruments as a means of influencing consumer and business behavior. Slovakia, with a value of (-0.296), is slightly below average, which may reflect weaker implementation of environmental fiscal policy. *Renewable energy sources*: Sweden is the clear leader (2.968), followed by Finland (1.709) and Latvia (1.517), all countries with a significant share of hydro, wind and biomass sources. Slovakia achieved a score of (-0.688), which points to the need for further development of renewable technologies. *Greenhouse gas emissions (reversed score)*: The most favorable results (i.e., lowest emissions per capita) are reported by Sweden (1.290), Malta (1.074), and Romania (1.041). Slovakia performed relatively well in this indicator, with an above-average value (0.588), which may be related to the reduction of the carbon footprint in energy and industry. *Energy productivity*: The most energy-efficient economies are Ireland (3.839), Denmark (1.296) and Luxembourg (0.905). Slovakia achieved a value of (-0.687), which indicates lower efficiency in converting energy into economic value and signals the need for investment in energy savings and technical modernization.

Based on the average of standardized values (z-scores), we have created a comprehensive Green Score indicator that provides an overview of the environmental sustainability of individual EU member states. The resulting values make it possible to identify not only environmental leaders, but also countries that are lagging in this area. Sweden achieved the highest Green Score (3.286), clearly dominated by excellent results in renewable energy, low emissions, and strong recycling policies. Other countries with

high scores are Slovenia (2.989), Austria (2.794), Croatia (2.651) and Latvia (2.630), these countries combine strong performance in several environmental dimensions. Conversely, Malta (-3.788), Luxembourg (-3.285), the Czech Republic (-3.192) and Cyprus (-2.388) have the lowest Green Scores. These countries lag behind mainly due to high emissions, low environmental taxes, or poor performance in the areas of renewable energy and energy efficiency. Slovakia, with a score of (-1.366), is below the EU average (0.070). This result reflects a combination of average to below-average performance in most of the indicators monitored, particularly in the areas of renewable energy and energy productivity. The challenge for Slovakia therefore remains not only to modernize its energy sector, but also to implement environmental policy instruments more consistently.

Principal component analysis (PCA) enabled us to reveal hidden structures and typical patterns of environmental behavior among EU member states. Based on the loadings of individual variables, the first two principal components can be interpreted as follows: *PC1 (emission-energy dimension)* - This axis separates countries according to their greenhouse gas emissions and energy productivity. *PC2 (material-transformation dimension)* - The second axis is based mainly on the rate of recycling and the use of renewable resources. The combination of these two axes allows countries to be divided into typological quadrants: Upper right quadrant - countries with strong performance in both renewable resources and energy productivity (e.g., Sweden, Finland, Latvia, Slovenia, Croatia). Lower left quadrant - countries with relatively weaker performance in all areas monitored (e.g., Ireland, Luxembourg).

At the end of the analysis, we focused on the relationship between countries' environmental performance, expressed through the Green Score index, and their economic level, represented by average real GDP per capita between 2014 and 2023. Since the distribution of real GDP was not normal (Shapiro-Wilk normality test, $p < 0.05$), we decided to use Spearman's nonparametric correlation. The results of the analysis show a moderately strong and statistically significant positive correlation between the Green Score and real GDP per capita ($rho = 0.553$; $p = 0.0027$). In other words, economically stronger countries tend to achieve higher environmental scores, suggesting that available economic resources and more developed institutions can create more favorable conditions for the implementation of environmental policies and sustainable technologies.

This result also supports the environmental Kuznets curve hypothesis, according to which, once a certain income level is reached, environmental indicators may improve as a result of technological progress, public pressure, and political priorities.

Conclusion

This paper examined the environmental performance of EU member states through five key indicators: *municipal waste recycling, environmental taxes, renewable energy, greenhouse gas emissions, and energy productivity*. By standardizing these variables and constructing a composite *Green Score*, we were able to objectively compare countries and identify both leaders and laggards in the green transformation process.

Our findings confirm substantial differences across the EU. Countries such as Sweden, Slovenia, and Austria stand out due to their consistent and balanced performance across multiple dimensions, while Malta, Luxembourg, and the Czech Republic show significant room for improvement. The results highlight the value of multi-indicator analysis, which can uncover trade-offs and complementarities between environmental policy areas.

The PCA offered an insightful typology of environmental behavior, distinguishing countries based on two dominant patterns: *emission-energy efficiency (PC1)* and *material transformation and renewable resources (PC2)*. This dimensional view allows policymakers to identify structural strengths and weaknesses that are not visible through aggregate scores alone.

Importantly, we also observed a moderately strong and statistically significant correlation between environmental performance and economic prosperity. This suggests that a country's fiscal and institutional capacity may be a critical enabler of sustainability. However, this also raises questions about equity and support mechanisms for less affluent countries striving to catch up in the green transition.

Despite the robustness of the analysis, several limitations should be acknowledged. The use of average data over a ten-year period smooths short-term fluctuations but may mask recent policy shifts.

The Green Score index and PCA mapping provide a valuable framework for evaluating environmental progress across the EU. For countries like Slovakia, the results point to a clear path forward strengthening renewable energy deployment and improving energy productivity, while leveraging

economic growth to accelerate sustainability. Coordinated, data-informed environmental strategies remain essential to ensuring that no country is left behind in Europe's green transformation.

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Greening the Entrepreneurial Path: Insights into the Development of Sustainable Start-ups

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Abstract

Research background: Green start-ups are at the forefront of driving the transition toward a sustainable economy by developing innovative solutions that address environmental challenges. Despite their critical role in accelerating sustainable development, the literature reveals persistent research gaps in understanding the unique challenges these ventures face.
Purpose of the article: This article aims to conduct a comprehensive bibliometric analysis to map the evolution of research on green start-ups and sustainable development. By identifying prime research themes, methodological approaches, and conceptual frameworks, the study seeks to clarify current knowledge structures and pinpoint gaps that hinder the effective integration of sustainability into start-up growth strategies.
Methods: The study employs a bibliometric approach using publications retrieved from the Scopus database, complemented by co-occurrence network analysis of keywords and advanced visualization tools such as VOSviewer.
Findings & Value added: The bibliometric analysis reveals that research on green start-ups is rapidly expanding, with increasing attention to themes such as sustainability-oriented innovation, business model development, policy frameworks, and the role of artificial intelligence and blockchain in fostering green entrepreneurship. This study adds nuanced value by offering a synthesized overview of the intellectual evolution of green entrepreneurship, identifying underexplored areas, and proposing directions for future research. The findings provide actionable insights for researchers, policymakers, and practitioners aiming to enhance the sustainable impact and competitiveness of green start-ups.

Keywords: Bibliometric analysis, Green start-ups, Sustainable development, Visualization

JEL classification: O31, O32, O38, M13

1. Introduction

Green start-ups are dynamic and visionary companies leading the charge toward a sustainable future. These innovative and youthful enterprises are dedicated to crafting groundbreaking products and services that not only benefit the environment but also drive us into a thriving green economy (Horne & Fichter, 2022). Imagine solutions that slash greenhouse gas emissions (GHGs), boost energy efficiency, and embrace the exciting principles of a circular economy. What challenges do green start-ups encounter in maintaining sustainability while scaling their business?

These trailblazers are shaping a greener future, and their impact is just beginning. By developing green technologies in the market, green start-ups play a crucial role in accelerating the transition towards a more sustainable economy (Bergset & Fichter, 2015). Furthermore, the significant influence of social entrepreneurship orientation (SEO) on societal performance in start-ups can be attributed to the focused nature of their activities, which typically center on specific goals rather than diversifying into a wide range of entrepreneurial endeavors and methods (Suchek et al., 2022).

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Sustainability-oriented start-ups can achieve success and effectively drive markets toward sustainable development (Sarango-Lalangui et al., 2018). These start-ups generate innovations that significantly influence the economy, society, culture, health, and overall quality of life; however, our understanding of their role in facilitating broader societal change is still limited (Fini et al., 2018).

However, green start-ups play a crucial role in the development and market introduction of radical sustainable innovations; there remains a considerable research gap concerning the specific challenges and opportunities. While much focus has been directed toward the impact of corporate greening strategies on established companies, there is notably limited research addressing studies related to green entrepreneurship (Halberstadt et al., 2021). Consequently, we aim to conduct a bibliometric review that explores and illustrates various research perspectives regarding how green start-ups navigate their sustainable growth and development. Given these considerations, it is imperative to review the evolution of different research perspectives to showcase the viewpoints on how green start-ups can achieve sustainable business success. Our research question guides this endeavor, focusing on the primary approaches, methodologies, frameworks, and tools necessary for integrating green start-ups with sustainable development.

In light of the above considerations, this bibliometric analysis aims to support researchers in sustainable start-up development by providing insights into the evolution of various research perspectives. It encourages a broader exploration of concepts and theories related to start-ups and sustainable development. However, there are lots of reviews that exist (Deyanova et al., 2022), but it is still not known what are the current gaps in the literature regarding start-ups and sustainable development that this analysis aims to address. Therefore, it is crucial to employ diverse methods and investigate additional research to develop theories that enhance findings (Máté et al., 2024). By drawing from multiple disciplines and adopting a multi-dimensional approach, this bibliometric analysis advocates for the utilization of novel visualization methods to gain a deeper understanding of the wider socio-economic impacts associated with start-up development.

A bibliometric review can identify intricate patterns, emerging trends, and gaps within the body of literature. Employing various visual tools and techniques provides an insightful and also holistic perspective on the research landscape, allowing scholars and researchers to navigate the complexities of existing studies with clarity and depth (Iscaro et al., 2021). In our study, we employed Scopus-based Artificial Intelligence (AI) and the co-occurrence network analysis of keywords (CONK) to reveal the core content of the literature and to illustrate the predominant research topics, publication timelines, and recent themes in the academic field. In addition, it provides valuable insights for policymakers and practitioners, along with recent and proposed research agenda for entrepreneurship scholars and researchers from other disciplines interested in advancing start-up development.

2. Data design and methods

The bibliometric analysis conducted utilizing the Scopus database is particularly relevant as one of the most widely employed resources for literary research across various disciplines. Scopus is renowned for its stringent indexing and classification techniques, which significantly enhance the ability to differentiate publications authored by individuals with similar names (Powell & Peterson, 2017).

Furthermore, Scopus stands out because of its extensive and comprehensive coverage of scientific literature, allowing researchers to access a wealth of information across numerous fields (Pranckutė, 2021). The platform offers unique features, such as individual profiles for authors, institutions, and scholarly series, which facilitate navigation and retrieval of relevant research content(Scopus Database, 2024). This user-centric approach enhances the practicality of Scopus in academic research. In addition, Scopus also provides complimentary access to author and source information, which is complemented by scientometric data. This capability allows scholars to perform in-depth analyses of publication trends, citation metrics, and the impact of specific works within the scientific community.

Compared to other prominent databases, e.g., PubMed and Web of Science (WoS), Scopus boasts a significantly wider array of high-impacted and indexed journals, particularly excelling in its capacity for citation analysis, especially for articles released after 1995. This comprehensive nature, alongside its user-friendly features, renders the Scopus database an invaluable tool for researchers aiming to engage in thorough and precise literary analysis. These characteristics are crucial for ensuring accurate attribution and recognition within the academic community.

Our bibliometric network and visualization analysis were utilized to select and assess the academic literature. The initial phase of this method involves performing a systematic review of the studies.

Drawing from prior evaluations of the literature on the relationship between the sustainable development of start-ups, we formulated the following research question. (RQ) What are the primary approaches that should be taken into account for integrating green start-ups with sustainable development?

Based on our identification of accessible research through specific keywords, we conducted a literature review examining the nexus between start-up and sustainable development research streams. We focused on various phrases and synonyms related to "start-up" and "sustainability," which were incorporated into our research query. In order to avoid duplication of articles, we initially utilized search phrases centered around the keyword "start-up," including (startup* OR start-up*) and in the context of academic research (spinout* OR spin-off*). We substitute sustainability with "green" OR "eco" OR "sustainable" keywords. The search was conducted in the Scopus database between 2001 and the end of the submission (30.04.2025).

Only English-language articles, conference presentations, book chapters, books, reviews, conference overviews, short surveys, notes, and editorials (including those printed in the press) were considered for further analysis.

The following Scopus query was developed taking the aforementioned factors into account:

TITLE-ABS-KEY(("green" OR "eco" OR "sustainable") AND ("startup*" OR "start-up*" OR "spinout*" OR "spin-off") AND ("sustainable growth" OR "sustainable development")) AND PUBYEAR > 2001 AND PUBYEAR < 2026.

Network visualization enhances the identification of reliable emerging research topics and themes using tools such as CONK. Network analysis is typically conducted when extensive research clusters are identified to represent the scope of a discipline (Fahimnia et al., 2015). This analysis has considered the titles, abstracts, and keywords of academic studies. VOSviewer (1.6.20) provides unrestricted access to bibliometric mapping data from Scopus, which can be utilized for further analysis. The Visualization of Similarities (VOS) algorithm facilitates the visualization of relationships between items, allowing both direct and indirect linkages to influence the proximity of entities on the network map. In this context, it can be assumed that it belongs to a broader and more diverse group of elements, exemplified by the most prominent cluster, which is color-coded in the appropriately constructed view.

3. Results and Discussion

At the time of the search, the Scopus query included 1280 such articles. First, Scopus analysis results were chosen for additional visualization. It provides a visual analysis of results broken up into categories, e.g., year, source, author, affiliation, country and territory, document type and subject area. Studies from a wide range of disciplines were chosen (Figure 1).

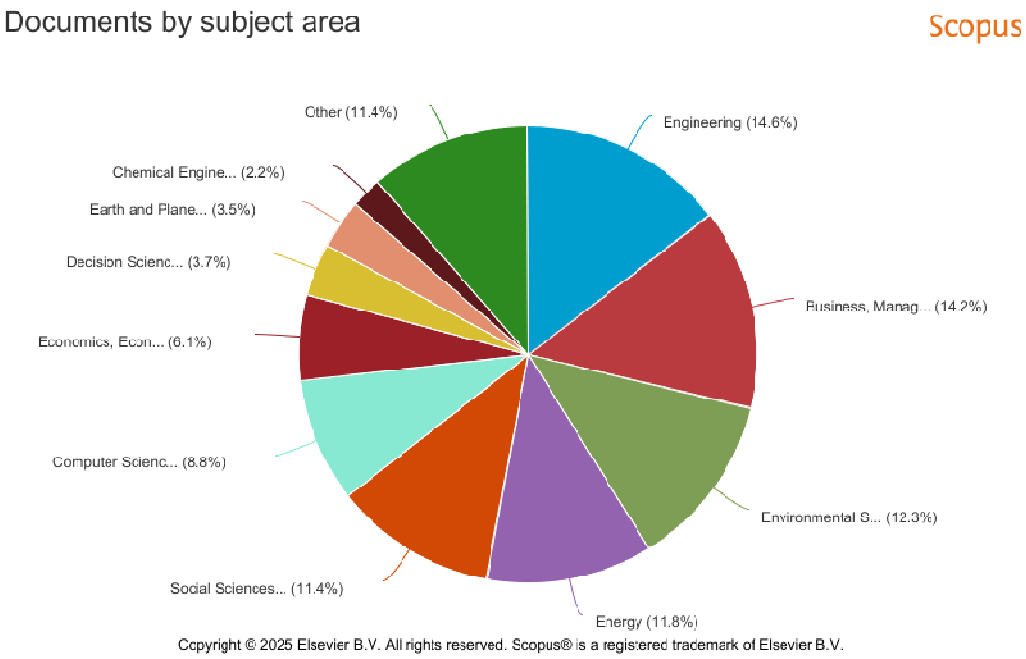

Figure 1. Documents by subject areas
Source: own processing (2025)

Engineering leads the discourse with 14.6% of the documents, emphasizing the technical and innovation-driven aspects of green start-up research. Followed by Business and Management at 14.2%, showing the significance of organizational strategy, entrepreneurship, and sustainable business models. Environmental Sciences comprises 12.3%, underscoring the sector's emphasis on ecological impact and sustainability outcomes. Energy, at 11.8%, and Social Sciences, at 11.4%, also hold substantial shares, reflecting the relevance of energy systems, policy, and societal implications.

The representation of Computer Science (8.8%) signals a growing interest in digital solutions, artificial intelligence (AI), and data-driven strategies within green entrepreneurship. Economics accounts for 6.1%, Decision Sciences (3.7%) and Earth and Planetary Sciences (3.5%) contribute to the economic, analytical, and environmental contexts of the field. Although Chemical Engineering represents a smaller segment at 2.2%, it underscores a crucial focus on material innovation and process optimization. The "Other" category, accounting for 11.4%, reflects a diversity of additional disciplines, reinforcing the interdisciplinary engagement in this research area.

This distribution figure illustrates that green start-up research transcends a single discipline, embodying an interdisciplinary nature that integrates technical, managerial, environmental, and social perspectives. The presence of engineering and business signifies that technological innovation and strategic management are essential for advancing green entrepreneurship. The notable representation of environmental, energy, and social sciences highlights the necessity for holistic approaches that take into account both ecological impacts and societal changes.

The variety of subject areas points to cross-disciplinary collaboration, particularly in fields that are currently underrepresented, such as decision sciences and chemical engineering. This analysis of the subject area emphasizes the complexity and richness of the green start-up research landscape. It stresses the importance of fostering interdisciplinary research, as well as integrating diverse methodologies to address the multifaceted challenges and opportunities within sustainable start-up development.

The line graph (Figure 2) from the Scopus database shows the progression of research output on green start-ups from 2002 to 2025. Initially, research activity was relatively modest, with annual publications generally remaining below 50. However, a steady increase in publications is evident, reaching around 50 documents by 2018. This period signifies the onset of heightened academic interest, likely spurred by growing global consciousness regarding climate change and sustainability.

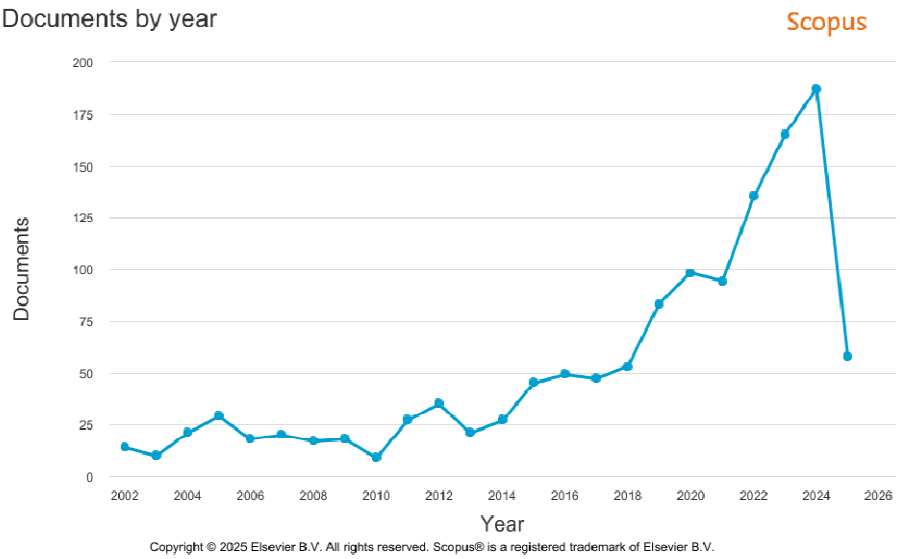

Figure 2. Documents by year
Source: own processing (2025)

A dramatic surge in research output occurred starting in 2019, with the number of publications rising sharply and peaking the number of publications cc. 200 documents in 2024. This rapid expansion indicates a substantial increase in scholarly interest, presumably driven by international policy initiatives, augmented funding, and the integration of green innovation into business and policy frameworks. The publication trend highlights the emergence of green start-ups as a significant area of interdisciplinary research, particularly in the last five years. This recent uptick reflects the relevance of sustainable entrepreneurship in tackling global environmental challenges.

The network visualization created with VOSviewer provides a detailed mapping of the intellectual structure of research on green start-ups and sustainable development based on co-occurrence patterns of author keywords (Figure 3).

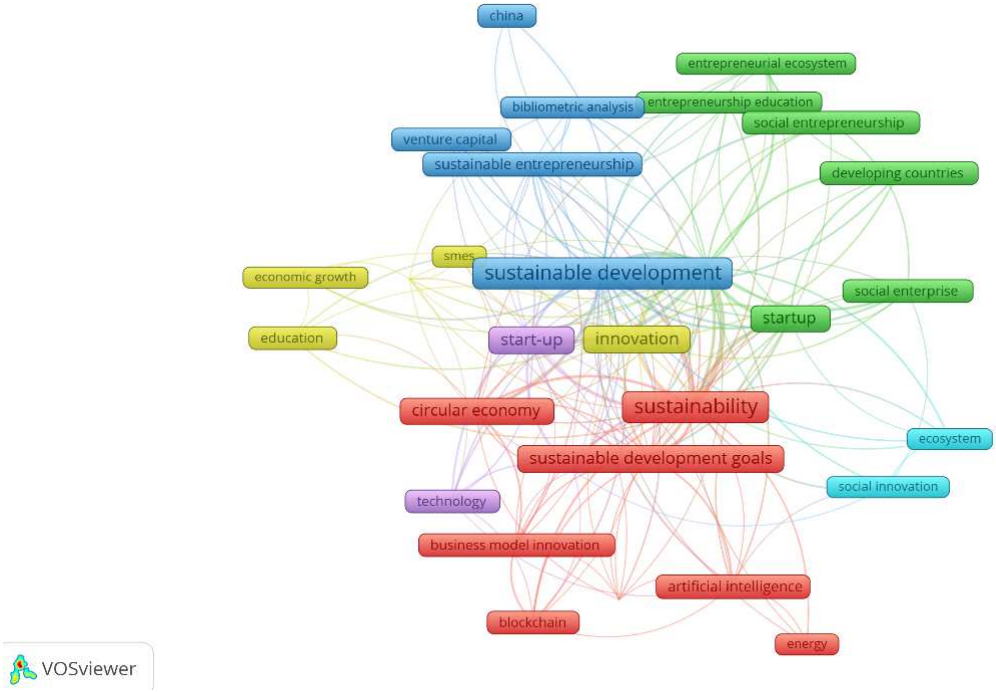

Figure 3. Co-occurrence of authors' keyword network
Source: own processing (2025)

This visualization reveals distinct, color-coded clusters that represent different thematic areas:

- Blue cluster centers around "sustainable development" and "sustainable entrepreneurship," with connections to "venture capital," "bibliometric analysis," and "China." It indicates a focus on funding mechanisms and regional contexts. Access to green finance is critical for green start-ups (Raza et al., 2023). Green investments, green credit, and other financial mechanisms that support sustainable business practices. These financial tools not only help in reducing operational costs but also improve the financial performance of the start-ups (George Bocean et al., 2024)
- The red cluster encompasses "sustainability," "circular economy," and "sustainable development goals," along with technology-related terms such as "blockchain," "artificial intelligence," and "business model innovation." Sustainable business model innovation, circular economy business model and sharing economy business model. (Bocken et al., 2019; Huynh, 2022). Combining digital technologies, e.g., AI and blockchain technology, with green initiatives can drive excellence and sustainability in business operations. This green approach includes developing digital solutions to enhance Environmental, Social and Governance (ESG) performance and sustainability (Rong et al., 2025).
- Green cluster focuses on social aspects, featuring terms like "social entrepreneurship," "entrepreneurial ecosystem," "entrepreneurship education," and "developing countries." It highlights the significance of educational and contextual factors in sustainability. Social entrepreneurs make their proposals based on a strong commitment to their social vision, respect for sustainable practices, and a drive for innovation. Entrepreneurship education can support these start-ups by providing resources and knowledge to enhance their sustainability impact (Lamperti et al., 2023).
- Yellow cluster connects "innovation," "SMEs," "economic growth," and "education," emphasizing the economic impact of these elements. Sustainable start-ups often adopt business models that integrate environmental, social, and economic goals (Bocken et al., 2019). Emphasizing resilience and adaptability in decision-making processes maintaining competitive advantages while pursuing sustainability goals and key success factors (Christodoulou et al., 2024).
- The purple cluster includes "start-up" and "technology," representing the core intersection of entrepreneurship and technology. Green start-ups often leverage novel and hardware technologies to

enhance their climate performance, even though this might sometimes come at the expense of immediate business performance (Leendertse et al., 2021). Combining digital technologies (AI, blockchain) with green initiatives can drive excellence and sustainability in business operations. This green approach includes developing digital solutions to enhance ESG performance and sustainability (Rong et al., 2025).

- The light blue cluster incorporates "ecosystem" and "social innovation," suggesting an emerging focus on systemic approaches within the field. Academic entrepreneurship and sustainable development are closely intertwined. University Business Incubators (UBIs) have implemented a program aimed at promoting sustainable entrepreneurship and assessing its effects on regional development (Wagner, 2021).

"Sustainable development" appears as the most prominent node in the visualization (the largest blue node), serving as a concept that connects multiple research streams. "Sustainability" and "innovation" act as secondary hubs with various connections, demonstrating their relevance across various disciplines. The co-occurrence of the keywords' network map illustrates strong interconnections between sustainability-related concepts and entrepreneurship terms, keywords confirming the interdisciplinary nature of this research field.

Emerging technologies such as "artificial intelligence" and "blockchain" are increasingly being integrated into sustainability research, particularly in connection with business model innovation and circular economy concepts. The prominence of "sustainable development goals" suggests alignment with global policy frameworks. Moreover, the connection between "circular economy" and "business model innovation" indicates a growing interest in how green start-ups are adopting alternative economic models (Dobrynina et al., 2024).

The presence of "developing countries" linked to „social entrepreneurship“ reflects a heightened focus on sustainability challenges in geographic contexts. Educational factors, e.g., "entrepreneurship education," are closely tied to ecosystem development, emphasizing the importance of capacity building. Overall, this network visualization effectively captures the multidisciplinary nature of green start-up research, showcasing how technological, business, social, and policy perspectives intersect within the sustainability domain.

The overlay visualization depicted in Figure 4 offers a valuable chronological perspective on the keyword co-occurrence network, utilizing a color gradient that transitions from blue (representing 2019) to yellow (indicating 2023) to highlight when specific research themes gained prominence in the green start-up literature.

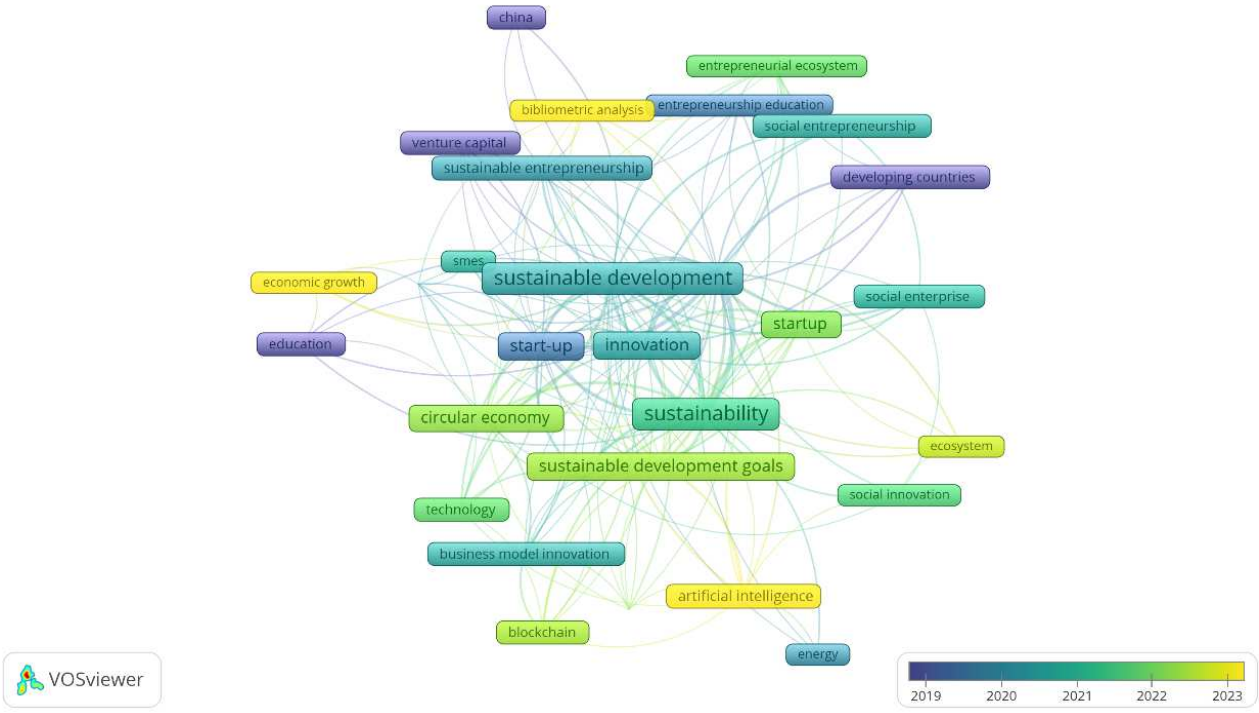

Figure 4. Co-occurrence of authors' keyword overlay
Source: own processing (2025)

The terms "sustainable development" and "sustainable entrepreneurship" are represented in darker blue, reflecting their role as foundational concepts in the early stages of the field. Similarly, "start-up" as a general concept is also colored blue, emphasizing its significance in earlier discussions. The term "sustainability" appears in teal, illustrating its ongoing relevance as the field has evolved.

The "circular economy" emerges in green, suggesting that this implementation framework began to gain traction somewhat later. "Business model innovation," also in teal, signals an increasing focus on the practical applications of sustainability principles.

Recent research frontiers from 2022 to 2023 are represented, with "artificial intelligence" in bright yellow, marking it as one of the latest research directions. "Blockchain," in light green, denotes another emerging technological focus. The term "ecosystem," displayed in yellow, indicates a growing interest in systemic approaches to green entrepreneurship, while "social innovation," in green-yellow, suggests recent attention to socially-oriented solutions.

The presence of "bibliometric analysis" in yellow reveals that meta-analytical approaches are a relatively recent development, signaling an increasing maturity within the research field. "Education," shown in purple, indicates a distinct research thread with its developmental timeline.

This temporal pattern aligns with broader technological and policy trends, demonstrating how research on green start-ups has adapted to emerging opportunities and challenges in sustainability. The most recent yellow nodes suggest that technological innovation and systems thinking represent the current frontiers in the expansion of green entrepreneurship research.

Conclusion

This bibliometric analysis suggests that green start-up research has matured significantly but continues to evolve rapidly. The field offers valuable insights for both theory development and practical application. For researchers, it demonstrates the value of cross-disciplinary approaches and emerging technological frameworks. For practitioners and policymakers, it highlights the importance of integrated support systems that address the unique challenges of sustainable innovation. The analysis confirms that green entrepreneurship research has established itself as a distinct and vibrant field that will continue to play a crucial role in advancing sustainable development goals and addressing global environmental challenges.

The field of green start-up research has undergone remarkable growth, transforming from a niche academic interest to a mainstream research domain. The publication trajectory reflects the increasing global urgency around climate change and sustainability transitions, with research output nearly quadrupling between 2018 and 2024. The subject area distribution confirms that green entrepreneurship research is fundamentally interdisciplinary. This cross-disciplinary nature provides rich opportunities for collaborative research but also presents challenges in developing cohesive theoretical frameworks.

The keyword co-occurrence network analysis reveals a clear conceptual structure organized around "sustainable development" with multiple interconnected clusters representing different research streams. The overlay visualization demonstrates a strategic evolution from foundational concepts of sustainable entrepreneurship), for instance, implementation frameworks like circular economy, digital lean and ultimately to cutting-edge technological applications (Csernoch, 2025; Gronba-Chyła et al., 2024).

Recent research trends (2022-2023) indicate an increasing emphasis on several key areas: (1) digital transformation and technological innovation (e.g., AI and blockchain) as vital enablers of sustainability; (2) systems-level approaches, including ecosystems and social innovation, which tackle complex sustainability challenges; (3) the social dimensions of entrepreneurship, especially within developing countries; (4) the integration of green start-ups with established sustainability frameworks, including the Sustainable Development Goals (SDGs) and the circular economy; and (5) the educational and capacity-building aspects of entrepreneurial development.

Despite the field's rapid growth, several research gaps and limitations remain evident. Limited integration exists between technological innovation clusters and social entrepreneurship domains. Disruptive innovation is emerging as a novel theme in the context of green start-ups, focusing on how innovative technologies and sustainable business models can transform small business operations and drive sustainable growth. This theme explores the role of innovation intermediaries, risk management, and support mechanisms in fostering the success of green start-ups. Moreover, there are opportunities for deeper investigation of funding mechanisms beyond traditional venture capital and potential for more applied research on scaling successful green business models (Becsky-Nagy & Fazekas, 2024).

Acknowledgments
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Consumer Values: Exploring the Relationship Between Consumer Materialism and Circular Economy Principles

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Abstract

Research background: Consumer materialism is a social phenomenon that reflects individuals' value orientation toward ownership, possessions, and consumption as sources of life fulfillment.
In the context of the climate crisis and environmental challenges, the need for sustainable behavior and responsible consumption is gaining increasing importance. The transition to a circular economy requires not only changes in production processes but also a shift in consumer thinking and values.
Purpose of the article: The aim of the article is to identify and analyze the relationships between the level of consumer materialism and the perception of circular economy principles among Slovak consumers.
The research focuses on assessing the degree of materialistic orientation and its compatibility with sustainable behavior and consumers' willingness to adjust their purchasing habits in favor of environmental responsibility.
Methods: Data collection was carried out using an online questionnaire consisting of 30 questions.
The initial section focused on collecting socio-demographic data, while the primary part of the questionnaire explored respondents' attitudes toward consumer materialism and their perception of the circular economy. To measure materialism, a validated scale developed by Richins (2004) was applied, covering three key dimensions: success, centrality, and happiness.
Findings & Value added: The findings offer insight into how consumer values relate to sustainability within the circular economy. The article enriches discussions on the compatibility of consumerism and circular principles, contributing to environmental psychology and marketing. It also demonstrates the usefulness of validated tools for future research in diverse socio-cultural settings.

Keywords: Consumer materialism, Circular economy, Consumer behavior, Consumer values, Sustainability

JEL classification: D12, M30, Q56

1. Introduction

In the past decade, academic research on circular economy has experienced exceptionally dynamic development. Scientific publications are dominated by approaches focused on natural sciences, technology, and business management. The perspectives of social sciences remain significantly underrepresented in the relevant literature (Zavos et al., 2024). Circular economy has gained significant importance in both business and political environments. It presents an opportunity to promote sustainable development through the protection of natural resources, climate change mitigation, and the minimization of negative environmental impacts. It contributes to the well-being of current and future generations. Despite the positive development of circular economy initiatives, there remains a risk of focusing on gradual and ineffective innovations that will not lead to substantial changes (Bocken, 2022).

Environmental problems have a multitude of causes. If we do not want to jeopardize the future of the planet and expose future generations to an uninhabitable world, it is essential to critically reconsider many aspects of life. The dominant economic system today is the linear model, which emerged after the industrial revolution. This model is based on the principle of "take – make – consume – dispose," in industries, agriculture, and trade. In this process, the emphasis is primarily on industrial production, while environmental protection issues remain on the periphery of concern.

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It is expected that in the coming decades, the global population will continue to grow, which will further deepen problems related to food shortages, housing, and other vital resources. An alternative to the unsustainable linear model is the concept of the circular economy, which is defined as an approach focused on maintaining the value of products, materials, and resources in the economy for as long as possible, while simultaneously minimizing waste production. Circular economy supports the transformation toward a renewable industrial economy, the use of renewable energy sources, the reduction of toxic substances, and more efficient resource management, thereby actively contributing to environmental protection and sustainable development (Nart, Öztürk, 2021).

Each of us, both individually and collectively, contributes to climate change, CO2 emissions, resource consumption, and societal attitudes and behaviors. Due to climate change, soil and water scarcity, consumption must be reduced. These challenges require a shift in the approach to production and consumption, necessitating not only technological innovations but also changes in societal values and habits (Papamichael et al., 2023). Insufficient interest and low levels of consumer awareness represent one of the key barriers to the development of the circular economy. Although consumers play a crucial role in this process, their significance and behavior remain relatively underexplored in academic literature, as most research focuses primarily on the implementation of circular principles in the business and industrial sectors (Szilagyi et al., 2022).

The goal of the circular economy is to decouple value creation from waste generation and resource use through a radical transformation of production and consumption systems. With the growth of the global population and rising living standards, the demand for basic needs such as food, healthcare, and energy resources is also increasing. The development of manufacturing automation has simultaneously supported mass production and consumption, leading to a rise in waste generation. The traditional linear economic model has thus contributed to a significant increase in waste and the depletion of natural resources, severely threatening the environment and public health. In response to these challenges, an alternative approach in the form of the circular economy concept is gaining ground in the global industrial landscape. This model, based on the principles of restoration, reuse, and waste minimization, offers a promising solution for environmental protection and supports economic development through more efficient use of energy and resources (Mukherjee et al., 2023).

The fashion industry causes environmental issues, mainly due to the shortening of the life cycle of garments and the culture of fast disposal. The circular economy provides solutions to minimize and prevent these problems through innovative circular business models that require changes in consumer behavior (Gomes et al., 2022). The transition of the agri-food sector from the traditional linear model to a circular bioeconomy model, which emphasizes reducing waste, recycling, regeneration, reuse, and renewal, is a crucial step toward meeting the needs of the growing global population in the areas of food and fuel in environmentally friendly ways. This approach also involves a shift from the use of fossil fuels and products toward biofuels and biologically renewable resources (Khanna et al., 2024; Hamam et al., 2024).

Strong materialistic values contribute to the maintenance of consumer capitalism, yet they can have a negative impact on personal well-being, social justice, and environmental sustainability. Materialism is a set of values and goals focused on wealth, possessions, social status, and position. These goals are key components of an individual's value system, often in contrast with goals aimed at the well-being of others or personal and spiritual growth. Significant evidence suggests that individuals who prioritize materialistic values tend to consume more and increase their debt (Isham et al., 2022; Kasser, 2016).

The connection between consumption, materialism, and the circular economy is essential for understanding the broader context of environmental challenges and solutions. Consumption is a fundamental driver of economic growth in contemporary society. In many cases, it is fueled by materialistic values that promote a constant desire for wealth, possessions, and social status. This value system often leads to excessive and unsustainable behavior, manifesting in increased consumption of products and services, and consequently, in excessive waste production. In such an environment, the transition to a circular economy is crucial, as it offers an alternative approach to production and consumption processes that does not focus on depleting natural resources and generating waste, but rather on restoration, recycling, and the reuse of materials (Hamam et al., 2024; Mukherjee et al., 2023). This shift in values is essential for driving the transition towards a circular economy, as it encourages sustainable consumption and production patterns, contributing to environmental protection and the efficient use of resources.

1.1 Consumption and Materialism

For a long time, economists studying consumption ignored the motivations behind consumer behavior. Traditional economic theory of the 20th century assumed that consumers behave rationally to maximize their utility. However, consumption is likely one of the economic activities most influenced by the social context. It is also important to recognize that consumption does not only involve satisfying our basic physical needs, such as food or shelter; material objects are also closely linked to the psychological and social aspects of an individual's life. Through material things, people create and maintain their identity. Physical objects have the ability to provoke various social discussions regarding status, identity, social cohesion, and personal or cultural significance (Goodwin et al., 2019).

According to Panitapu (2013), consumer behavior is closely related to various psychological processes that shape how individuals approach consumption and make purchase decisions. Consumers go through several psychological stages, including identifying their needs, searching for solutions to meet them, deciding on a purchase, and interpreting information and evaluating available options. This process begins with the awareness of a need or desire, which arises as a response to a certain stimulus, whether it is practical needs such as food and clothing, or emotional needs such as status, comfort, or security.

Materialism can be understood as an excessive interest in money and material possessions. Since the 1990s, a significant number of psychologists and philosophers have increasingly addressed this issue, attempting to find appropriate methods for measuring it. Materialism has long been considered one of the less desirable traits of a person (Maison, Adamczyk, 2020). The most widely recognized concept of materialism, which has also become the most commonly used tool for measuring it, is the so-called material values scale. Richins (2004) states that materialism has three basic dimensions:

- Centrality – acquiring possessions occupies a central place in an individual’s life;
- Success – treating possessions as a criterion for individual life success;
- Happiness – the belief that owning and accumulating material goods will lead to happiness and life satisfaction for the individual.

A factor supporting materialism is also the abundance of advertisements in various media and social networks. Social networks play a significant role in spreading materialistic values in modern society. Many of their features, such as comparison, showcasing success, advertising, and the influence of influencers, lead to materialism becoming an increasingly prominent measure of happiness and personal success. The societal pressure to be the most beautiful, funniest, or popular is one of the reasons why the current generation differs from previous ones. The lack of deep conversations and long-lasting relationships promotes the tendency to show one's value to the world in various ways (Hwang, Jeong, 2020). Ultimately, it depends on the consumer's decision whether they consider a shared future important or not. The current lifestyle, on a large scale, wastes precious natural resources, produces large amounts of waste, and contributes to global warming and climate change (Pillai, 2013).

Current materialism and consumer behavior, fueled by advertising, social media, and societal pressure to succeed, significantly influence our relationship with natural resources. Circular economy offers a solution to this issue by helping shift the focus from endless consumption to more sustainable and efficient use of existing resources, thereby reducing pressure on the environment and promoting a balance between consumption and environmental protection (Hwang, Jeong, 2020; Goodwin et al., 2019).

1.2 Circular Economy

The concept of the circular economy has become a strong alternative to the linear economic model, which is a major factor contributing to the environmental problems that increasingly affect us as a society. The linear model follows the cycle of "take, make, dispose," where raw materials are extracted, used to produce goods, and then discarded after consumption. This leads to the depletion of natural resources, pollution, and excessive waste production, worsening global sustainability issues. The "take, make, dispose" model accurately represents the essence of the linear economy but does not account for other critical phases that contribute to unsustainability. These phases include, for example, the transportation of raw materials and goods, which are energy-intensive and lead to emissions and further resource consumption. This has a negative impact on the environment. The main goal of the circular economy is to shift from the linear approach to a model that focuses on reducing waste, reusing, recycling, and renewing (Sillanpää, Ncibi, 2019).

Achieving sustainable development is currently an essential condition for all societies and governments. Agenda 2030 presents an action plan that focuses on all sectors and stakeholders. Key areas

for achieving social change include economic growth, technological progress, social development, peace, justice, environmental protection, inclusion, and prosperity. Moreover, the circular economy has the potential to increase the efficiency of product and resource utilization, which can contribute to this change. However, there is a lack of research in the literature on whether companies' focus on circular economy strategies can actually contribute to achieving the goals of sustainable development (Gallardo-Vázquez et al., 2024).

The circular economy can be achieved through the repurposing, renovation, reuse, and recycling of resources, as well as the repair of goods and resources consumed during production or usage, thereby protecting the natural environment. Essentially, it is a long-lasting closed system of product services (Macarthur Foundation, 2013). This system balances economic development with environmental and resource protection. It leads to higher operational efficiency through responsible behavior in both production and consumption.

From a consumer perspective, this means a shift in purchasing habits and approaches to product use. Consumers are becoming more environmentally responsible and are starting to focus on products that have a longer lifespan, are easily repairable, recyclable, or can be returned to manufacturing cycles. This approach can also manifest in preferences for products and services that offer reuse or sharing options, such as repairs, rentals, or product exchanges. Another aspect is the change in consumer attitudes toward unnecessary consumption. The circular economy aims to redirect attention to the quality and value of products rather than their quantity. This includes favoring sustainable and ethical brands that are committed to eco-friendly and fair production processes. Consumers adopting this approach often seek products that promote environmental responsibility, reduce waste, and minimize negative impacts on the environment. From a consumer's point of view, the circular economy requires a rethinking of traditional consumption patterns and the adoption of a responsible approach to consumption, which has a positive impact not only on personal development but also on the broader environmental and social context (Nart, Öztürk, 2021; Maison, Adamczyk, 2020).

The circular economy extends into many areas of economic and social life, impacting a wide range of industries and activities. This approach goes beyond the manufacturing sector and also influences consumer habits, business strategies, public policy, and environmental initiatives (Geissdoerfer et al., 2017). The circular economy is increasingly mentioned in areas such as:

- Manufacturing and industry;
- Agriculture and food processing;
- Energy;
- Education and public policy;
- Healthcare;
- Commerce and consumer behavior.

The circular economy transcends many aspects of our lives and has the potential to significantly influence how businesses, governments, individuals, and societies operate. This model offers a more sustainable alternative to the traditional economic system, promoting long-term balance between growth, environmental protection, and social responsibility (Saha et al., 2025; Bocken et al., 2022).

1.3 Variables in the Context of Materialism and Circular Economy

The growing interest in the field of consumer behavior, materialism, and the circular economy in recent years has created an ideal foundation for deeper exploration of various variables that can significantly contribute to a better understanding of the issue (Geissdoerfer et al., 2017). This interest reflects the complexity and interconnectedness of these phenomena in contemporary society, where patterns of consumption and attitudes toward the environment are constantly evolving and influencing each other. Studies suggest that materialistic consumers may be less willing to engage in the circular economy, while others indicate that cultural and demographic factors such as age, gender, or country of origin can significantly influence their approach to such activities. For example, younger people are more inclined towards materialism and prefer new products, while older generations are more likely to donate or reuse items. These factors point to the need to tailor approaches to supporting the circular economy depending on the target group and cultural context. Ultimately, it is important to consider the dynamics between materialism and the values of the circular economy in order to create effective strategies for promoting sustainable consumer behavior.

Young adults in Northern European cities place great value on using second-hand and inherited items when creating households, which fosters sustainable behavior. These consumers appreciate not only the aesthetics and durability of materials but also the stories that these items carry, contributing to the extension of their life cycle. These practices are associated with a low rate of material circulation within households, positively influencing the development of the circular economy (Varpa et al., 2024). Similarly, Kevin van Langen et al. (2017) examined how consumers perceive various end-of-life scenarios for electronic products, such as reuse, recycling, and remanufacturing. The findings show that consumers prefer reuse over recycling and remanufacturing, with their decisions being influenced by factors such as age, education, and environmental awareness. These results highlight the need to consider demographic and environmental factors when designing policies and strategies to support the transition to a circular economy.

The study by Jaspers and Pieters (2016) analyzed the development of materialism throughout life. It was found that materialism follows a curved trajectory, with the lowest levels occurring during middle age, while higher levels are observed before and after this period. This conclusion challenges the common belief that materialism decreases with age. Furthermore, it was found that the influence of age on materialism varies across its three main themes: the central role of acquisition, success defined by ownership, and acquisition as a path to happiness. These findings suggest that materialism changes over the course of life and that these changes are complex and dependent on various factors.

Issock (2023) explored the relationship between materialism, sustainable practices, and subjective well-being in the context of electronic waste in developing markets. The results suggest that materialism and sustainable practices can coexist and be mutually reinforcing, with the ecological disposal of electronic waste contributing to an increase in consumers' subjective well-being. This research provides empirical evidence supporting the integration of materialism and sustainability in policies and initiatives aimed at responsible management of electronic waste in households..

Kulli et al. (2023) analyzed consumer behavior in Albania, Poland, and Portugal within the context of the circular economy, focusing on generational differences. They found that the understanding of the definition of the circular economy varies across nationalities and generations (X, Y, Z), with preferences for purchasing second-hand products and the places where they are bought being influenced by age and country of origin. These findings suggest the need to tailor strategies for promoting circular behavior to different demographic groups and cultural contexts. Similarly, Ostrowska (2024) shows that age significantly influences consumer behavior regarding circular waste management. Younger people tend to buy new products, are willing to sell unnecessary items, but often store them, while older consumers are more willing to donate functional items to those in need. These findings again highlight the importance of considering age when designing strategies to support the circular economy. Likewise, Antinienė et al. (2021) analyzed the impact of demographic factors on materialistic values among consumers in Lithuania, finding that younger respondents exhibited higher levels of materialism than older ones. Women differed from men in dimensions such as the importance of ownership, happiness, and success, with respondents with lower incomes and education showing more materialistic values. These studies emphasize the key role of age, gender, and other demographic factors in shaping consumer values and behavior related to the circular economy and materialism.

In psychological and marketing research, several validated methodologies are commonly used to measure materialism. A well-known one is the Material Values Scale (MVS) by Richins (2004), which we used for the purposes of our study. Another significant methodology is Belk’s materialism scale (Belk, 1985), which assesses materialism through three factors: ownership, greed, and unwillingness to share. A review of the literature reveals various other adaptations for measuring consumer materialism, such as the MVS-c, MAS, YMS, SMS, and others.

2. Methods

The aim of the article is to identify and analyze the relationships between the level of consumer materialism and the perception of circular economy principles among Slovak consumers. The research focuses on assessing the degree of materialistic orientation and its compatibility with sustainable behavior and consumers’ willingness to adjust their purchasing habits in favor of environmental responsibility.

The data collection was conducted based on the validated materialism methodology (MVS) by Richins (2004), which provides tools for systematically measuring materialistic values and consumer attitudes. This methodology includes a scale that assesses various dimensions of materialism, such as the importance of ownership, acquiring material goods as a means of achieving happiness, and perceiving

success through material values. Additionally, the study included its own questions focused on circular economy and ecological behavior (EFB), with a total of 10 questions. This variable and its items have not been validated. Respondents answered these questions using a 5-point Likert scale of agreement. The data were analyzed using PLS-SEM (Partial Least Squares Structural Equation Modeling), which represents a modern approach to modeling relationships between latent variables.

The research sample consisted of 161 Slovak respondents, including 89 women and 72 men, aged between 18 and 68, with an average age of 29.3 years. In terms of education, 90 respondents had completed secondary education, while 71 had higher education. Regarding the economic status of the respondents, it was found that the largest group consisted of employed individuals, specifically 81 respondents (50.30%), followed by working students, with 40 respondents (24.8%). Some respondents reported being on maternity leave, self-employed, or classified as unemployed. Respondents' net income and age were categorized into the groups shown in Table 1 and Table 2.

Table 1. Net monthly income

Net Monthly Income	Absolute Frequency	Relative Frequency (%)
Up to 500€	34	21.1%
From 501 € to 1,000 €	35	21.7%
From 1,001 € to 1,500 €	48	29.8%
From 1,501 € to 2,000 €	21	13.0%
Above 2,000 €	23	14.3%
Total	161	100.0%

Source: author (2025)

Table 2. Age Categories

Age category	Absolute frequency	Relative frequency (%)
Up to 19 years	2	1.2 %
20 – 29 years	83	51.6 %
30 – 39 years	43	26.7 %
40 – 49 years	14	8.7 %
50 – 59 years	18	11.2 %
60 years and over	1	0.6 %
Total	161	100%

Source: author (2025)

Based on the defined research objective and the chosen methodology, research hypotheses were formulated based on the assumption that certain demographic characteristics are related to the level of materialism and the tendency toward environmentally sustainable behavior. Among the key variables considered potentially significant were the respondents' age and their net monthly income.

Hypotheses:

H1: We hypothesize that there is a statistically significant relationship between the level of materialism and net monthly income.

H2: We hypothesize that there is a statistically significant relationship between the level of materialism and age.

H3: We hypothesize that there is a statistically significant relationship between materialism and ecological behavior.

H4: We hypothesize that there is a statistically significant relationship between ecological behavior and net monthly income.

H5: We hypothesize that there is a statistically significant relationship between ecological behavior and age.

3. Results

The model is based on the assumption that age and net monthly income play the role of predictors, that is, independent variables that influence the level of materialism and ecological behavior. In this

model, materialism (MVS) is understood as an attitudinal and value orientation that may be shaped by demographic factors and can also act as a mediator in the relationship between sociodemographic variables (age, income) and ecological behavior. Materialism is a higher-order latent variable explained by the latent variables Centrality, Success, and Happiness. Ecological behavior, which represents the individual's willingness and motivation to act sustainably towards the environment, is conceived in the model as a dependent variable, influenced both directly and indirectly. The structural model (design of relationships according to the hypotheses):

- Age → Materialism (H2)
- Age → Ecological Behavior (H5)
- Income → Materialism (H1)
- Income → Ecological Behavior (H4)
- Materialism → Ecological Behavior (H3)

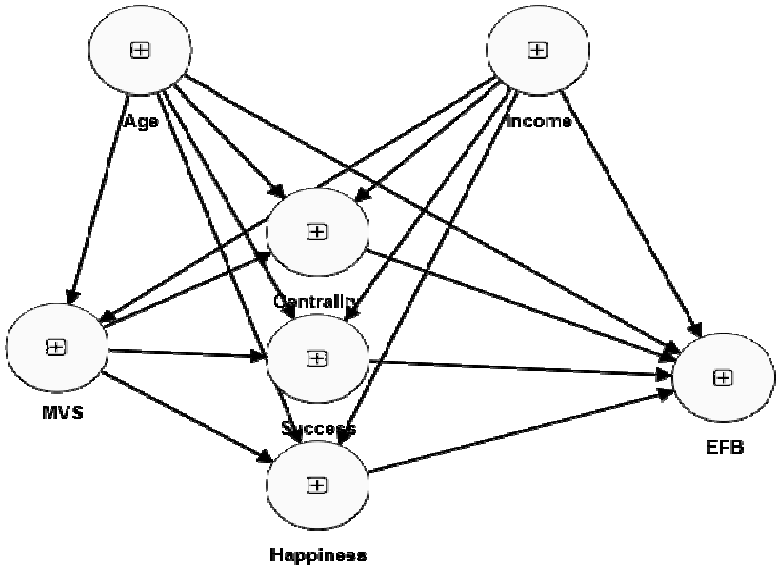

Figure 1. The model of relationships between variables.
Source: author (2025)

The model presents the relationships between variables according to the tested hypotheses. In the model, the factor loadings of individual items were observed to be ≥ 0.7. The indicators of Cronbach's Alpha and R-square are shown in Table 3.

Table 3. Reliability of constructs

	Cronbach's alpha	R-square
Centrality	0,629	0,526
EFB	0,753	0,255
Happiness	0,681	0,674
MVS	0,545	0,410
Success	0,574	0,779

Source: author (2025)

The results of the analysis show varying levels of internal consistencies. Cronbach's alpha for EFB reached a value of 0.753, indicating high reliability and internal consistency of this construct. Happiness achieved a value of 0.681, which is still acceptable, although slightly lower, possibly due to the smaller number of items. On the other hand, Centrality, MVS (Material Values Scale), and Success exhibit lower values of Cronbach's alpha (ranging from 0.545 to 0.629), suggesting lower to borderline reliability of these constructs, which may require revision or adjustments. In terms of R^2, the results show that Success reached a high value of 0.779, meaning that the model explains more than 77% of the variability in this variable, while other variables, such as Centrality ($R^2 = 0.526$) and Happiness ($R^2 = 0.674$), show slightly lower predictive power. EFB and MVS have relatively lower R^2 values, indicating that the model is less strong in explaining the variability in these constructs.

Table 4. Relationships between Variables - Path Coefficients

	Original sample (O)	Sample mean (M)	(STDEV)	T statistics (|O/STDEV|)	P values
Age -> Centrality	-0,083	-0,081	0,063	1,305	0,192
Age -> EFB	-0,232	-0,223	0,076	3,058	0,002
Age -> Happiness	-0,006	-0,005	0,049	0,124	0,901
Age -> MVS	0,101	0,101	0,075	1,347	0,178
Age -> Success	0,045	0,044	0,035	1,272	0,203
Centrality -> EFB	-0,334	-0,337	0,096	3,467	0,001
Happiness -> EFB	0,091	0,077	0,114	0,798	0,425
Income -> Centrality	-0,025	-0,025	0,051	0,487	0,626
Income -> EFB	0,048	0,045	0,087	0,546	0,585
Income -> Happiness	0,001	0,002	0,047	0,019	0,985
Income -> MVS	-0,034	-0,034	0,073	0,465	0,642
Income -> Success	0,016	0,015	0,045	0,349	0,727
MVS -> Centrality	0,727	0,730	0,050	14,482	0,000
MVS -> Happiness	0,822	0,821	0,041	19,846	0,000
MVS -> Success	0,877	0,879	0,020	44,460	0,000
Success -> EFB	-0,221	-0,227	0,114	1,934	0,043

Source: author (2025)

The results of the PLS-SEM analysis show that not all relationships between variables are statistically significant. Age has a significant negative impact on ecological behavior (EFB), with this influence being statistically significant ($p = 0.002$), suggesting that as age increases, the tendency toward ecological behavior decreases. Age does not have a significant impact on centrality, happiness, or success.

Materialism (MVS) shows a strong positive impact on centrality, happiness, and success, with all of these relationships being statistically significant ($p < 0.0001$). This result is understandable, as these are latent factors of MVS. Centrality and success have a significant negative impact on ecological behavior, indicating that individuals with a stronger focus on self, success, and material values are less inclined to engage in ecological behavior.

Income, as a predictor, does not have a direct significant impact on any of the observed variables.

4. Discussion

Based on the analysis of the results, we can confirm or reject the following hypotheses. H1, which hypothesized a statistically significant relationship between the level of materialism and net monthly income, was rejected because the p-value was 0.642, indicating that the relationship between these two variables is not statistically significant. Similarly, H2, which stated that there is a statistically significant relationship between materialism and age, was also rejected, as the p-value was 0.178. In contrast, H3, which hypothesized a statistically significant relationship between materialism and ecological behavior, was confirmed, as the p-value was 0.001, indicating a negative impact of materialism on ecological behavior. Hypothesis H4, which discussed the relationship between ecological behavior and net monthly income, was rejected because the p-value was 0.585, meaning this relationship is not statistically significant. Finally, H5, which hypothesized a relationship between ecological behavior and age, was confirmed with a p-value of 0.002, indicating that age has a statistically significant negative impact on ecological behavior.

Our results align with some aspects of the existing literature, but in certain cases, they also differ. The growing interest in materialism, consumer behavior, and the circular economy, as highlighted by Geissdoerfer et al. (2017), forms the foundation of our study. Our results suggest a complex relationship between materialism and ecological behavior (EFB), where we confirm the negative impact of materialism on ecological behavior, which is consistent with previous studies stating that materialistic consumers are less likely to engage in sustainable practices such as the circular economy. This negative relationship we confirmed is similar to those identified by other researchers, such as Issock (2023), who pointed to the negative influence of materialism on sustainable practices, such as ecological disposal of electronic waste.

The findings regarding age also align with some studies, particularly the work by Kulli et al. (2023), which emphasizes the role of generational differences in consumer behavior. In our study, we found that age has a significant negative impact on ecological behavior (EFB), suggesting that older individuals may be less inclined to engage in ecological activities. This result is consistent with the research by Varpa et al. (2024), who found that younger consumers are more likely to adopt sustainable behaviors such as reusing items, while older generations prefer second-hand or inherited items.

In contrast to Jaspers and Pieters (2016), who argued that materialism follows a curvilinear trajectory throughout life, with the lowest levels occurring in middle age, our findings do not suggest a significant relationship between age and materialism. This may be due to various factors, such as the specific context and sample selection.

Overall, our results align with existing theories about the relationship between materialism and ecological behavior, but they also provide new perspectives, especially regarding the impact of age and income on consumer behavior and values in relation to the circular economy.

Conclusion

This study focused on the relationship between materialism (MVS), ecological behavior (EFB), age, and net monthly income, analyzing several hypotheses. The results confirmed a negative impact of materialism on ecological behavior, which aligns with existing research suggesting that materialistic consumers are less inclined to engage in sustainable practices. It also confirms that age has a negative impact on ecological behavior, which is in line with some previous studies indicating that older generations are less involved in ecological activities than younger ones. The results did not show any significant relationship between materialism and age or between materialism and income.

A limitation of the study is the sample size, which could have affected the results. The low variability in income may have hindered the demonstration of significant relationships between income and variables such as materialism or ecological behavior. For ecological behavior (EFB), an established methodology was not used. The questions related to EFB were specifically created for this study and were not previously validated, which may affect the reliability and validity of these measurements. In the case of materialism, we used the MVS (Material Values Scale), which is a validated method, but in the future, other approaches and adaptations could be considered to further explore the relationships between materialism and behavior in the context of the circular economy.

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Importance of Sustainable Approaches in Gastronomy from the Consumer Perspective

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Abstract

Research background: Sustainable gastronomy is a way of preparing, consuming and producing food that takes into account the protection of the environment. Amidst growing global attention to sustainable consumption, understanding consumer perspectives on sustainable approaches within the gastronomy sector is increasingly crucial.
Purpose of the article: The primary purpose of this article is to explore current consumer perceptions of sustainable approaches in gastronomy, particularly among consumers in Eastern Slovakia. Furthermore, it aims to identify and analyze potential statistically significant differences in these perceptions between male and female respondents, recognizing gender as a significant demographic factor influencing attitudes and behaviors towards sustainability.
Methods: Data were collected through an online questionnaire survey administered via Google Forms to respondents in the Prešov and Košice regions of Eastern Slovakia, employing a non-probability quota sampling method based on gender distribution of the region. After data cleaning, 221 valid questionnaires were analyzed. The survey comprised 36 questions, including socio-demographic and theoretical sections utilizing a five-point Likert scale for theoretical inquiries. Data analysis involved descriptive statistics for individual questionnaire items and for comparative analysis between genders, the Kolmogorov-Smirnov test revealed non-normal distributions, necessitating the use of non-parametric methods, specifically the Mann-Whitney U test.
Findings & Value added: The findings indicate a high general awareness of sustainable gastronomy and strong positive dispositions towards its environmental importance, as well as the significance of sustainability support from gastronomic establishments. Consumers widely engage in practices like supporting local food and reducing food waste. However, the study also revealed areas of more varied opinions, such as knowledge of sustainable food certificates, willingness to pay more for organic products, and skepticism regarding the genuine commitment behind "sustainable" labels. Crucially, statistically significant gender-based differences were found across all four areas of perception and practice investigated, with female respondents consistently exhibiting stronger positive perceptions or more frequent engagement. These insights highlight that gender is a relevant variable influencing consumer sustainability behaviors in gastronomy, providing valuable direction for policymakers and businesses to develop more targeted and effective communication strategies and interventions.

Keywords: Sustainable gastronomy, Consumer perspective, Sustainable approaches, Food sustainability

JEL classification: D12, M31, Q18

1. Introduction

Contemporary gastronomy is profoundly shaped by globalization, leading to a dynamic interplay of diverse culinary traditions and dietary habits. This trend fosters the exploration of novel and exotic flavors, enhancing the overall gastronomic experience (López-Ojeda et al., 2022). Alongside this culinary

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evolution, there is a growing interest in personalized nutrition and efficient resource utilization, with an increasing prominence of environmentally friendly raw materials. This shift emphasizes energy efficiency and environmental protection to minimize harmful ecological impacts (Kompasová, 2021).

Sustainable consumption is becoming increasingly critical for national growth. Governments are intensifying efforts to promote sustainable consumption among citizens to encourage its expansion and maximize sustainability outcomes. Key concepts like responsible and conscious consumption are integral to sustainable consumption theory. This encompasses not only a reduction in overall consumption but also its gradual transformation towards a more sustainable lifestyle (Yaqub et al., 2024). The ecologically conscious consumer embodies these principles by actively seeking products of natural and organic origin, often favoring local sources. Such consumers are acutely aware of environmental values and the impact of their purchasing decisions on the planet. They are concerned about contemporary global issues, including genetically modified foods, excessive chemical use, and global warming (Horská et al., 2022). With rising public awareness of climate change, consumers are increasingly scrutinizing the environmental responsibility of their purchases, a phenomenon termed green control. This heightened environmental awareness fuels a growing willingness among consumers to pay a premium for eco-friendly products with a lower environmental footprint (Xu & Lee, 2024). Characteristic traits of an ecologically conscious consumer include preference for eco-friendly foods (e.g., organic, raw), utilization of natural household cleaning agents, use of rechargeable batteries, wearing clothing made from ecological materials (e.g., organic cotton), preference for furniture from sustainable sources, energy conservation through simple actions like turning off lights, recycling of raw materials, use of reusable textile shopping bags, and composting kitchen waste (Horská et al., 2022).

Consumer behavior, encompassing the stages of searching, purchasing, using, evaluating, and disposing of products and services (Horská et al., 2022), is a decision-making process influenced by the desired fulfillment of needs and expectations (Pavićević et al., 2024). For consumer behavior to be deemed sustainable, it must incorporate sustainable values. Responsible consumers, for instance, gravitate towards brands demonstrating social consciousness (Horská et al., 2022). Sustainable consumer behavior in gastronomy is significantly influenced by green marketing. Green marketing promotes and fulfills consumer needs and desires by providing environmentally safe and healthy products. It encompasses all traditional marketing activities (production, planning, pricing, process, promotion, and personnel), executed with the explicit goal of minimizing the environmental impact of goods and services (Agarwal & Dubey, 2024). A cornerstone of green marketing is building consumer trust in a brand's environmental commitments through transparent communication and verifiable eco-friendly practices (Tu et al., 2024). Green marketing initiatives directly influence consumer intent to purchase green products by communicating environmental attributes and benefits through eco-labeling and green advertising (Li et al., 2024b). However, while green marketing can build consumer trust, excessive promotion of environmental attributes can lead to "greenwashing" (Tu et al., 2024). Greenwashing involves the selective disclosure of environmental information, deliberately obscuring negative aspects to mislead the public and create a misleading ecological image. This can involve creating confusion, obfuscation, and pretense (Huang et al., 2022). Such deceptive practices foster skepticism and erode consumer trust in making informed, sustainable choices (Gupta & Singh, 2024). Greenwashing, though challenging to measure (Ghitti et al., 2023), has become prevalent in the corporate world, with many businesses merely feigning environmental protection efforts (Huang et al., 2022). Authentic and transparent green marketing is crucial to mitigating the negative impact of perceived greenwashing and maintaining a positive green brand image, thereby enhancing market competitiveness (Agarwal & Dubey, 2024). Consumer attraction to sustainable behavior is growing, characterized by five subthemes: consumer attitude, consumer purchase, consumer knowledge, consumer preferences, and consumer influence. Consumer attitudes, encompassing feelings, beliefs, and perceptions, significantly impact behavior, choices, and decisions, influenced by psychological characteristics, cultural background, and various barriers. Consumer purchase involves frequency, product types, and channels, with brand reputation, price, and quality playing key roles. Information from social media, brand names, and marketing also shapes consumer decisions (Balasubramanian & Sheykhmaleki, 2024; Li et al., 2023). Consumer knowledge, particularly regarding eco-labels, fundamentally shapes attitudes and purchasing behavior towards sustainability. Studies indicate a willingness to pay more for eco-labeled products. Understanding consumer preferences (materials, designs, styles, colors) is vital for businesses. Consumers are easily influenced by others, directly or

indirectly (word-of-mouth, social media, physical presence), and consumer influence can significantly raise broader societal awareness (Balasubramanian & Sheykhmaleki, 2024).

The dynamic and mutually beneficial connection between gastronomy and sustainable practices is evident in their interplay. The culinary arts intertwine with sustainability principles to generate positive impacts on the environment, the gastronomic experience, and society. Sustainable gastronomy encompasses various initiatives that promote environmental protection, responsible sourcing, food waste reduction, and the adoption of energy-efficient kitchen practices. It encourages the inclusion of plant-based alternatives on menus to support a global shift towards healthier and more sustainable diets. Furthermore, sustainable gastronomy elevates consumer awareness by educating both consumers and culinary professionals about the environmental and social implications of food choices (Mishra, 2023). A key catalyst for the development of sustainable gastronomy has been the pervasive issue of food waste. Sustainable gastronomy emphasizes the judicious use of natural resources throughout the entire food preparation and presentation process, ensuring minimal waste. It also prioritizes the preservation of traditional gastronomic heritage for future generations. Theoretically, sustainable gastronomy contributes to economic, cultural, social, and environmental sustainability (Brennan et al., 2023; Arslan et al., 2023). The United Nations Food and Agriculture Organization estimates that the value of food wasted annually in the global food supply chain is approximately 940 billion USD (Wang & Ko, 2024). Food waste is a significant global sustainability challenge, contributing up to 10% of global greenhouse gas emissions, often alongside rising food and nutritional insecurity. This issue extends beyond just the discarded food to include the resources invested in its growth, production, and distribution. All stakeholders across the food chain, from primary production to manufacturing, retail, and households, contribute to this problem, with over 60% of global food waste originating in households. A critical factor contributing to consumer food waste is the perceived freshness of food. Consumer-driven food waste is attributed to four categories of factors: broader values (e.g., feelings about waste), challenges of daily life (e.g., purchasing behaviors, predetermined portion sizes), household inventory management (e.g., food storage practices), and material factors (e.g., food and packaging properties, such as food safety risks) (Brennan et al., 2023). The concept of sustainable gastronomy, as defined by Paunic et al. (2024), is rooted in the implementation of ecological practices, consumer protection and health improvement, sociocultural quality and intergenerational transfer, and economic business aspects. These facets are intrinsically linked to the production and supply of local products, reflecting a unique gastronomic identity, though emphasis on individual aspects may vary.

Sustainable dieting, a concept intertwined with sustainable gastronomy, refers to diets with low environmental impacts that contribute to food and nutritional security, and healthy lives for present and future generations (Kaner et al., 2024). Such diets are characterized by being culturally acceptable, accessible, nutritionally adequate, and respectful of ecosystems. Research suggests that nutritionally balanced diets are compatible with environmental goals (Yassıbaş & Bölükbaşı, 2023). This integrated approach to sustainability, health, and gastronomy fosters long-term solutions for resource conservation and quality of life. Plant-based diets are widely regarded as environmentally sustainable. They primarily involve the consumption of foods derived from plants, which may include minimal animal-derived components. The goal is to replace animal products (Li et al., 2024a; Kerstner & Garda-Buffon, 2024). Plant-based food products are composed mainly of fruits, vegetables, grains, legumes, nuts, and seeds. They can be consumed whole or processed into alternatives that mimic the texture and taste of animal products (de Villiers et al., 2024). Various plant-based dietary patterns with low animal food consumption include vegetarian, vegan, lacto-vegetarian, pesco-vegetarian, and semi-vegetarian diets (Kerstner & Garda-Buffon, 2024). For example, plant-based burgers, made from ingredients like lentils, peas, mushrooms, and beetroot, are designed to replicate the texture and taste of traditional beef burgers, appealing to consumers seeking eco-friendlier options. Similarly, plant-based milks (almond, oat) offer nutritional benefits and address environmental concerns associated with traditional cow's milk (de Villiers et al., 2024). The increasing global population exerts pressure on natural resources, leading to limited availability of high-value proteins. Growing environmental and ethical concerns have spurred the development of meat analogues (Kerstner & Garda-Buffon, 2024). Alternative proteins, including insects, algae, fungi, and plant-based proteins, offer sustainable and efficient means to meet rising protein demand while mitigating environmental impact (Jafarzadeh et al., 2024). Rising consumer awareness of the adverse effects of high meat consumption has led to increased interest in flexitarian or reduced-meat diets (Strässner & Wirth, 2024). A flexitarian diet involves limiting, but not entirely abstaining from, animal products (meat, dairy, eggs). Flexitarians actively reduce animal food intake

without complete exclusion, differing from vegetarians/vegans who strictly eliminate specific animal products (Sheen et al., 2023).

Local foods symbolically represent local rules, processes, traditions, and rituals. They possess significant social and cultural added value, fostering positive consumer attitudes and purchasing preferences, and are considered highly attractive elements of a local community (Bölükbas & Yazicioglu, 2024). The interest in local production is steadily growing, driven by 'locavores' who prioritize foods from local producers and growers and increasingly inquire about the origin of ingredients, animal welfare, and cultivation practices (Kompasová, 2021). Bölükbas & Yazicioglu (2024) identified seven sub-dimensions of local food value: emotional, epistemic, health, prestige, taste, price, and interaction. These values, ranging from emotional connection and curiosity to health concerns, social status, and economic factors, significantly influence consumer preferences and purchasing decisions for local products.

Restaurants can effectively attract guests by presenting sustainability in a positive and experiential manner, communicating the ideal of sustainability. Meals prepared can be both sustainable and functional, utilizing sustainable ingredients and techniques. The ability to creatively combine this knowledge is highly valued (Östergren et al., 2023). An increasing number of food service establishments are committing to sustainability by minimizing food waste, using local and seasonal products, and adopting eco-friendly practices (Malinowska et al., 2024). Chef creativity in menu development is a priority for sustainability, highlighting the need for sustainable menu creation. Following the adoption of the 17 Sustainable Development Goals (SDGs), numerous culinary innovation competitions have emerged, focusing on resource-efficient, low-carbon cooking methods, local and seasonal ingredient utilization, and the integration of SDG principles into the innovation process (Wang & Ko, 2024). Environmental labeling, awarded to products with significantly lower ecological impact than comparable alternatives, promotes pollution prevention and efficient natural resource use, while enhancing public and manufacturer awareness of products' environmental attributes (Horská et al., 2022).

The link between gastronomy, heritage, and tourism is integral to cultural identity and economic development. Gastronomic heritage, encompassing culinary knowledge, skills, and traditions, serves as a common legacy and social practice, forming unique regional identity markers through diverse local dishes, spices, preparation methods, and kitchen equipment. This fosters a symbolic relationship between locals and tourists, enhancing destination image and attracting visitors seeking authentic experiences (González-Macías et al., 2024; Pivarski et al., 2023). Gastronomy also plays a vital role in destination marketing, creating a distinct identity that drives tourism demand, enhances regional attractiveness, and stimulates local economic growth, fostering pride among residents who become cultural ambassadors (González-Macías et al., 2024). Gastronomic authenticity, linking tourists to local culture through specific foods, preparation, presentation, and traditional equipment, strengthens destination appeal, long-term sustainability, and competitiveness, ensuring tourists return with a deep appreciation for local culture (Kaner et al., 2024). Ultimately, gastronomy, as a powerful cultural symbol, contributes to local community development by providing employment, enhancing economic stability, and promoting a positive global perception of the destination, serving as a critical tool for tourism support and the preservation of local identity (Fernandes et al., 2024).

Empirical studies further illuminate consumer behavior and sustainability in gastronomy. Cetin & Cetin (2024) highlighted that behavioral intention positively influences food waste reduction, driven significantly by attitude and moral norms. Maynard et al. (2020) demonstrated increasing engagement in sustainability within food service, with 77.41% of case studies covering environmental, economic, and social indicators, and common practices including recycling, energy saving, and local product use. Furthermore, Neacsu & Tulbure's (2023) study indicated that 88.3% of respondents consider sustainability important for fast-food, with preferred measures including paper straws, recycled packaging, and reusable containers. Herrmann et al. (2022) found that consumers are willing to pay for perceived sustainable alternatives but hesitant for uncertain ones, particularly bioplastics, underscoring a demand for more environmental information on packaging. Finally, Pellinen et al. (2024) revealed that an ANIMAL diet (70% animal-sourced protein and 30% plant-sourced protein) elicited predominantly negative perceptions (52% negative, 28% positive), while a 50/50 diet (50% animal-sourced protein and 50% plant-sourced protein) saw slightly more positive (44%) than negative (38%) experiences, and a PLANT diet (30% animal-sourced protein and 70% plant-sourced protein) was largely perceived positively (54% positive, 31% negative), with participants finding it easy to adhere to and reporting higher energy levels than the ANIMAL diet.

2. Methods

Data were collected through an online questionnaire survey administered via Google Forms. This method was chosen for its reach and efficiency in collecting diverse consumer opinions. The questionnaire was primarily distributed through social media networks to consumers in Eastern Slovakia, specifically targeting residents of the Prešov and Košice regions. A non-probability quota sampling method based on gender distribution of the region was employed for participant selection. Data collection took place from February 10, 2025, to March 10, 2025, with 222 respondents initially participating in the survey. After data cleaning to remove incomplete responses, the final sample for evaluation comprised 221 valid questionnaires.

The survey questionnaire comprised 36 questions, categorized into socio-demographic and theoretical sections. Its design was partially inspired by the study conducted by Pavićević et al. (2024), drawing upon their questions related to consumer behavior concerning sustainability in food purchasing and consumption. Key inspirations included questions on the preference for local foods, packaging recycling, waste avoidance, and respect for ethical aspects when selecting food products and dining establishments. Socio-demographic questions included inquiries about gender, age, place of residence, region of residence, and the highest attained education level of respondents. The theoretical questions in this questionnaire covered the following areas: general awareness of sustainability and certifications, food purchasing behavior, food waste and recycling, sustainability in gastronomy, plant-based diets and alternatives, social dimension and ethics in gastronomy, and green marketing.

All questions in the survey were closed-ended, with the exception of the age question, which was open-ended. For theoretical questions where respondents were required to select only one option, a five-point Likert scale was used (1 strongly disagree – 5 strongly agree, 1 very weak – 5 excellent, 1 definitely not – 5 definitely yes, 1 never – 5 always, 1 not at all important – 5 very important and 1 do not trust at all – 5 fully trust).

For data analysis, firstly, the descriptive statistics were employed, including the minimum, maximum, arithmetic mean, standard deviation, median, mode, and variance, along with a basic analysis of the results for individual questionnaire items.

To explore potential variations in consumer perceptions of sustainable gastronomy, a comparative analysis was conducted between male and female respondents. The normality of variable distributions was assessed using the Kolmogorov-Smirnov test. Given that all analyzed variables exhibited a non-normal distribution ($p < 0.05$), non-parametric methods were employed for subsequent statistical comparisons. Differences between independent groups (male and female) were specifically evaluated using the Mann-Whitney U test.

3. Results

The survey sample consisted of residents from the Prešov and Košice regions, and the final sample for evaluation comprised 221 valid questionnaires.

The age of the respondents ranged from 17 to 84 years. The mean age of the survey participants was 33.3 years, with a standard deviation of 14.6 years, indicating a relatively high diversity in the age range. The median age was 27 years. The most frequently reported age was 22 years (mode). The variance of 211.9 further confirms the considerable variability in the age of the research group.

Table 1 details the demographic composition of the research sample. The sample exhibits a near-even gender distribution, with males comprising 51.1% and females 48.9%. Regarding place of residence, nearly half of the respondents (49.8%) reside in cities with up to 100,000 inhabitants, while 40.7% are from rural areas (up to 2,000 inhabitants). A smaller proportion (9.5%) lives in larger cities (over 100,000 inhabitants). With Košice being the sole city in Eastern Slovakia to have a population over 100,000, it follows that our respondents from this category are from Košice. The region of residence shows a slightly higher representation from the Prešov region (56.6%) compared to the Košice region (43.4%), which is consistent with the regional population distribution. In terms of educational attainment, the majority of the sample (54.3%) holds a secondary education degree. University graduates constitute a significant portion, with 27.1% having a 1st level university degree, 15.4% a 2nd level, and 0.9% a 3rd level. Only a small percentage (2.3%) reported primary education as their highest attainment.

Table 1. Characteristics of the research sample

Variable	Category	Frequency	Percent
Gender	male	113	51.1
	female	108	48.9
	total	221	100.0
Place of residence	rural area - up to 2,000 inhabitants	90	40.7
	city - up to 100,000 inhabitants	110	49.8
	city - over 100,000 inhabitants	21	9.5
	total	221	100.0
Region of residence	Košice	96	43.4
	Prešov	125	56.6
	total	221	100.0
Highest education attained	primary	5	2.3
	secondary	120	54.3
	1st level university degree	60	27.1
	2nd level university degree	34	15.4
	3rd level university degree	2	0.9
	total	221	100.0

Source: own processing

The descriptive analysis of consumer perceptions regarding sustainable gastronomy and related practices revealed several key insights. A high level of awareness regarding "sustainable gastronomy" was observed, with a majority of respondents either agreeing (40.7%) or strongly agreeing (22.6%) that they understand the term. Furthermore, a strong consensus exists regarding the importance of sustainable gastronomy for environmental protection, with a combined 66.5% of respondents either agreeing or strongly agreeing that "sustainable gastronomy is important for environmental protection." Consumers also highly value sustainability support from restaurants and gastronomic establishments, evidenced by 81.9% of respondents who either agreed or strongly agreed with its importance. This strong environmental consciousness was further supported by 77.8% of respondents agreeing or strongly agreeing that "packaging recycling in gastronomy is of great importance." Regarding specific sustainable practices, a substantial majority (84.6% combined agreement/strong agreement) stated they "visit local markets or stores that sell local food", underscoring a preference for local sourcing. The belief that "purchasing local food supports the development of the local economy" was also widely affirmed by 78.2% of respondents (43.4% agree, 34.8% strongly agree). In terms of reducing food waste, consumers generally demonstrated responsible behavior: a notable 72.9% of respondents (43.9% agree, 29.0% strongly agree) reported that they "buy food closer to its expiry date to help stores avoid waste," and a substantial 82.4% (32.6% agree, 49.8% strongly agree) stated they "consume food even after its best-before date if it is still fit for consumption." A majority of respondents (79.2% combined agreement/strong agreement) actively "recycle packaging," but not all of them (73.7% combined agreement/strong agreement) "attempt to reuse it when possible," suggesting room for improvement in specific circular economy practices. Conversely, while generally positive towards sustainability, responses regarding "knowledge of certificates for labeling sustainable food" (46.6% combined agreement/strong agreement) and "willingness to pay more for organic food" (36.7% combined agreement/strong agreement) show more varied opinions, indicating areas where consumer awareness or motivation could be further enhanced. A notable proportion of respondents (26.7% strongly disagree, 19.0% disagree) also expressed skepticism regarding the impact of buying sustainable food on improving the standard of living for small farmers. Similarly, a considerable number of respondents (16.3% strongly disagree, 19.5% disagree) did not believe that "plant-based meat alternatives could completely replace animal products in the diet in the future." Notably, a substantial portion (74.2% combined agreement/strong agreement) expressed skepticism that the "sustainable" label is merely a marketing trick rather than a genuine commitment, highlighting a potential trust deficit. These findings collectively suggest a generally positive consumer disposition towards broader sustainable practices, particularly concerning local food and waste reduction, though some areas like specific certifications, the impact on farmers, or certain circular economy practices show room for increased awareness or differing views, alongside a notable level of skepticism towards green marketing. The complete results for all questions are presented in Table 2.

Table 2. Frequency and percentage distribution of responses to sustainable gastronomy survey questions

Variable	1	2	3	4	5
Do you understand the term "sustainable gastronomy"?	6 (2.7)	16 (7.2)	59 (26.7)	90 (40.7)	50 (22.6)
Do you know certificates for labeling sustainable food?	18 (8.1)	37 (16.7)	63 (28.5)	76 (34.4)	27 (12.2)
How would you rate your knowledge of sustainable food?	15 (6.8)	36 (16.3)	76 (34.4)	73 (33.0)	21 (9.5)
Are you informed about the environmental impacts of food waste?	11 (5.0)	27 (12.2)	31 (14.0)	109 (49.3)	43 (19.5)
When buying groceries, do you pay attention to whether the food has certificates labeling sustainable food?	26 (11.8)	59 (26.7)	39 (17.6)	73 (33.0)	24 (10.9)
When you buy groceries, do you prefer food of local origin?	6 (2.7)	23 (10.4)	35 (15.8)	92 (41.6)	65 (29.4)
Do you think that supporting local food has greater environmental significance than buying sustainable food from other countries?	7 (3.2)	35 (15.8)	36 (16.3)	90 (40.7)	53 (24.0)
Do you believe that purchasing local food supports the development of the local economy?	2 (0.9)	9 (4.1)	37 (16.7)	96 (43.4)	77 (34.8)
Do you visit local markets or stores that sell local food?	4 (1.8)	8 (3.6)	22 (10.0)	72 (32.6)	115 (52.0)
Are you willing to pay more for food or groceries that are organic?	16 (7.2)	46 (20.8)	78 (35.3)	66 (29.9)	15 (6.8)
When buying groceries, do you carefully assess the quantity you need to prevent waste?	14 (6.3)	28 (12.7)	59 (26.7)	91 (41.2)	29 (13.1)
Do you buy food closer to its expiry date to help stores avoid waste?	11 (5.0)	25 (11.3)	24 (10.9)	97 (43.9)	64 (29.0)
If you have food closer to its expiry date, do you consume it first?	27 (12.2)	51 (23.1)	35 (15.8)	80 (36.2)	28 (12.7)
Do you consume food even after its best-before date if it is still fit for consumption?	9 (4.1)	15 (6.8)	15 (6.8)	72 (32.6)	110 (49.8)
When preparing meals, do you carefully estimate the quantity of ingredients to minimize waste?	19 (8.6)	34 (15.4)	19 (8.6)	84 (38.0)	65 (29.4)
After consuming a packaged food product, do you carefully recycle the packaging?	9 (4.1)	17 (7.7)	20 (9.0)	105 (47.5)	70 (31.7)
Do you try to reuse food packaging whenever possible?	13 (5.9)	17 (7.7)	28 (12.7)	77 (34.8)	86 (38.9)
Do you think sustainable gastronomy is important for environmental protection?	19 (8.6)	36 (16.3)	19 (8.6)	70 (31.7)	77 (34.8)
Do you agree that packaging recycling in gastronomy is of great importance?	8 (3.6)	9 (4.1)	32 (14.5)	75 (33.9)	97 (43.9)
Is it important for you that restaurants and gastronomic establishments support sustainability?	6 (2.7)	8 (3.6)	26 (11.8)	72 (32.6)	109 (49.3)
Do you prefer gastronomic establishments that actively promote their sustainable initiatives?	9 (4.1)	11 (5.0)	26 (11.8)	89 (40.3)	86 (38.9)
Do you think that promoting sustainable approaches in gastronomy in the media helps change consumer behavior?	11 (5.0)	17 (7.7)	68 (30.8)	75 (33.9)	50 (22.6)
Do you think plant-based proteins are as nutritious as animal-based proteins?	6 (2.7)	15 (6.8)	61 (27.6)	79 (35.7)	60 (27.1)
Do you think transitioning to an exclusively plant-based diet would have a positive impact on your health?	24 (10.9)	41 (18.6)	56 (25.3)	58 (26.2)	42 (19.0)
Do you think plant-based meat alternatives could completely replace animal products in the diet in the future?	36 (16.3)	43 (19.5)	56 (25.3)	60 (27.1)	26 (11.8)
Do you think that buying sustainable food contributes to improving the standard of living for small farmers?	59 (26.7)	42 (19.0)	57 (25.8)	36 (16.3)	27 (12.2)
When choosing food, do you also consider ethical aspects, such as working conditions in agriculture?	8 (3.6)	12 (5.4)	38 (17.2)	89 (40.3)	74 (33.5)
Would you prefer a catering establishment that declares fair wages and good working conditions for employees?	33 (14.9)	41 (18.6)	73 (33.0)	52 (23.5)	22 (10.0)
Do you consider it important for catering establishments to engage in community and social projects, such as supporting local farmers, employing disadvantaged groups, or donating surplus food?	5 (2.3)	12 (5.4)	47 (21.3)	77 (34.8)	80 (36.2)
Do you think that businesses in the catering sector use the label "sustainable" more as a marketing trick than a real commitment to environmental protection?	4 (1.8)	8 (3.6)	45 (20.4)	89 (40.3)	75 (33.9)
Does green marketing influence your decision when buying food or choosing a catering establishment?	6 (2.7)	38 (17.2)	64 (29.0)	93 (42.1)	20 (9.0)

Source: own processing

To gain a comprehensive understanding of consumer perspectives on sustainable approaches in gastronomy, it is crucial to investigate potential differences across demographic groups. This section focuses on analyzing variations in responses between male and female respondents, as gender can significantly influence attitudes, knowledge, and behaviors related to sustainability. Specifically, this analysis aims to determine if statistically significant differences exist in opinions concerning two key areas: 1) the importance of sustainable gastronomy for environmental protection; 2) the significance of supporting sustainability by restaurants and gastronomic establishments; and two more specific issues: 3) the role of purchasing local food in supporting the local economy; and 4) the personal practice of consuming food close to its expiry date first. Identifying these distinctions is essential for tailoring effective strategies and communication efforts aimed at promoting sustainable practices within the gastronomic sector.

For further statistical testing, we used the Kolmogorov-Smirnov test for the normality of the variable distribution to test the normality of the investigated variables. Since the p-value for all analyzed variables in the test was less than 0.05, the data are not normally distributed, necessitating the use of non-parametric tests. Based on the nature of the data, the Mann-Whitney U test was used for statistical testing of differences between independent groups of respondents.

In the first analysis of differences, we wanted to test the existence of statistically significant differences in the perception of whether sustainable gastronomy is important for environmental protection between male and female respondents. The output of the statistical difference testing using the Mann–Whitney U test, shown in Table 3, points out that the statistical significance value of the test is 0.000, which is less than the selected alpha value (0.05). According to the results, there is a statistically significant difference in the perception of whether sustainable gastronomy is important for environmental protection between male and female respondents, with female respondents showing a higher mean rank (126.70) compared to males (96.00).

Table 3. Results of the first analysis of differences

	Group	Mean rank	U test	Z-score	p-value
Sustainable gastronomy is important for environmental protection	male	96.00	7797.500	3.819	0.000
	female	126.70			

Source: own processing

In the next analysis of differences, we wanted to test the existence of statistically significant differences in the perception of whether supporting sustainability by restaurants and gastronomic establishments is important between male and female respondents. The output of the statistical difference testing using the Mann–Whitney U test shown in Table 4 points out that the statistical significance value of the test is 0.000, which is less than the selected alpha value (0.05). According to the results, there is a statistically significant difference in the perception of whether sustainable gastronomy is important for environmental protection between male and female respondents, with female respondents showing a higher mean rank (127.97) compared to males (94.78).

Table 4. Results of the second analysis of differences

	Group	Mean rank	U test	Z-score	p-value
Supporting sustainability by restaurants and gastronomic establishments is important	male	94.78	7935.000	4.126	0.000
	female	127.97			

Source: own processing

The subsequent analysis of differences tested the existence of statistically significant differences in the perception of whether purchasing local food supports the development of the local economy between male and female respondents. The output of the statistical difference testing using the Mann–Whitney U test shown in Table 5 points out that the statistical significance value of the test is 0.002, which is less than the selected alpha value (0.05). According to the results, there is a statistically significant difference in the perception of whether purchasing local food supports the development of the local economy between male and female respondents, with female respondents showing a higher mean rank (123.19) compared to males (99.35).

Table 5. Results of the third analysis of differences

	Group	Mean rank	U test	Z-score	p-value
Purchasing local food supports the development of the local economy	male	99.35	7418.500	3.053	0.002
	female	123.19			

Source: own processing

The last analysis of differences was aimed at testing the existence of statistically significant differences in the perception of whether respondents consume food close to its expiry date first between male and female respondents. The output of the statistical difference testing using the Mann–Whitney U test shown in Table 6 points out that the statistical significance value of the test is 0.000, which is less than the selected alpha value (0.05). According to the results, there is a statistically significant difference in the perception of whether respondents consume food close to its expiry date first between male and female respondents, with female respondents showing a higher mean rank (130.06) compared to males (92.78).

Table 6. Results of the fourth analysis of differences

	Group	Mean rank	U test	Z-score	p-value
I consume food close to its expiry date first	male	92.78	8161.000	4.724	0.000
	female	130.06			

Source: own processing

4. Discussion

Our study offers a comprehensive look at consumer perceptions and behaviors regarding sustainable approaches in gastronomy among Eastern Slovak residents, focusing on gender-based differences. We found a high general awareness of "sustainable gastronomy" and strong positive dispositions towards its environmental importance, with consumers also highly valuing sustainability support from gastronomic establishments. A key takeaway is the widespread recognition among respondents that sustainable gastronomy plays a vital role in environmental protection, coupled with a strong expectation that restaurants actively embrace sustainability. Many respondents actively engage in sustainable practices, such as visiting local markets (a key aspect of the 'locavore' movement, Kompasová, 2021) and proactively reducing food waste by carefully assessing quantities and consuming food near its expiry date. These findings suggest a strong consumer base in the Prešov and Košice regions that is not only aware but often actively participating in sustainable food behaviors, consistent with growing global attention to sustainable consumption (Yaqub et al., 2024) and increased engagement in food service sustainability (Maynard et al., 2020). This solid foundation indicates significant potential for further growth in sustainable gastronomy in the region.

However, our analysis also brought to light areas where consumer perceptions were more nuanced or revealed potential gaps. Knowledge of specific sustainable food certifications and willingness to pay more for organic food showed varied opinions, suggesting that while the broader concept of sustainability is understood, specific mechanisms or economic implications may not be fully embraced by all consumers (Herrmann et al., 2022). This highlights a need for clearer communication regarding the value and impact of such certifications. Moreover, we observed notable skepticism regarding the direct impact of sustainable food purchases on improving the standard of living for small farmers. A considerable portion of respondents also did not believe plant-based meat alternatives could completely replace animal products in the future, despite growing discussions on alternative proteins. Crucially, a substantial portion of respondents expressed skepticism that the "sustainable" label is merely a marketing trick rather than a genuine commitment, pointing to a significant trust deficit consistent with concerns about "greenwashing" (Tu et al., 2024; Ghitti et al., 2023). While active packaging recycling was widespread, the lower propensity for reusing packaging indicates further opportunities for promoting a more comprehensive circular economy approach.

Our analysis, utilizing the Mann-Whitney U test, revealed statistically significant gender-based differences across all four investigated areas, highlighting distinct perceptions and behaviors between male and female respondents. In every instance – the perceived environmental importance of sustainable gastronomy, the importance of establishments supporting sustainability, the belief in local food's economic impact, and the personal practice of consuming food nearing expiry dates – female respondents

consistently exhibited stronger positive perceptions or more frequent engagement than their male counterparts (Tables 3-6, all $p \leq 0.05$).

These consistent gender-based distinctions align with existing literature that recognizes the importance of gender equality and differing attitudes toward sustainable consumption between men and women (Kennedy, 2018; Godin & Langlois, 2021). Notably, MacGregor (2006) emphasizes the link between women's caring roles and ecological politics, further supported by scientific evidence from Brough et al. (2016) indicating a cognitive connection between "greenness" and femininity. These findings are also consistent with research by Pavićević et al. (2024), from whose questionnaire we adapted several questions. Their study concluded that female respondents exhibited higher levels of sustainable consumption intentions across purchasing, post-purchasing, and environmental awareness dimensions. Recognizing these nuances can lead to more effective interventions aimed at promoting widespread adoption of sustainable gastronomic practices, emphasizing the importance of tailoring educational campaigns and marketing strategies that acknowledge and address these differing perspectives.

Conclusion

This study provides a comprehensive overview of consumer perceptions and behaviors related to sustainable approaches in gastronomy within Eastern Slovakia. Our findings indicate a strong general awareness and positive disposition towards sustainable gastronomy, its environmental benefits, and the importance of sustainability initiatives by food establishments. Consumers actively engage in practices such as supporting local food and reducing food waste. However, the research also identified areas requiring further attention, including limited awareness of specific sustainable food certifications, a hesitant willingness to pay more for organic products, skepticism towards the genuine commitment behind "sustainable" labels, and differing views on the role of plant-based alternatives and the direct impact on small farmers.

Crucially, the comparative analysis revealed statistically significant gender-based differences across all four investigated aspects of sustainable gastronomy perception and practice. In all four areas examined – the perceived environmental importance of sustainable gastronomy, the importance of establishments supporting sustainability, the belief in local food's economic impact, and the practice of consuming food nearing expiry dates – female respondents consistently showed stronger agreement or more frequent engagement than their male counterparts. These findings highlight that gender is a relevant factor influencing consumer attitudes and behaviors towards sustainable food and gastronomy, suggesting that one-size-fits-all strategies may be less effective. Understanding these nuances is vital for policymakers, businesses, and educational institutions in developing targeted interventions. Future efforts to promote sustainable gastronomy should consider these demographic distinctions, focusing on transparent communication, building trust, and addressing specific knowledge gaps to foster even greater consumer engagement in sustainable food systems, potentially with gender-specific messaging where appropriate.

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Generational Differences in the Acceptance of Eco-product Communication in Times of Global Crisis: Bibliometric Analysis of Research Trends

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Abstract

Research background: At a time of deepening climate crisis and growing social uncertainty, communication about eco-products is becoming a key tool for brands in shaping consumer attitudes toward sustainability. However, effective environmental communication does not have a universal impact— different generational groups respond differently to its form, content, and communication channels. Within academic discourse, these generational differences in ecological communication are developing dynamically, with an emphasis on digitalization, collaborative approaches, and personalized strategies.
Purpose of the article: The aim of this article is to analyze how academic research reflects generational differences in ecological communication through bibliometric analysis. The analysis is based on a comprehensive search strategy that includes key terms such as "green marketing," "generational differences," "eco-friendly communication," and "crisis" in order to identify thematic, geographical, and methodological trends and their significance for the creation of generationally sensitive communication strategies.
Methods: The research is based on a bibliometric analysis of the Web of Science database, which allows for quantitative and qualitative evaluation of publications according to thematic focus, geographical coverage, and temporal development. Research trends, thematic areas, and methodologies used within both terms are compared.
Findings & Value added: The analysis shows that since 2020, research on generational differences in environmental communication has grown, especially in English-speaking countries. Younger generations prefer digital channels and social media, while older ones lean towards traditional and educational approaches. The study highlights the need for generationally sensitive strategies and collaborative methods, offering insights for more effective environmental communication.

Keywords: Environmental communication, Generational differences, Bibliometric analysis, Global crisis

JEL classification: M31, Q56

1. Introduction

The present era brings significant changes and crises that affect everyday life and marketing activities. The focus is on sustainability and a growing interest in eco-friendly products, which, however, varies between generational groups. Climate change is a serious global challenge that manifests itself in extreme weather events that threaten the environment and society (Padmaja & Renuka, 2020). In response to these global issues, the concept of sustainable consumption is gaining importance and has become a key focus of interest not only for academics but also for policymakers (Diprose et al., 2019).

Despite growing awareness of eco-friendly products, there is often a gap between consumers' attitudes and their actual purchasing behavior, with decisions being influenced by factors such as price and quality (Padmaja & Renuka, 2020). It is therefore crucial for marketers to create communication that takes generational differences into account and gives younger groups a sense of awareness and engagement, thereby increasing their motivation to consume ecologically (Taufique et al., 2021). In addition, the

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current global economy is affected by multiple crises that have reduced trust in institutions and caused social and economic uncertainty. Addressing these environmental, economic, and social challenges is therefore essential for the sustainable development of society (Mladjan & Marković, 2021). This article focuses on analyzing the responses of consumers from different generational cohorts to environmental communication and provides recommendations on how marketing strategies should be tailored to the specifics of individual groups in order to effectively promote sustainable behavior.

1.1 Definition and significance of eco-products and their communication

Climate change is one of the most serious challenges of our time, and we are in a critical period that requires immediate and effective solutions. With growing environmental awareness in society, the importance of consumer awareness of eco-friendly products is also increasing (Usha & Kumar, 2024). In this context, green marketing plays an important role as a tool to promote environmentally responsible behavior. It involves the promotion and sale of products that are environmentally friendly and take into account their entire life cycle, from design and selection of raw materials, through production and distribution, to their final disposal (Padmaja & Renuka, 2020).

Eco-products are products designed to minimize their impact on the environment as much as possible. Emphasis is placed on the efficient use of resources, the use of renewable materials, and reducing the carbon footprint (Usha & Kumar, 2024). Eco-products are the result of sustainable innovations aimed at contributing to the achievement of environmental goals through conscious and responsible consumption. The development of these products and their effective communication to consumers are key to shaping sustainable consumer behavior (Wang, 2022). The main attributes of eco-products that influence their acceptance include reasonable price, long service life, repairability or upgradeability, and clear environmental benefits (Mladjan & Marković, 2021). Green marketing includes modifications in products, production processes, more environmentally friendly packaging, as well as in advertising communication itself (Padmaja & Renuka, 2020). Properly communicated values, especially during times of crisis, can significantly influence consumer decisions across generations, especially when linked to a narrative of generational responsibility and support for local communities (Mladjan & Marković, 2021). Other key elements of green marketing include product design, efficient use of resources, eco-friendly packaging, and green promotion (Padmaja & Renuka, 2020). Eco-labels and environmental certificates also play an important role, providing consumers with transparent information about the environmental characteristics of products. Environmental labeling not only increases consumer awareness but also significantly influences their purchasing behavior by facilitating the evaluation and comparison of products directly at the point of sale (Miklenčičová, 2015). These labels not only increase awareness but also promote the preference for products with a lower negative impact on the environment throughout their life cycle (Wang, 2022).

Eco-labels play a crucial role in consumer decision-making. Environmental communication has traditionally involved journalism and the media, but today it also includes personal and visual forms, such as protests and symbolic actions that influence public debate on climate change (Morgan, 2022). Consumers are the end recipients of products and services, and their decisions influence the success of eco-products on the market. It is therefore essential that they are clearly and comprehensively informed about the environmental and social aspects of products. Sustainability communication is thus a key tool for promoting the choice of environmentally friendly solutions (Wang, 2022). From this perspective, consumer awareness of eco-friendly products plays a crucial role in promoting sustainability, protecting public health, and shaping a more ethical and responsible work environment (Usha & Kumar, 2024). Through conscious decisions and support for environmentally friendly products, consumers can actively contribute to creating a more sustainable future for society as a whole. Green purchasing behavior is considered a form of socially responsible action that requires consumers to make ethical and conscious decisions. Green consumers consider the impact of their consumption on society and strive to contribute to positive social change through their purchases (Taufique et al., 2021). Research confirms that companies can make a significant contribution to environmental protection and sustainability through responsible marketing communication (Padmaja & Renuka, 2020). Sustainability communication is particularly important in industries with a high environmental impact, and effectively communicated environmental values can fundamentally change consumer perceptions and behavior (Bekil & Genel, 2024). From the above, it can be concluded that effective communication of environmental values is not just a supporting element, but an essential condition for the development of sustainable consumer thinking and social change towards more responsible consumption.

1.2 The importance of environmental communication in the context of climate and social crises

In the last decades of the 21st century, our society has faced several crises that have fundamentally affected its development and values. Economic shocks, the climate and environmental crisis, and the global COVID-19 pandemic have tested not only economic stability but also the resilience of individuals, communities, and institutions. Major economic crises affect both individuals and communities (Mladjan & Marković, 2021). In addition, rapid economic growth and industrial development over the past 20 years have led to the overexploitation of natural resources. This has caused serious environmental problems such as pollution, soil degradation, deforestation, and climate change (Bhutto et al., 2023). In many cases, these events have called into question the way society has functioned so far and, at the same time, accelerated the need to implement specific changes in how we use technology, how we live our daily lives, and what values and priorities we consider important. Globalization has also played a role in this, simplifying access to goods and information, but at the same time increasing vulnerability to global fluctuations and crises. The past three decades have seen a significant acceleration of globalization, resulting in stronger interconnections between individuals, societies, and states. This process has had a profound impact on social, cultural, economic, and political areas of life (Mladjan & Marković, 2021).

As a result of these global changes, including accelerating globalization and growing climate challenges, sustainable and generationally responsible consumption is becoming increasingly important. This is a way of shopping and using resources that takes into account not only the current needs of individuals, but also their long-term impact on future generations (Kabir, 2023; Mladjan & Marković, 2021). Interest in environmental and sustainable behavior was already growing before the COVID-19 pandemic, and the pandemic has further strengthened this trend as people have become more conscious of healthy and conscious consumption (Kabir, 2023). In this context, environmental communication takes on strategic importance. It takes into account not only the informational but also the cultural and social dimensions of climate change and its consequences. It plays a key role in shaping public opinion and motivating individuals and groups to act responsibly. At the same time, it creates space for linking individual decisions with collective goals. Nevertheless, environmental communication faces barriers. As Morgan (2022) points out, communication about climate change is influenced by political and economic interests, which complicates the way the media presents information. Consumers are often overwhelmed by conflicting messages, which can lead to information fatigue or skepticism. Furthermore, even if people are aware of the importance of sustainability, this awareness is not always reflected in their purchasing behavior. This is mainly due to the perception that sustainable products are more expensive, of lower quality, or unreliable (Bekil & Genel, 2024). This is compounded by the fact that consumers often lack sufficient awareness of environmental products, which represents a significant barrier to the development of the green market (Miklenčičová, 2015). This points to insufficient or ineffective communication about sustainability, which does not take into account the psychological and cultural barriers to accepting environmental values in everyday life. In order to overcome the psychological and cultural barriers associated with the acceptance of environmental values, it is essential that companies choose communication approaches that are understandable to the target group and reflect current digital trends. It is precisely in the context of eco-innovation that modern technologies play a key role in creating dynamic and extensive communication that has the potential to more effectively address and shape consumer perceptions (Kubovics et al., 2022).

From this perspective, environmental communication is an integral part of solving climate and social crises. Its importance lies not only in disseminating facts, but also in creating a comprehensible and value-based way of talking about issues that promotes shared awareness, behavioral change, and people's involvement in solving environmental and social challenges. Effective communication can transform public attitudes toward environmental issues, mitigate the negative consequences of the climate crisis, strengthen social resilience, and promote sustainable development.

1.3 Generational differences in attitudes towards eco-products

The climate crisis, pandemic, and other societal challenges do not affect all population groups equally. Generational differences in life experiences, value orientations, and access to information and resources significantly influence how different generations perceive these crises, how they attribute importance to them, and what strategies they choose to cope with them (Divasson et al., 2025). Generations differ from each other because they grew up in different historical and social conditions that shaped their values, attitudes, and behavior. These differences also influence how different generations

perceive brands and respond to their environmental and social activities (Moisescu & Gică, 2020). Understanding these differences is key to effective environmental communication across generations.

Generation Z is emerging as the most active and critical group in response to current social and environmental challenges. It is characterized by a high level of environmental awareness, strong digital engagement, and openness to new trends (Surmacz et al., 2024). Compared to older generations, young adults from this generation are more active in promoting the need for climate action, more likely to consume and share content about the climate crisis through digital platforms, and actively involved in environmental initiatives. Participation in protests, volunteer activities, and organizing campaigns are typical forms of climate activism for Generation Z (Tyson et al., 2021). They often perceive personal responsibility as a key tool for change, which is reflected in their willingness to limit their own consumption, preference for minimalism, and conscious consumption (Divasson et al., 2025). As they are mainly young workers or students who do not yet have their own or stable financial resources, their purchasing behavior may be limited. Even if they do have some income, these resources tend to be limited, which can be an obstacle to regularly purchasing more expensive eco-friendly products. Despite their limited financial resources, members of this generation are willing to pay a higher price for products with environmental or social benefits (Brand et al., 2022). The environmental behavior of this generation is closely linked to digital civic engagement, which underscores the importance of digital tools and personalized platforms in shaping their behavior (Surmacz et al., 2024). Combining environmentally-oriented messages with financial incentives and interactive digital elements is proving to be a particularly effective strategy in motivating this generation to adopt a sustainable lifestyle. Thanks to their digital literacy, value orientation, and intense engagement, they can be not only agents of change but also key allies in creating effective, inclusive, and sustainable solutions for the future.

Millennials, Generation Y, were until recently considered the most environmentally conscious group. Their purchasing behavior has long reflected an interest in healthy lifestyles, product quality, and sustainability (Kabir, 2023). Unlike Generation Z, millennials have greater financial resources, as they are an older age group of financially independent individuals. Therefore, they can afford to pay more for ecofriendly products and are not as economically constrained as Generation Z. They are tech-savvy, open to new forms of communication, and willing to invest in eco-friendly alternatives, making them an ideal target for brands focused on green marketing (Kabir, 2023). This view is also shared by Taufique et al. (2021), who argue that millennials make up a significant portion of the population with growing purchasing power and a significant influence on consumer behavior in households, making them an extremely attractive target group for marketers. On the other hand, millennials grew up during major technological and social changes, so they find themselves between old values and new trends. This gives them a broader perspective, but they often feel frustrated by rapid change and uncertainty (Divasson et al., 2025). In addition, their ecological purchasing decisions are shaped by their perception of quality, health benefits, and overall lifestyle (Kabir, 2023). An interesting example is millennials in Lithuania, where research has shown that although they belong to an individualistic culture, they feel strong pressure from their environment to behave ecologically. Their decisions are significantly influenced by normative and informational social influence, while personality traits such as conscientiousness or neuroticism play a lesser role (Bhutto et al., 2023). It therefore appears that the environmentally motivated behavior of millennials is more socially than internally conditioned. Although young millennials often express a positive attitude toward environmental activism, their actual behavior does not always correspond to this. This discrepancy between knowledge, values, and actual behavior is commonly observed in this group (Taufique et al., 2021). Millennials have a specific attitude toward authority, where on the one hand they trust formal systems and institutions as agents of change, but on the other hand they avoid authoritarian regulations if they lack legitimacy and participation (Divasson et al., 2025). It can be said that millennials are environmentally conscious but also realistic. They seek practical and clear solutions that support society. They take responsibility seriously but expect change to be driven primarily by credible institutions, not just themselves.

One notable finding is that feelings of irritation or reluctance diminish with age. Younger generations such as Generation Z and Millennials experience these emotions more often, which may be related to their natural tendency to view authority and social norms critically. There are also significant differences in how different generations perceive social pressure, revealing different attitudes toward social responsibility and expectations (Divasson et al., 2025). Older generations such as Generation X and Baby Boomers show lower participation, react less emotionally to climate issues, and are less likely to consider solving the climate crisis a priority (Tyson et al., 2021). Nevertheless, their behavior often reflects stable

values. As Mladjan and Marković (2021) point out, these are generationally responsible consumers who take into account long-term goals, community ties, and the environmental impact of products in their decisions. However, their motivation tends to be pragmatic rather than emotional and is based on a need for stability, experience, and collective values. Younger generations, such as Generation Y, are more sensitive to environmental issues and more likely to support "green" products. Conversely, older generations, such as Generation X, appreciate it more when companies engage in community support and act in a socially responsible manner (Moisescu & Gică, 2020).

Although they are not the main target group of green marketing, more educated members of Generation X more often prefer fair trade products and demonstrate a certain degree of environmental awareness (Brand et al., 2022). For Generation X, corporate social responsibility is more important than environmental activities. Their brand loyalty is more influenced by community support, ethical treatment of employees, and the company's social engagement. This means that marketing communications aimed at this generation are more effective when they emphasize the social contribution and human dimension of the brand (Moisescu & Gică, 2020). They are cautious when shopping, thoroughly verify information, and rely on trustworthy sources, which is also related to the fact that they only began using digital technologies in adulthood (Brand et al., 2022).

Compared to younger generations, Baby Boomers tend to be less involved in sustainability-related activities, which may be due to the fact that during their adolescence, climate change and environmental issues were not as prominent in the media and society as they are today (Brand et al., 2022). This generation is characterized by a belief in community values and the conviction that real solutions to social problems arise through everyday actions, interpersonal relationships, and local engagement. They perceive responsibility as a moral and ethical obligation of the individual or community rather than a systemic role of the state or institutions (Divasson et al., 2025). However, this generation has the highest rate of such consumption, indicating a greater tendency to buy products that are not essential (Brand et al., 2022). They show selective interest in eco-friendly products. They showed the least interest in sustainable fashion, both in their attitudes and in their actual purchasing behavior (Taborecka et al., 2023), which may also be related to the fact that they primarily communicate online. On the contrary, their engagement may be higher when it comes to food or cleaning products.

It follows from the above that effective communication about sustainability and marketing of ecofriendly products requires adaptation to generational differences. As Kubovics et al. (2021) state, "it is necessary to consider the recipient of this innovation, focusing on online consumers who can learn about eco-subjects through a selected communication platform – social media" (p. 219). Older generations often perceive sustainability as practical thriftiness and personal responsibility, resulting from their life experiences and historical context (Diprose et al., 2019). In contrast, younger generations emphasize a sense of awareness, personal meaning, and social uniqueness in ecological behavior (Taufique et al., 2021). This generational diversity suggests that a one-size-fits-all approach to sustainability marketing may not be effective. Differentiated and targeted strategies that reflect the different values and motivations of individual age groups can contribute to wider acceptance of environmentally responsible behavior (Divasson et al., 2025; Dias & Joshi, 2024). It is therefore important that marketing campaigns take these differences into account and target the specific needs and expectations of individual generations.

2. Methods

In order to examine how academic research reflects generational differences in the reception of environmental communication during global crises, we conducted a bibliometric analysis of scientific publications for the period 2017 to 2025. The main source was the Web of Science database, where we worked with combinations of key terms from the areas of sustainability, generational groups, and communication approaches in the context of climate change, the COVID-19 pandemic, and social uncertainty. The research was conducted in two phases. First, we analyzed publication activity, keyword occurrence, thematic focus, and geographical distribution of research. We then subjected selected publications to qualitative analysis in terms of their approach to generational differences in environmental communication. We further enriched the theoretical framework with sources from ResearchGate and Google Scholar, as well as literature from the fields of environmental psychology, marketing communication, and media studies.

When processing the data, we combined inductive and deductive methods – we interpreted quantitative findings in a broader cultural and social context. The results point to developments in

academic discourse, reveal research gaps, and offer recommendations for effective, generationally sensitive communication about eco-products in times of global challenges.

3. Results

As part of our research on environmental communication during global crises, we focused on how the scientific literature reflects generational differences in access to eco-products. We were interested in which generations are most often the subject of research, which countries and scientific disciplines are most interested in this topic, and which sustainable development goals are most often associated with it.

A bibliographic analysis was conducted in the Web of Science database using a comprehensive search phrase that linked the areas of environmental communication, generational differences, and the context of global crises (e.g., climate change, COVID-19, economic uncertainty). By combining key terms such as "green marketing," "generational differences," "eco-friendly communication," and "crisis," we captured a wide range of research approaches. This search strategy was chosen to comprehensively cover all key areas of our research. We prioritized covering environmental communication, generational differences, and last but not least, the context of global crises. We focused on the widest possible range of relevant terms to minimize the risk of omitting important works while capturing different approaches to the issue. Despite the extensive and complex search, it turned out that this is a current and lively discussed topic, as the result was as many as 953 relevant records, which were subsequently analyzed in terms of temporal development, linguistic, thematic, geographical and professional distribution. In terms of time, a significant increase in publications was recorded in the period 2021–2024, which represent up to 62.96% of all analyzed records (Figure 1.). The most publications come from 2023 (160) and 2024 (158), which confirms the topicality and dynamic development of research in the field. This increase may also be related to the pandemic period, during which social interest in environmental issues, health and overall sustainability of lifestyle increased. The pandemic has intensified the discussion about the relationship between humans, nature and global crises, which was also reflected in scientific production.

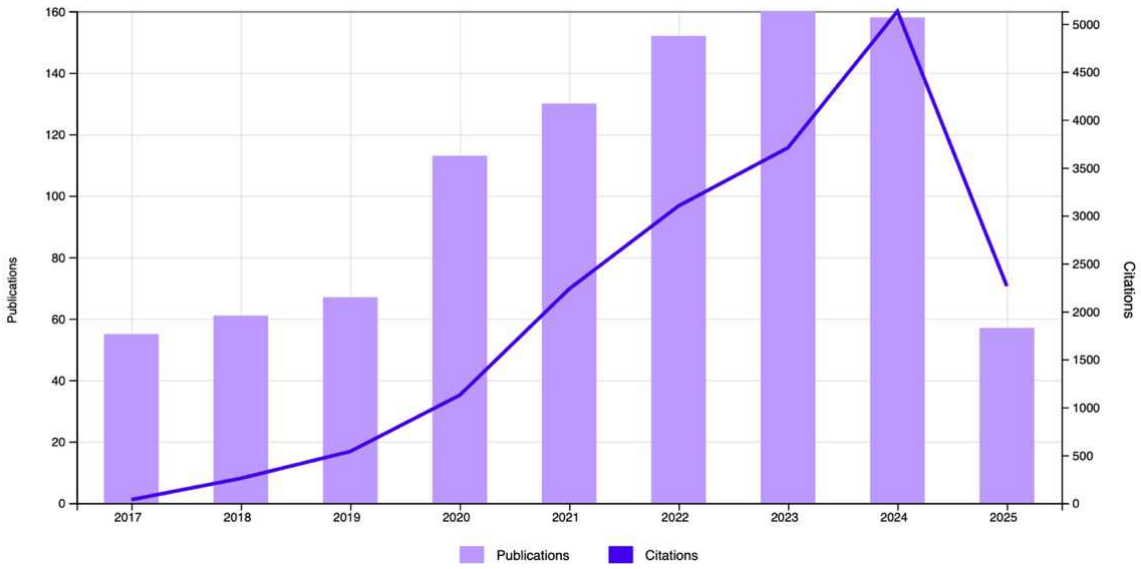

Figure 1. Publications and Citations on Generational Differences in Eco-Communication (2017–2025)
Source: Web of Science, own processing (2025)

When we looked at the language of the published articles, we found that most of them (up to 96.6%) were written in English. This suggests that the topic of environmental sustainability and generational differences in consumer behavior is addressed primarily at the international level. Publications in other languages were rare, which may be related either to the lower level of involvement of individual countries in research or to language barriers when publishing in scientific databases. Thematic analysis showed that the publications examined most often focused on sustainable development goals such as "Affordable and Clean Energy" and "Industry, Innovation and Infrastructure" (262 articles). Significant attention was also paid to topics such as "Hunger Reduction" (180), "Quality Education" (102) or "Health and Quality of Life" (92). This diversity suggests that researchers approach the issue from different perspectives and combine environmental, social and economic aspects of sustainability (Figure 2).

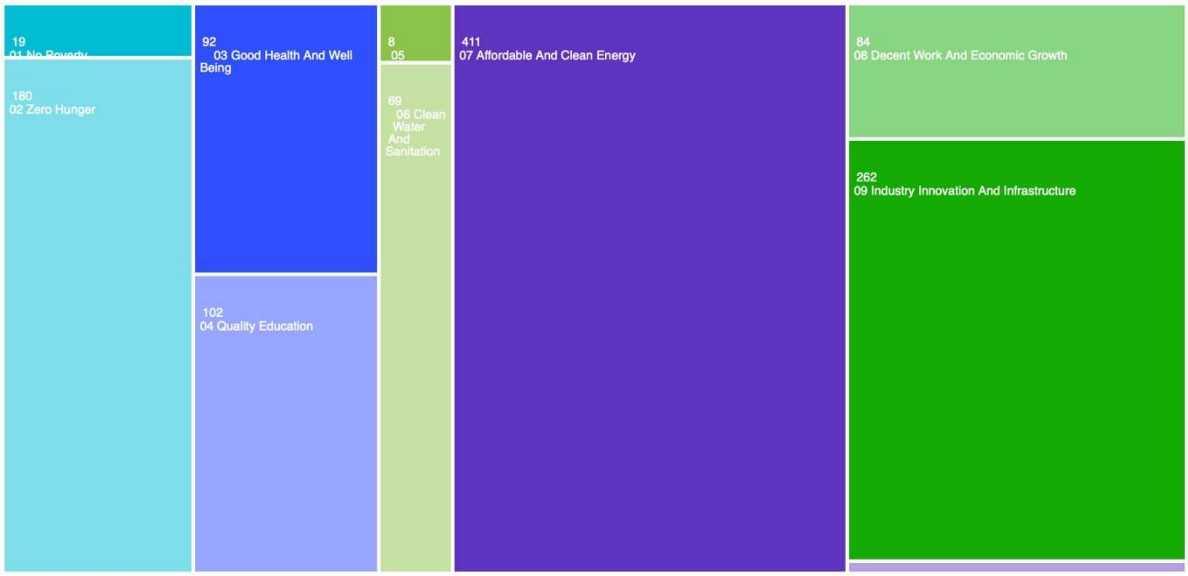

Figure 2. Thematic Focus of Research by Sustainable Development Goals
Source: Web of Science, own processing (2025)

In terms of scientific areas, publications focused on energy and fuels dominated (245 articles), but the fields of economics, business, chemical engineering and information technology were also strongly represented. This confirms that this is a topic that connects natural, technical and social sciences and requires an interdisciplinary approach. When observing geographical areas, publications were most represented in the USA (158) and China (147) (Figure 3.). European countries such as the United Kingdom, Germany, Italy and Spain also showed significant research activity, as did India, which show at least some interest in this issue. On the contrary, developing countries were only minimally represented, which points to the uneven distribution of research activity in the world. The high number of outputs from China may also be related to the fact that it is one of the countries with the largest share of global pollution and a high rate of industrialization, which increases the need for research in the field of environmental sustainability.

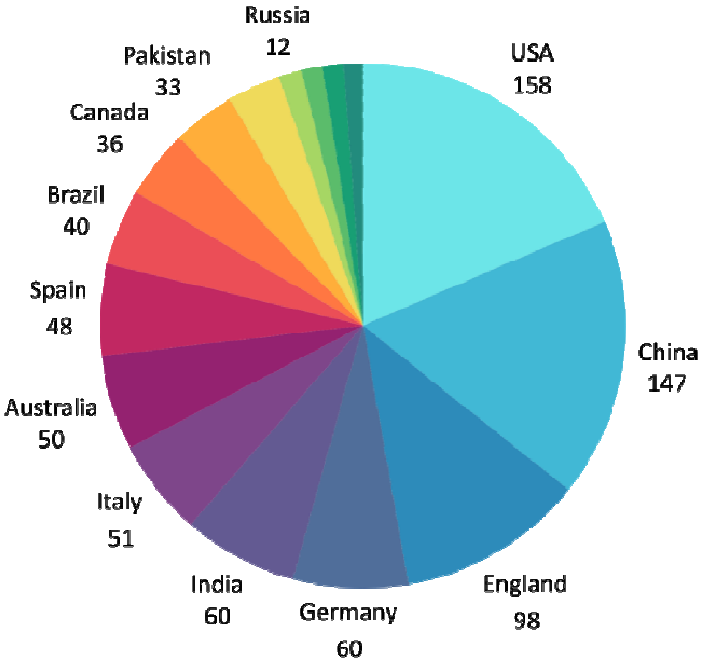

Figure 3. Geographic Distribution of Publications on Environmental Communication and Generational Differences
Source: own processing (2025)

The bibliographic analysis also included a separate search focused on individual generations (Baby Boomers, Generation X, Y, Z) to more precisely identify the development of scholarly interest in each of them in the context of sustainable communication and global crises (Figure 3.). Only those publications that directly addressed a specific generation were taken into account.

Generation Z was the most frequently reported. Research explicitly targeting this generation has emerged primarily in recent years: 4 publications were identified in 2021, 5 publications each in 2022 and 2023, and another 2 in 2024. This development suggests that Generation Z is currently the most widely reported, likely in relation to its environmental engagement and active stance on sustainability issues. Generation Y (millennials) was in the researchers' sights especially in 2021, 2022 and 2023, with 4 to 5 publications specifically dedicated to this generation in each of these years. This confirms its important position in the context of consumer behavior and sustainable communication. Generation X appeared in separate publications in the following years: 2017 (1 publication), 2018 (1), 2019 (2), 2020 (2), 2021 (1), 2022 (4), 2023 (6), and 2024 (2). In recent years, there has been a significant increase in the attention paid to this generation, which indicates its gradual advancement in academic discussions on sustainable consumption and communication. The Baby Boomers generation was studied in fewer publications, with relevant occurrences noted in 2020 (1 publication), 2021 (1) and 2023 (2). The lower occurrence may indicate less research interest in this group, which may be related to the assumed lower impact on future sustainable purchasing behavior.

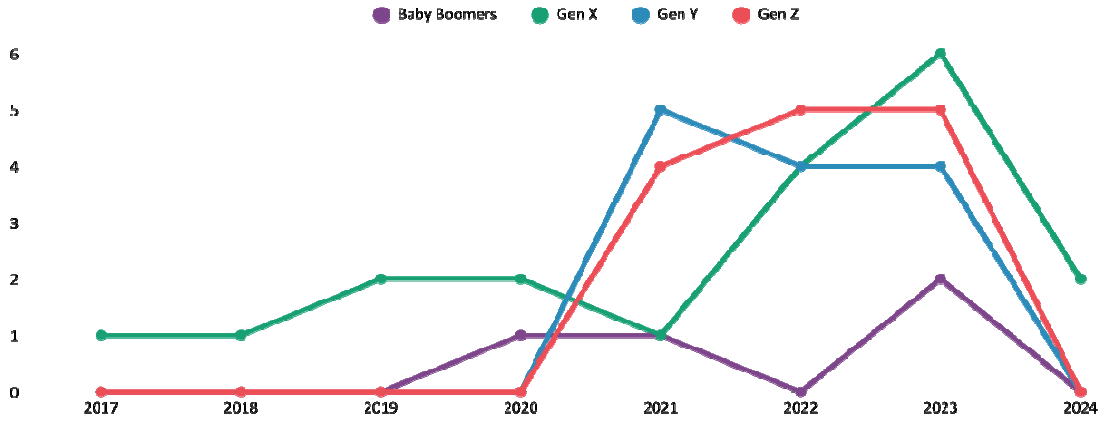

Figure 3. Publications by Generation (2017–2024)
Source: own processing (2025)

4. Discussion

Based on the analyzed data, a shift in research interest towards younger generations can be observed, with Generation Z emerging as the most frequently researched group in recent years. This trend may be related to the growing environmental awareness of younger consumers and their active participation in social and climate issues. Generation Y continues to maintain a stable position in research publications, while Generation X has seen a gradual increase in attention, especially after 2020. This development suggests that there is room for deeper research into this transitional generation, which combines traditional values with the advent of the digital era.

Conversely, Baby Boomers remain underrepresented, which may be due to the lower relevance of sustainability in the context of this generation or the assumed lower consumer influence. This disproportion also points to the existence of a research gap that may be relevant in the future, especially in terms of intergenerational transmission of values and behavior. The observed increase in publications after 2020 may reflect broader societal changes associated with the climate crisis and the COVID-19 pandemic. These events may have significantly influenced perceptions of sustainability and raised new questions regarding generational attitudes and consumer decisions in times of crisis.

From a regional perspective, research is predominantly concentrated in Anglophone and economically developed countries, which confirms the need to expand academic interest to the global South. Cultural and economic differences in these regions require a more sensitive and localized research approach that could enrich global knowledge about generational differences in the area of sustainable consumption. At the same time, a thematic analysis of publications shows that generational studies are often linked to the areas of energy, food security, health and education. This trend points to the need for a

multidisciplinary approach that can effectively respond to the complex challenges of sustainability. The findings indicate that relying on a single strategy in environmental marketing may not yield effective results. Instead, targeted and segmented approaches that consider generational differences can play a crucial role in promoting broader acceptance of ecological values and fostering responsible behavior amid global challenges.

Conclusion

Looking at the knowledge from the theoretical part and the results of the analytical part of the work, several important findings can be reached. First of all, it has been shown that effective communication of ecological values today plays much more than just an informational role. It becomes a tool for social change and influences attitudes, shapes values and motivates individuals and entire groups to behave more responsibly. Generational differences have proven to be a particularly important aspect. The analysis confirmed that different age groups approach sustainability differently. While older generations perceive ecological behavior mainly as part of responsibility and thrift based on personal experience, younger generations, especially generation Z, perceive sustainability as part of their value system and identity. This indicates that a unified approach in the field of environmental communication and marketing of ecological products is not enough today. On the contrary, there is a growing need for differentiated and more targeted strategies that will better respond to the values and motives of individual generations.

At the same time, it has become clear that research interest in this area is not evenly distributed. Most attention is paid to younger generations in English-speaking and economically developed countries, while older generations and regions of the Global South remain on the margins of interest. These findings represent a significant challenge and opportunity for the future to create more inclusive and culturally sensitive research that will better reflect the true diversity of society. Finally, it can be said that environmental communication has great potential to be a bridge between science, society and the individual. If it is thoughtful, authentic and reflective of the diversity of the audience, it can play a key role in addressing climate challenges and supporting sustainable development.

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Testing the Environmental Kuznets Curve Hypothesis under the EU Net-Zero Agenda

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Abstract

Research background: The European Union's commitment to achieving net-zero greenhouse gas emissions by 2050 intensifies the need to understand the interplay between economic growth and environmental outcomes. The Environmental Kuznets Curve (EKC) hypothesis, which posits a nonlinear relationship between income and environmental degradation, offers a useful conceptual lens—but requires empirical validation within contemporary policy contexts. This study re-examines the EKC hypothesis in broader, policy-relevant framework, by incorporating aditional structural variables that may influence CO_2 emissions, including energy use, the share of renewable energy sources, urbanization, and land use, land-use change and forestry (LULUCF).
Purpose of the article: The article investigates whether economic growth in EU countries follow the EKC trajectory in relation to CO_2 emissions in the context of wider spectrum of structural variables. The focus is on identifying critical thresholds that mark shifts in the relationship between these variables and CO_2 emissions.
Methods: The thereshold panel regression techniques are used in the analysis to capture nonlinear relationship between income (GDP), other structural variables and CO_2 emissions. This method not only allows us to identify the turning points that separate the different regimes of this relationship but it also enables us to understand the role of other structural variables in achieving decarbonisation goals within the EU.
Findings & Value added: Results provide strong empirical support for EKC hypothesis. In lower-income EU countries, GDP growth significantly increases CO_2 emissions, while in higher-income countries above the threshold, the effect is significantly negative, suggesting the decoupling of economic growth from emissions.By embeding EKC analysis within a broader decarbonisation framework, this study highlight the contextual nature of emissions drivers. The results inform the development of more effective and differentiated climate policies, suggesting that strategies for reducing emissions must consider economic development stages and the interactions between multiple structural variables.

Keywords: Economic growth, Decarbonization, Land use, Urbanization, Thershold panel regression, EU countries

JEL classification: O44, Q56, Q58

1. Introduction

The accelerating threat of climate change has placed decarbonization at the center of global and regional policy agendas. The 2015 Paris Agreement marked a watershed moment, establishing the collective ambition to limit global temperature rise to well below 2 °C. However, at the current pace of CO_2 emissions, projections suggest that global temperatures could exceed 3 °C by 2050 (UN, 2015), raising the risk of widespread ecological disruption, extreme weather events, and pressure on economic and natural systems (Lee & Romero, 2023). Recognizing these risks, the Intergovernmental Panel on Climate Change (IPCC) and other scientific bodies have emphasized the need for immediate and systemic mitigation efforts—including the transformation of energy systems, land use practices, and urban infrastructures.

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Within this broader context, the European Union (EU) has emerged as a global leader in climate governance. Through initiatives such as the European Green Deal (EC, 2019) and the legally binding European Climate Law (EU, 2021), the EU has committed to reducing greenhouse gas emissions by at least 55% by 2030 and achieving climate neutrality by 2050. These targets require not only technological innovation but also a nuanced understanding of the structural and economic factors driving emissions across Member States.

A widely discussed framework for exploring the relationship between economic growth and environmental degradation is the Environmental Kuznets Curve (EKC) hypothesis. The EKC posits an inverted U-shaped relationship, suggesting that pollution and emissions initially rise with increasing income, but begin to decline after reaching a certain development turning point (see Figure 1). This dynamic is attributed to structural shifts toward less emission-intensive sectors, stronger environmental regulations, technological innovation, and increased public demand for environmental quality (Galeotti & Lanza, 2005; Grossman & Krueger, 1995; Stern, 2004). Although several studies have found empirical support for the EKC in developed economies, results remain inconclusive and highly sensitive to methodological choices, sample heterogeneity, and the pollutants or indicators used (Bo, 2011; Dogan & Inglesi-Lotz, 2020; Shahbaz & Sinha, 2019). In the context of the European Union, where countries differ significantly in economic structure, energy systems, and climate policy implementation, the EKC hypothesis requires renewed empirical attention using tools capable of capturing these underlying differences.

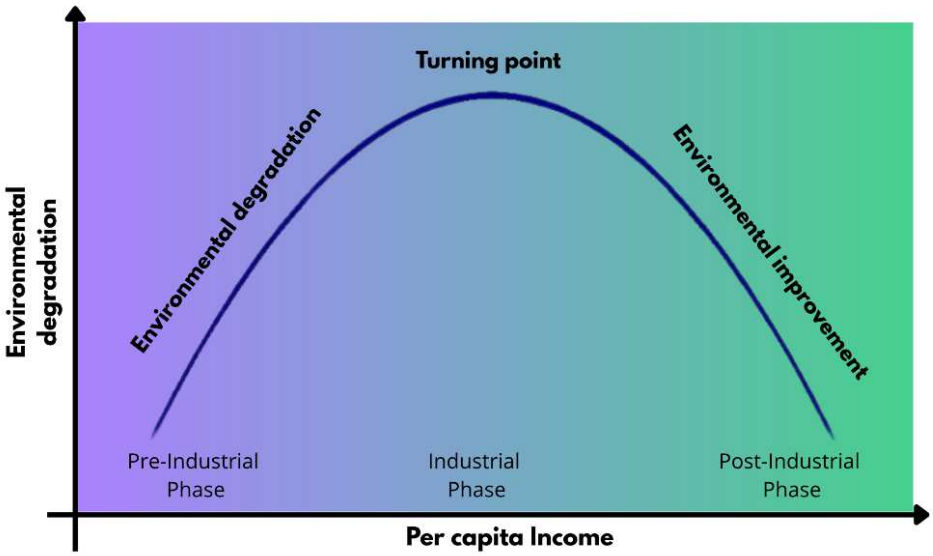

Figure 1. Environmental Kuznets Curve
Source: own processing in Canva

This study advances the EKC literature by moving beyond a one-dimensional income–emissions relationship and situating the analysis within a broader structural and policy-relevant context. Specifically, we incorporate additional key variables that influence CO_2 emissions—energy use per capita, the share of renewable energy in the energy mix, urbanization levels, and land use, land-use change and forestry (LULUCF) emissions.

This multidimensional perspective reflects the complex drivers of emissions within the EU's climate transition. Methodologically, the application of threshold panel regression models enables us to detect nonlinearities and regime-specific effects—identifying turning points at which the impact of income and other variables on emissions fundamentally changes. This provides a more realistic and nuanced understanding of the EU's decarbonization dynamics, and offers novel empirical evidence to inform climate policy strategies that are sensitive to the diversity of development paths and structural conditions across Member States.

The paper is structured as follows: "Literature review" provides a review of related literature. "Data and methods" focuses on data and methodological procedures employed. "Results and discussion" concentrates on the interpretation of empirical findings in the context of fincdings of previous studies. Finally, "Conclusion" concludes the study and provides considerations for policy-makers.

2. Literature review

The Environmental Kuznets Curve (EKC) hypothesis, which posits an inverted U-shaped relationship between environmental degradation and economic growth, has served as a cornerstone in environmental economics. Within the context of the European Union (EU), however, its application requires considerable nuance. The EKC framework may exhibit varying manifestations across EU member states due to differences in economic structures, regulatory regimes, and societal values. This nuanced interpretation is particularly salient as the EU advances comprehensive strategies, such as the European Green Deal (EGD), to align economic growth with environmental sustainability.

The urgency of decoupling economic growth from environmental degradation is central to the EU's sustainability agenda. As part of the EGD, the European Commission has recognized the need to revise policy instruments, including „no-debit rule" (EU, 2018), RED III Directive (EU, 2023), and others, to better support environmental objectives (Romppanen, 2020). This reflects a broader recognition that achieving sustainability within the EU requires balancing economic growth with ecological responsibility. The varying capacities of EU countries to implement such changes further complicate the EKC's one-size-fits-all trajectory.

The empirical literature on EKC in the EU context presents mixed results. Some studies validate the EKC pattern in specific countries or for specific pollutants, while others find no such evidence. For instance, (Pata & Yurtkuran, 2023) scrutinize EKC in five highly globalized countries of the EU. The study confirms EKC hypothesis for Denmark and Switzerland, however, in Sweden and Austria, the income and globalization have adverse effect. Study by (Dogan & Inglesi-Lotz, 2020) focusing on panel of EU contries, confirms EKC hypothesis when aggregated economic growth is taken as independent variable, suggesting that economic growth is associated with and inverted U-shaped relation with CO_2 emissions. However, when considering economic structure of EU countries, the EKC was not confirmend. Moreover, (Chandra Voumik et al., 2022) analysed data from 34 european countries and confirmed the existence of U-shaped link between environmental pollution and economic output. This finding rejects EKC hypothesis. Study also finds that the long term perspective, renewable energy use and R&D investments contribute significantly to reducing carbon footprint of European countries. These and other studies found inconclusive or atypical patterns, suggesting that economic growth alone does not universally lead to environmental improvement. These inconsistencies highlight the need to explore additional explanatory variables and contextual factors. Also study by (Bekun et al., 2021) confirms the validity of the EKC hypothesis, indicating that while economic growth contributes to environmental degradation in the short term, a turning point may eventually lead to improvements. However, this pattern is not uniform across the EU, as only a few member states have made significant progress in reducing emissions.

The role of renewable energy in shaping environmental outcomes has received considerable attention. Recent studies confirm that increasing the share of renewables contributes to CO_2 reduction, supporting the downward slope of the EKC in high-income countries (Chen et al., 2022; Narayan & Doytch, 2017; Pata et al., 2025; Stefko et al., 2021). For example, (Bongers, 2020) observed that the transition to renewables enhances GDP growth while simultaneously curbing emissions, although the effect is contingent on national energy structures and policy support. However, some studies caution that renewables alone may not suffice if domestic material consumption and energy demand, especially from fossil fuels, continue to grow (Chen et al., 2022). This implies that renewable adoption must be embedded within broader systemic changes to effectively contribute to decarbonization.

Urbanization is another variable that has shown both mitigating and exacerbating effects on emissions. While increased urban density can reduce per capita emissions through improved public transport, shared infrastructure, and energy-efficient housing ((Bai et al., 2019; Chovancová et al., 2023; Luqman et al., 2023), rapid and unplanned urban growth can lead to greater energy use and congestion. The literature highlights that the relationship between urbanization and environmental quality is non-linear and may differ based on income levels and the stage of urban development. Few EKC studies directly model this interaction, underscoring a gap in understanding how urbanization fits into the broader decarbonization agenda.

Land use and land-use change—including emissions and removals from the LULUCF sector—have received relatively limited attention in EKC-focused research, despite their crucial role in the EU's climate targets. The IPCC and EU climate frameworks recognize that forests and soils can act as carbon sinks or sources, depending on land management practices. The inclusion of LULUCF in national inventories underlines its growing importance. However, few empirical studies have incorporated LULUCF emissions

into EKC models, and those that do often face data limitations. This omission represents a significant gap, especially given that land-based mitigation strategies are central to achieving net-zero targets.

Research Gap and Contribution

While the EKC hypothesis continues to provide a useful starting point for analyzing the growth–environment relationship, its explanatory power is limited when applied in isolation. The dominant focus on GDP fails to capture the full range of structural and policy-related factors influencing emissions trajectories in the EU. The mixed results in the literature signal that a more comprehensive, context-aware approach is necessary. Methodologically, recent studies have advocated moving beyond simple linear or quadratic EKC models and called for threshold and nonlinear approaches that capture the regime-dependent nature of the growth–emissions relationship.

This study addresses these limitations by integrating key variables—renewable energy share, urbanization, and LULUCF-related emissions—into a threshold panel regression framework. By doing so, it goes beyond conventional EKC modeling and captures the non-linear, multi-dimensional drivers of CO_2 emissions in the EU. This comprehensive approach provides new insights into the conditions under which economic growth may support or hinder the EU's climate goals, offering empirically grounded guidance for differentiated policy strategies.

3. Data and methods

The analysis uses data from the 27 European Union (EU) member states. This data covers the period 2000–2022. The variables used in this study are detailed in Table 1. This table also gives their descriptions, measurement units and data sources. We will analyse the key variables as factors influencing the emissions dynamics. The variables include CO_2 emissions as the dependent variable and GDP per capita, land-use management (LULUCF), energy use per capita, the share of renewable energy (RESshare) and the urbanisation rate as the explanatory variables.

Table 1. Variable descriptions

Variable	Description	Unit	Source
CO2	Annual CO2 emissions (per capita)	tonnes per capita	OWD
GDPpc	GDP per capita	current US$ (thousands)	World Bank
EnUsepc	Primary energy consumption per capita	MWh per capita	OWD
LULUCFpc	Net greenhouse gas emissions of the Land use, Land use change and Forestry (LULUCF)	Tonnes per capita	Eurostat
RESshare	Renewable energy consumption	(% of total final energy consumption)	World Bank
Urban	Urban population	(% of total population)	OWD

Table 2 presents the descriptive statistics of the key variables, which are presented in order to provide a comprehensive overview of the data. For most variables—GDP per capita (GDPpc), energy use per capita (EnUsepc), LULUCF per capita, and urbanization rate (Urban)—the dataset contains a total of 621 observations. However, slightly fewer observations (594) are given for the variable renewable energy share (RESshare) due to missing data for the year 2022 in some EU countries. The descriptive statistics provide an overview of the distribution and variability of the data, including the number of observations (Obs), mean values, standard deviations (Std. Dev.), and the minimum (Min) and maximum (Max) values.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
CO2	621	7.7694	3.5081	2.8998	25.9849
GDPpc	621	30.3171	22.2034	1.6212	133.7118
EnUsepc	621	42.2948	17.5443	15.7799	113.1062
LULUCFpc	621	-0.9893	1.4977	-6.4	2.6
RESshare	594	17.4787	11.9406	0	57.9
Urban	621	72.1695	12.6344	50.754	98.153

Source: own processing in Stata

To account for potential non-linear relationships between CO_2 emissions and their explanatory variables across different structural or policy regimes, we apply a threshold panel regression model as introduced by (Hansen, 1999) and later extended to dynamic panels by (Seo & Shin, 2016). This approach allows the estimated coefficients to vary depending on whether the threshold variable falls above or below an estimated cut-off point, thereby capturing regime-dependent effects.

The threshold model is specified as follows:

$$CO_{2it} = \begin{cases} \alpha_1 + \beta_1 X_{it} + \mu_1 + \varepsilon_{it} \; if \; q_{it} \leq \gamma \\ \alpha_2 + \beta_2 X_{it} + \mu_1 + \varepsilon_{it} \; if \; q_{it} > \gamma \end{cases}$$

Where:

CO_{2it} is the dependent variable representing per capita CO_2 emissions,
X_{it} is a vector of explanatory variables,
q_{it} is the threshold variable (e.g., GDP per capita, renewable energy share, urbanization, etc.),
γ is the endogenously determined threshold value,
μ_1 denotes unobserved individual-specific effects,
ε_{it} is the idiosyncratic error term.
i= 1,2,3…. N and t = 1,2,3,… T (N = 27, T = 23)

The threshold value γ is estimated by minimizing the residual sum of squares ($RSS = \sum_{i=1}^{N} \sum_{t=1}^{T} e'_{i,t}.e_{i,t}$) over a grid search of possible values. Statistical inference for the presence of a threshold effect is conducted via bootstrap procedures, following the methodology proposed by Hansen (1999), which provides valid confidence intervals and significance tests for the threshold estimates.

The model enables the analysis of regime-specific marginal effects, allowing for greater flexibility in assessing how structural characteristics (e.g., level of renewable energy use or urbanization) influence the sensitivity of emissions to policy and economic variables. This is particularly relevant in heterogeneous panels, such as EU countries, where national contexts and policy frameworks differ.

To ensure robustness, we report:

- Estimated threshold values and their confidence intervals,
- Bootstrap F-statistics and p-values testing the null hypothesis of no threshold,
- Regime-specific coefficient estimates with confidence intervals to assess the significance of parameter differences across regimes.

This method is implemented using the procedures outlined by Seo and Shin (2016).

4. Results and discussion

4.1 Threshold analysis with GDP per capita as the threshold variable

To investigate potential nonlinearities in the relationship between CO_2 emissions and their socioeconomic and environmental drivers, we employ a threshold panel regression model using GDP per capita as the threshold variable. The goal is to assess whether the marginal effects of the explanatory variables differ significantly depending on a country's level of economic development.

As shown in Table 3, the model identifies a single threshold value of 19.4864, with a 95% confidence interval between 19.3680 and 19.6155. This split divides the sample into two distinct groups:

- Region 1: Countries with GDPpc < 19.4864 thousand USD (generally lower-income or transitional economies)
- Region 2: Countries with GDPpc > 19.4864 thousand USD (more advanced or high-income economies)

Table 3. Threshold estimator

Model	Threshold	Lower	Upper
Th- 1	19.4864	19.3680	19.6155

Source: own processing in Stata

Although the bootstrap p-value of 0.1867 does not confirm threshold significance at the 10% level, the differences in regression coefficients across regimes—as reported in Table 4—are theoretically meaningful and consistent with existing literature on the Environmental Kuznets Curve (EKC) and the energy-economy-emissions nexus.

Table 4. Threshold effect test (bootstrap 300)

Threshold	RSS	MSE	F stat	pvalue
Single	249.4869	0.4362	86.55	0.1867

Source: own processing in Stata
Note: RSS - the residual sum of squares; MSE - mean squared error

The EKC hypothesis posits an inverted U-shaped relationship between income and environmental degradation, suggesting that:

- In the early stages of economic development, pollution and emissions tend to rise with income due to industrialization, energy demand, and limited environmental regulation.
- As income increases beyond a certain threshold, countries gain the resources and institutional capacity to invest in cleaner technologies, shift toward service-oriented economies, and implement effective environmental policies, resulting in a decline in emissions.

In this study, the positive and significant coefficient for GDPpc in Region 1 (0.0571***) and the negative and significant coefficient in Region 2 (–0.0119***) provide clear empirical support for the EKC pattern. This finding implies that EU countries below the threshold are in the upward-sloping phase of the EKC, while those above the threshold may have reached or passed the turning point, benefiting from a relative decoupling of growth and emissions. Similar patterns have been identified in other empirical studies across the European context. For example, (Armeanu et al., 2018) confirmed the EKC hypothesis for greenhouse gas emissions using panel data from 28 EU countries. Likewise, (Madaleno & Moutinho, 2021)found robust evidence supporting the EKC when analyzing various greenhouse gases, including CO_2, noting that wealthier and more established EU member states tend to exhibit stronger signs of decoupling. Hatmanu's study of the EU-15 countries, however, underscores the heterogeneity within the bloc, finding that only a subset of countries fully validate the EKC hypothesis (Hatmanu & Cautisanu, 2022). These varying outcomes emphasize the importance of disaggregated, country-specific analysis and suggest that structural and policy differences influence the trajectory of emissions.

In the next section, we deepen this analysis by examining the nuanced and regime-specific drivers of CO_2 emissions, incorporating variables such as energy use, renewable energy share, urbanization, and land use emissions (LULUCF) to provide a more comprehensive understanding of decarbonization dynamics in the EU.

4.2 Regime-specific drivers of CO_2 emissions

The threshold model using GDP per capita as the splitting variable reveals meaningful differences in how key drivers affect CO_2 emissions across two income-based regimes, as captured in Table 5.

Table 5. Estimated Coefficients from Threshold Panel Regression with GDP as a threshold variable

CO2	Region	GDPpc_th	Coef	95% Conf. Interval	
GDPpc_th	1	GDPpc_th < 19.4864	0.0571***	0.0288	0.0854
	2	GDPpc_th > 19.4864	-0.0119***	-0.0201	-0.0038
EnUsepc_MWh	1	GDPpc_th < 19.4864	0.1597***	0.1366	0.1828
	2	GDPpc_th > 19.4864	0.1278***	0.1121	0.1436
LULUCFpc	1	GDPpc_th < 19.4864	0.0999*	-0.0036	0.2036
	2	GDPpc_th > 19.4864	-0.1488***	-0.2406	-0.0570
RESshare	1	GDPpc_th < 19.4864	-0.1494***	-0.1743	-0.1246
	2	GDPpc_th > 19.4864	-0.1223***	-0.1417	-0.1028
Urban	1	GDPpc_th < 19.4864	-0.0796***	-0.1195	-0.0398
	2	GDPpc_th > 19.4864	-0.0616***	-0.1195	-0.0398
constant			9.2834***	6.4501	12.1167

Source: own processing in Stata

Among the set of variables examined, the threshold analysis reveals that two key drivers—GDP per capita (GDPpc_th) and LULUCF emissions per capita (LULUCFpc)—exhibit statistically significant differences in their effects across income regimes. These differences are evident not only in the direction of the coefficients but also in the non-overlapping confidence intervals, which confirm the robustness of the income-dependent divergence.

For GDP per capita, the positive and significant effect in lower-income countries and the negative and significant effect in higher-income countries align with the Environmental Kuznets Curve hypothesis and point to a structural turning point in the relationship between economic growth and emissions.

For LULUCF, the shift from a positive (emission-enhancing) impact in lower-income countries to a strongly negative (emission-mitigating) effect in higher-income countries suggests that land-use governance and forest management practices are highly sensitive to economic and institutional development.

In contrast, for Energy Use (EnUsepc_MWh), Renewable Energy Share (RESshare), and Urbanization (Urban), although the estimated coefficients vary numerically, the overlapping confidence intervals indicate that these differences are not statistically significant. This implies that their influence on emissions is relatively stable across income levels, reinforcing their role as universal policy targets within the EU decarbonization strategy. However, the direction and size of coefficients across regimes offer valuable insights.

In case of energy use per capita, both coefficients are positive and statistically significant. However, the marginal effect of energy use on CO_2 emissions decreases from lower incpme countries (0.1597) to 0.1278 in higher-income countries. This suggests that energy consumption is less emissions-intensive in wealthier EU states—possibly due to cleaner technologies, higher efficiency, or a greater share of renewables. Even without statistical separation, this trend points to partial decoupling in more developed economies. In higher-income EU countries, this trend may be explained by several reinforcing factors. These economies are more likely to benefit from cleaner energy mixes, greater deployment of renewables, and stricter environmental regulations, which collectively reduce the carbon footprint of each unit of energy consumed. Moreover, energy efficiency measures—such as advanced building standards, industrial optimization, and smart energy management systems—are more widely adopted in wealthier nations. These factors help reduce emissions intensity, even as overall energy use remains high. By contrast, lower-income countries often still rely more heavily on carbon-intensive fuels, such as coal and gas, for power generation and heating. In these contexts, energy consumption tends to have a more direct and stronger correlation with emissions, due to limited access to clean technologies and the slower pace of energy transitions. This explains the higher coefficient observed in the lower-income group, where each additional unit of energy consumed results in more emissions on average.

For share of renewable energy, both coefficients are negative and significant, indicating that renewables reduce emissions in both income groups. However, the effect is slightly stronger in lower-income countries (-0.1494) compared to higher-income countries (-0.1223), which may reflect greater marginal benefits from initial renewable adoption—e.g., replacing fossil-heavy energy systems. This pattern reflects the classic concept of "low-hanging fruit" in environmental policy—early-stage investments in renewables in less developed economies often result in rapid and substantial emission reductions, as they replace more polluting energy sources such as coal or oil. In contrast, in higher-income countries, where the energy transition is more advanced and renewable infrastructure is already widely established, further improvements face diminishing marginal returns. Here, most of the low-hanging fruit has already been picked, and additional progress may require more complex and costly systemic changes—such as energy storage solutions, smart grids, or integration with other sectors (e.g., heating, transport). Also, further expansion of renewables adoption in higher-income countries faces structural limitations, including intermittency, grid stability, and integration costs – another factor that may contribute to the lower marginal effect of renewables on CO_2 emissions.

These findings align with broader literature. For example, (Albulescu et al., 2020) uses static and dynamic panel data analysis and confirm mitigating effect of an increased renewable energy share on CO_2 emissions. (Chovancová et al., 2021), focusing on V4 countries, also highlight the critical role of renewable energy in achieving CO_2 reductions while supporting economic growth. Their analysis reinforces the view that renewables enable the kind of sustainable economic development consistent with the downward trajectory of the EKC. Similarly, (Moutinho et al., 2018) found that across various EU member states, greater renewable energy use was associated with successful decoupling of economic growth from environmental degradation, especially in countries that maintained long-term investments in clean energy technologies.

This study finds that urbanization is negatively associated with CO_2 emissions in both income-based regimes across EU countries, indicating that increasing urbanization contributes to emissions reduction in overall. Interestingly, the effect is slightly stronger in lower-income countries (–0.0796) compared to higher-income countries (–0.0616). This suggests that urbanization processes in less affluent EU countries

offer greater opportunities for emissions reduction, likely because they involve substantial shifts from inefficient energy systems to more centralized and optimized infrastructures. In higher-impact countries, further emissions reductions from urbanization may depend on incremental improvements such as smart city technologies, retrofitting existing infrastructure, and densification strategies—approaches that are more complex, costly, and less immediately impactful. Dual role of urbanization as both a driver or environmentl degradation and a catalyst for sustainability is highlighted in numerous studies (Chovancová et al., 2023; Sadorsky, 2014; Wang et al., 2018) etc. These studies emphasise that while urban growth often increase energy demand, it can also facilitate emissions reductions through infrastructure efficiency, smart-city approaches and centralised public services.

These findings underscore the importance of designing both common and differentiated policy approaches. While energy efficiency, renewables, and sustainable urbanization offer broad benefits, emissions from economic growth and land-use change require more targeted interventions that account for a country's development trajectory and institutional capacity.

Conclusion

This study reaffirms the Environmental Kuznets Curve (EKC) hypothesis within the context of EU countries, revealing that economic growth initially contributes to rising CO_2 emissions but may eventually support emissions reductions once a certain income threshold is surpassed. The inclusion of structural variables—such as renewable energy share, urbanization, and energy use per capita—provides a more nuanced understanding of the drivers of emissions across income regimes. The findings of the study offer important policy implications:

- Since renewables have a stronger emission-reducing effect in lower income countries, EU funding and technical support should prioritize early-stage clean energy transition.
- Growing cities can yeld significant environmental gains, but investments should focus on public transport systems, smart infrastructure, and affordable energy-efficient housing.
- The role of LULUCF is often underutilised in the EU region. Policies should incentivize carbon sink preservation and nature-based solutions.

Study also highlignts, that given the variation in EKC trajectories and structural conditions, one-size-fits-all approaches may not be effective. Instead, the EU should promote knowledge sharing and cross-border collaboration on best practices, while allowing flexibility in how national climate targets are met.

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Climate Risk and Regulation: The Way to EU Taxonomy Reporting

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Abstract

Research background: The focus on Environmental, Social, and Governance (ESG) factors has intensified over the past decade, driven by the Paris Climate Agreement and the United Nations Sustainable Development Goals (SDGs) introduced in 2015. These global initiatives underscored the necessity for measurable data on carbon footprint, energy efficiency, and climate adaptation to achieve meaningful climate targets.
Purpose of the article: The article aims to explore the evolution of ESG reporting from voluntary frameworks to mandatory, data-driven, and standardized processes, particularly within the European Union. It examines the impact of the EU Taxonomy Regulation and the Corporate Sustainability Reporting Directive (CSRD) on corporate sustainability reporting.
Methods: The article analyzes the transition from the Non-Financial Reporting Directive (NFRD) to the CSRD and the introduction of the EU Taxonomy Regulation through KPI criteria.
Findings & Value added: The shift from narrative-driven disclosures to strict, data-based evaluation has significantly enhanced the credibility and comparability of ESG reporting. The EU Taxonomy Regulation has introduced objective criteria for environmentally sustainable economic activities, requiring companies to quantify their environmental impact using specific Key Performance Indicators (KPIs). This has moved ESG reporting from broad storytelling to objective, science-based evaluation. The article highlights the importance of standardized ESG KPIs and the rigorous EU regulatory framework in establishing credible, comparable, and actionable sustainability reporting. It emphasizes the role of transparency and accountability in modern corporate strategy, enabling investors, regulators, and stakeholders to accurately assess corporate sustainability performance and drive progress toward a greener economy.

Keywords: Paris Climate Agreement, ESG, CSRD, NFRD, KPI, Taxonomy

JEL classification: G20, Q50

1. Introduction

Environmental, Social, and Governance (ESG) factors have become the central focus of investors, regulators, and companies over the past decade. With increasing emphasis on transparency and sustainability, it has become clear that without standardized Key Performance Indicators (KPIs) in ESG, it is impossible to seriously assess corporate progress. This paper gives an overview of the ESG reporting from voluntary framework to now. We describe the evolution of the reporting to the regulatory framework that included in European Union taxonomy reporting in this time.

In 2015, the Paris Agreement was adopted, setting global goals for limiting temperature rises to well below 2°C. This agreement triggered the urgent need for measurable data on carbon footprint, energy efficiency, and climate adaptation. Companies and investors realized that achieving any meaningful climate targets without quantifiable information would be very difficult (Rajamani, 2016).

2015 was also the year the United Nations introduced the Sustainable Development Goals (SDGs), which expanded the ESG agenda to include areas such as equality, employee rights, and business ethics (Saxena et al., 2021).

After 2015, several voluntary frameworks for reporting environmental, social, and governance (ESG) data emerged. Among the most prominent were the Global Reporting Initiative (GRI) Standards, which emphasized broader social and environmental impacts.(Halkos et al., 2021) the Task Force on Climate-

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related Financial Disclosures (TCFD), established in 2017, which issued recommendations for the disclosure of climate-related risks and opportunities; and the Sustainability Accounting Standards Board (SASB), which developed sector-specific metrics targeting financially material ESG factors. These initiatives introduced the first quasi-standardized key performance indicators (KPIs) for corporate ESG reporting, yet their adoption remained largely voluntary (Diwan et al, 2024).

2. Methods

The aim of this paper is to describe the difference between NFRD, which was marked as the first European Union paper with legislative effort to large public-interest entities to the EU Taxonomy KPIs, that transfer Non-financial annual reporting to data-driven verifiable format. This regulation estabilished a new classification system for environmentally sustainable economic activities, that required companies under the NFRD criteria to report KPIs related to the taxonomy-eligible and taxonomy-alligned activities, also including turnover, OpEx and CapEx.

This transition from the NFRD to the EU Taxonomy framework represents the markable shifts in corporate sustainability reporting. Taxonomy reporting brings a new classification, how sustainability is reported and measured. Companies falling under NFRD are now required to review their economic activites against detailed technical screening criteria. This evolution aligned corporate reporting with broader climate and environmental objectives, which empowers investors to make more informed decisions and improves regulatory oversight.

3. Results

3.1 NFRD Directive and the EU Taxonomy

Launched in 2019, the European Green Deal was the real printed document for transitioning toward climate neutrality. The main objectives include reducing greenhouse gas emissions by at least 55% to 2030, investing 1 trillion EUR into sustainable investments and achieving climate neutrality by 2050 (Wolf et al., 2021).

A significant transformation in ESG reporting occurred from 2020 onwards. The European Union introduced the EU Taxonomy Regulation, establishing objective criteria for identifying environmentally sustainable economic activities. (Brožek et al., 2024) This regulatory development marked a turning point in aligning financial flows with sustainability objectives. In 2022, the Non-Financial Reporting Directive (NFRD) was replaced by the more comprehensive Corporate Sustainability Reporting Directive (CSRD), significantly expanding the scope and depth of sustainability reporting requirements (Baumüller, Grbenic, 2021). The CSRD mandated ESG data disclosure for a broad range of companies operating within the EU, requiring the publication of specific key performance indicators (KPIs) aligned with the EU Taxonomy, such as the proportion of turnover, capital expenditures (CAPEX), and operational expenditures (OPEX) associated with environmentally sustainable activities. Furthermore, the directive imposed mandatory external verification of reported data through independent audits, thereby enhancing the reliability and comparability of ESG disclosures.

The Non-Financial Reporting Directive (NFRD), formally known as Directive 2014/95/EU, was adopted by the European Union in 2014 and came into effect for reporting periods beginning in 2017. Its primary objective was to strengthen corporate transparency in relation to non-financial information by imposing disclosure obligations on large companies. Under this directive, organizations were required to report on key areas such as environmental performance, social and employee-related matters, respect for human rights, anti-corruption and bribery practices, as well as diversity within company boards, including aspects such as gender, age, and educational or professional background. The NFRD marked the European Union's initial legislative move toward the institutionalization of mandatory ESG reporting for selected categories of enterprises (Tettamanzi et al., 2024).

Under the Non-Financial Reporting Directive (NFRD), the obligation to disclose non-financial information applied to specific categories of large entities operating within the European Union. This included publicly listed companies on EU-regulated markets, banks, insurance undertakings, and other public-interest entities as defined by national legislation. To fall within the scope of the directive, these entities were additionally required to meet certain quantitative thresholds, namely, employing more than 500 individuals and exceeding specified balance sheet totals or net turnover limits as established by national accounting standards. These criteria were designed to ensure that only the most significant economic factors, whose activities have considerable societal and environmental impacts, were subject to the directive's reporting requirements.

The EU taxonomy system helps figure out, which business activities are environmentally friendly. With the entry into force of the EU Taxonomy Regulation in 2020, companies falling under the scope of the Non-Financial Reporting Directive (NFRD) were explicitly targeted for mandatory disclosure of Taxonomy-related key performance indicators (KPIs). Beginning with the reporting year 2021, for reports published in 2022, these entities were required to indicate whether their business activities qualified as eligible under the EU Taxonomy framework referred to as taxonomy-eligible activities. Additionally, they were obligated to report the proportion of key financial indicators, specifically turnover (revenue), capital expenditure (CapEx), and operating expenditure (OpEx) associated with taxonomy-eligible and, in later stages, taxonomy-aligned economic activities. These disclosures constituted the first formalized set of Taxonomy KPIs and marked a critical step in operationalizing the EU's sustainable finance agenda through corporate reporting obligations (Schütze, Stede, 2021).

NFRD was the first legislative step by the EU towards mandatory disclosure of information on the environmental and social impacts of large companies. It applied to approximately 11,000 companies and required the disclosure of information in areas such as environmental protection, human rights, and anti-corruption measures. (Hummel, Jobst, 2024) However, the NFRD faced several challenges. Lack of standardization, limited scope, and low comparability of data. In response, a new directive was adopted in 2022 – the Corporate Sustainability Reporting Directive (CSRD), which replaced it.

The CSRD significantly expands the scope of mandatory entities (to more than 50,000 companies in the EU), introduces mandatory use of ESRS standards, requires more detailed data linked to the EU Taxonomy, and establishes the obligation for external audits of ESG data. The aim is to improve the quality, consistency, and credibility of sustainability information and enable investors to better assess the impact of companies on sustainability (Gortsos, Kyriazis, 2024). Thus, the CSRD represents a key shift from non-financial information to integrated and verified ESG reporting as part of the main business assessment.

3.2 EU Taxonomy Requirements for Companies shifted to Environmental KPIs in Reporting

The EU Taxonomy Regulation has significantly impacted companies subject to the CSRD. Rather than providing general, narrative disclosures about their environmental efforts, companies are now required to quantify their environmental impact using specific KPIs related to Taxonomy-aligned and Taxonomy-eligible activities.

This meant that for the first time under EU law, environmental sustainability had to be measured numerically and objectively, based on science-driven criteria (Slevin et al., 2020). Moreover, ESG reporting moved from broad storytelling to strict data-based evaluation.

Taxonomy regulation set out 6 climate and environmental objectives. Environmental performance constitutes a critical dimension of ESG (Environmental, Social, and Governance) reporting frameworks, especially in light of regulatory developments such as the EU Taxonomy Regulation and the Corporate Sustainability Reporting Directive (CSRD). The assessment of environmental impacts and dependencies is operationalized through a suite of standardized key performance indicators (KPIs) that enable organizations to quantify and disclose their environmental footprint and sustainability-related efforts. (Zarzycka, Krasnodomska, 2021) Below is a structured overview of the principal environmental objectives and corresponding KPIs, as aligned with both international sustainability standards and EU regulatory criteria (Odobaša, Maroševič, 2023).

First one among the six envornmental objectives defined by EU Taxonomy is climate change mitigation.The objective of climate change mitigation is to reduce greenhouse gas (GHG) emissions and to promote a transition toward low-carbon technologies and energy systems. Companies are required to monitor and report emissions in accordance with the Greenhouse Gas Protocol, which classifies emissions into three scopes.

Total greenhouse gas (GHG) emissions are measured in carbon dioxide equivalents (CO_2e) across three scopes: Scope 1, which includes direct emissions from owned or controlled sources; Scope 2, covering indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company; and Scope 3, which encompasses all other indirect emissions that occur in a company's value chain. These emissions are quantified in metric tons. Companies are also required to report the percentage reduction in emissions relative to a defined baseline year. This metric indicates the progress made in their decarbonization efforts.

Additionally, companies must provide taxonomy-aligned financial indicators. These include the share of revenue, capital expenditure (CapEx), and operating expenditure (OpEx) that are derived from economic activities contributing to climate mitigation, according to the criteria set out in the EU Taxonomy.

Energy efficiency metrics are another important aspect of reporting. These metrics reflect process optimization and technological innovation and are typically measured as energy consumption per unit of production, such as kilowatt-hours (kWh) per product.

The second aim is related to climate change adaptation.Adaptation to climate change pertains to the organization's resilience against physical climate risks, including extreme weather events, sea-level rise, and long-term environmental shifts. Key indicators include the proportion of activities covered by climate adaptation strategies or plans, demonstrating organizational preparedness. Quantification of implemented adaptation measures, such as infrastructure reinforcement or early warning systems, is also essential. Additionally, systematic risk assessments addressing physical climate risks like floods, heatwaves, and droughts, integrated into enterprise risk management systems, play a critical role. First two aims are known as climate Aims.

The remaining aims are focused on environmental aims. First of them, The Sustainable use and protection of water and marine resources are fundamental to long-term environmental and economic stability. Common KPIs include total water withdrawal and consumption, typically measured in cubic meters, to monitor resource efficiency. The percentage of water recycled or reused indicates circular water practices, and reduction metrics for waterborne pollutants, including chemical contaminants and microplastics, are vital. Furthermore, the existence and scope of strategic policies for the conservation and restoration of marine ecosystems are important indicators of sustainable management.

Next aim is related to The transition to a circular economy. The model promotes the decoupling of economic growth from resource consumption through reuse, recycling, and material efficiency. Relevant indicators comprise the proportion of input materials derived from secondary (recycled) sources, expressed as a percentage. Waste management performance is assessed specifically by the share of waste recycled versus landfilled, which reflects the effectiveness of circular practices.

Efforts in another aim: pollution prevention control has to reduce emissions of harmful substances into air, water, and soil. Key performance indicators include annual emissions of pollutants like nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOCs), and particulate matter (PM), measured in tons. Incidents involving hazardous substance release serve as a proxy for operational safety and environmental risk. Pollution abatement technologies, such as filtration and catalytic reduction, highlight measures to mitigate environmental impact.

These efforts ensure industrial activities do not compromise air and water quality, safeguarding public health and preserving ecological balance. Monitoring and reporting these indicators demonstrate companies' commitment to environmental stewardship and regulatory standards. Innovation and investment in pollution control technologies are essential for achieving these objectives.

The 6th aim Biodiversity Protection and Restoration of Biodiversity and Ecosystems is integral to environmental stewardship and long-term sustainability. Key performance indicators for this domain include the area of natural habitat protected or restored, measured in hectares, reflecting the extent of conservation efforts. Additionally, financial allocations toward biodiversity initiatives, reported in euros per year, indicate investment commitment. Lastly, biodiversity impact assessments, including the percentage of projects evaluated for potential harm to ecosystems, align with environmental impact assessment protocols.

In the framework of the EU Taxonomy Regulation, a critical distinction is made between taxonomy-eligible and taxonomy-aligned economic activities. While taxonomy-eligibility serves as a preliminary classification, denoting whether an activity is listed within the EU Taxonomy as potentially sustainable, alignment entails a higher standard of compliance with environmental and social criteria. This differentiation is foundational to interpreting environmental key performance indicators (KPIs) under both the Non-Financial Reporting Directive (NFRD) and the Corporate Sustainability Reporting Directive (CSRD).

An activity is deemed taxonomy-eligible if it is explicitly recognized within the EU Taxonomy's list of economic sectors and activities that are considered capable of contributing to one or more of the six environmental objectives defined in Regulation (EU) 2020/852. However, eligibility alone does not confirm that the activity is environmentally sustainable in practice.

To qualify as taxonomy-aligned, an eligible activity must satisfy three cumulative conditions:

1. Substantial Contribution: The activity must make a measurable and substantial contribution to at least one of the EU's six environmental objectives—namely, climate change mitigation, climate change adaptation, sustainable use of water and marine resources, transition to a circular economy, pollution prevention and control, or the protection and restoration of biodiversity and ecosystems. This contribution must be validated through adherence to detailed technical screening criteria (TSC) established by the European Commission. It must meet a structured set of technical, environmental and social requirements.

2. Do No Significant Harm (DNSH): The activity must not cause significant adverse impacts on any of the remaining environmental objectives. The DNSH principle acts as a safeguard, ensuring that progress in one domain does not undermine other sustainability goals. These two contributions must be validated through adherence to detailed technical screening criteria (TSC) established by the European Commission. It must meet a structured set of technical, environmental and social requirements.

3. Minimum Social Safeguards: Compliance with international human rights and labor standards—such as those articulated in the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights—is mandatory. This ensures that environmental benefits are not achieved at the expense of fundamental social rights.

Only when all three of these conditions are met can the revenues, capital expenditures (CapEx), and operating expenditures (OpEx) associated with a given activity be formally reported as taxonomy aligned. This classification represents a rigorous threshold for environmental sustainability and is central to the credibility and comparability of ESG disclosures under EU law.

In summary, while taxonomy-eligible activities are listed within the EU's classification system as potentially sustainable, only taxonomy-aligned activities fulfill the complete set of environmental and social criteria necessary to be deemed truly sustainable in regulatory terms. This distinction has direct implications for corporate ESG reporting, investor decision-making, and compliance with CSRD requirements (Moneva et al., 2023).

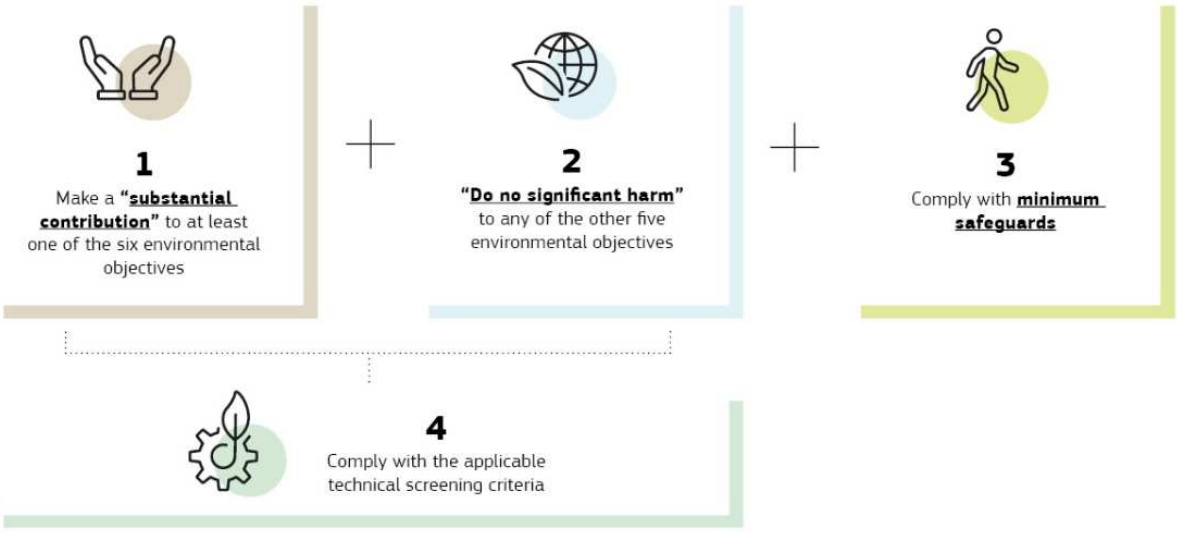

Figure 1. Decision Flowchart for Taxonomy-Aligned Activities
Source: own processing (2025)

4. Discussion

The shift toward mandatory ESG reporting under the EU's regulatory framework, particularly CSRD and the EU Taxonomy Regulation, has introduced a high degree of complexity for companies. Sustainability is no longer a matter of vague commitments or voluntary disclosures. Instead, companies are now required to quantify environmental, social, and governance performance through a dense matrix of key performance indicators (KPIs). These indicators span emissions, energy efficiency, biodiversity, circularity, and social safeguards, often demanding sector-specific, science-based data. The ambition is not only to report, but to report in a way that is traceable, comparable, and, most importantly, auditable. Targets declared by companies must now be substantiated by verifiable data, independently assured and aligned with standardized definitions. This transformation requires substantial internal capacity building: from data management systems to cross-departmental integration. Ultimately, the EU is setting a global benchmark where sustainability performance must withstand external scrutiny, satisfy regulatory rigor,

and support investor confidence. For organizations navigating this transition, success lies in their ability to move beyond storytelling and embed sustainability into core strategy, governance, and operations—backed by numbers, not narratives.

Conclusion

Over the past decade, ESG reporting has undergone a fundamental transformation—from voluntary initiatives to comprehensive legal frameworks with clearly defined Key Performance Indicators (KPIs). This shift reflects the increasing demand for transparency, comparability, and accountability in corporate sustainability practices.

The early years of ESG reporting were characterized by the emergence of global frameworks like GRI, TCFD, and SASB, which provided the first structure for disclosing environmental and social impacts. However, due to their voluntary nature, adoption remained uneven, and data often lacked consistency.

The turning point came with the introduction of the EU Taxonomy and the transition from the Non-Financial Reporting Directive (NFRD) to the Corporate Sustainability Reporting Directive (CSRD). These regulations not only broadened the scope of mandatory reporting to include more companies but also introduced detailed, standardized KPIs aligned with clearly defined environmental objectives. Companies are now legally required to quantify their environmental performance, such as GHG emissions, water use, and circularity, using robust, comparable metrics.

One of the most significant contributions of the EU framework is the distinction between taxonomy-eligible and taxonomy-aligned activities, ensuring that companies don't just claim sustainability but must prove it through measurable results and external audits.

ESG is no longer a marketing buzzword. It is an integrated part of financial decision-making and regulatory compliance. Companies must now treat sustainability data with the same rigor as financial data, and future professionals will need to interpret, assess, and communicate these metrics effectively.

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ESG Reporting from the Czech and Estonian SMEs' Perspective

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Abstract

Research background: The regulatory environment concerning corporate sustainability is undergoing a fundamental shift across the European Union. The primary catalyst for this change is the CSRD, aiming to elevate sustainability reporting to the same level as financial reporting, increasing the transparency, credibility, and comparability of ESG data to support the EU's sustainable finance goals and Green Deal objectives.
Purpose of the article: This paper investigate stakeholders' perceptions of ESG reporting in Czechia and Estonia, identifying the main drivers, challenges, and how well ESG disclosure aligns with stakeholder expectations. By integrating insights from stakeholder and institutional theory, this research provides valuable empirical evidence on how ESG is adopted in transitional economies.
Methods: A qualitative methodology was utilized, employing a perceptual instrument in the form of interviews with relevant stakeholders. Primary data was collected through in-depth, semi-structured interviews to gain insights into the perceptions of company representatives involved in ESG reporting.
Findings & Value added: Research indicates a generally receptive, albeit cautious, attitude towards sustainability among companies. Many companies acknowledge the increasing importance of ESG for key stakeholders like investors, banks, customers, and government bodies. While many SMEs intuitively implement practices that align with ESG principles (e.g., good employee relations, waste reduction), they often do so without explicitly labeling or structuring these activities within an ESG framework. They face significant barriers related to lack of information, expertise, time, and financial resources to formally engage with ESG reporting.

Keywords: ESG reporting, ESG, Sustainability, Estonia, Czechia

JEL classification: E00, E02

1. Introduction

The landscape of corporate responsibility in CEE region is undergoing a significant transformation, driven by the dual forces of impending European Union regulation and evolving stakeholder expectations. The Corporate Sustainability Reporting Directive (CSRD) looms large, mandating comprehensive Environmental, Social, and Governance (ESG) disclosures for an expanding scope of companies.

Europe's growing dedication to sustainable development is clearly demonstrated by the evolution of Environmental, Social, and Governance (ESG) reporting. What began as simple, voluntary environmental disclosures has transformed into a thorough, regulated framework, driven by the urgent need to tackle global challenges. ESG reporting has become a crucial tool for corporate transparency and accountability, fueled by increasing regulatory demands, investor expectations, and the needs of various stakeholders. While the European Union (EU) has implemented directives like the Non-Financial Reporting Directive (NFRD) and the Corporate Sustainability Reporting Directive (CSRD) to standardize these disclosures, notable differences still exist among member states. Czechia and Estonia offer a fascinating comparison, as both countries have adopted EU regulations but show distinct corporate governance traditions, economic structures, and stakeholder expectations.

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The necessity of ESG reporting stems from several major factors. It's essential for addressing climate change and promoting sustainable finance, given Europe's recognition of the urgent need to mitigate climate change and transition to a low-carbon economy. ESG reporting plays a vital role in tracking and reducing greenhouse gas emissions. Additionally, it significantly enhances corporate transparency and accountability, as investors increasingly demand clear information on ESG performance to make informed decisions. This allows various stakeholders—including investors, customers, and civil society—to assess a company's environmental and social impact, fostering accountability and encouraging responsible business practices. ESG reporting also helps companies manage risks and opportunities; prior research by Strouhal et al. (2015) indicates that sustainability factors can notably influence a company's financial performance. Meeting stakeholder expectations is another key driver, as growing public awareness of sustainability issues has increased pressure on companies to demonstrate their commitment to responsible practices. Finally, regulatory pressure continues to push for more comprehensive disclosures.

While most research on ESG reporting has focused on Western European and North American markets, less attention has been given to Central and Eastern European (CEE) economies. In these regions, sustainability practices are often influenced more by external pressures than by an inherent corporate commitment.

This study aims to investigate stakeholder perceptions of ESG reporting in Czechia and Estonia, identifying the main drivers, challenges, and how well ESG disclosure aligns with stakeholder expectations. By integrating insights from stakeholder and institutional theory, this research will provide valuable empirical evidence on how ESG is adopted in transitional economies. This will offer practical implications for policymakers, regulators, and businesses working to improve sustainability transparency and corporate responsibility. Ultimately, the findings will contribute to the broader discussion on ESG, shedding light on how sustainability reporting is shaping corporate practices in the CEE region.

2. Literature Review

2.1 ESG/CSR Related Studies

For several decades, researchers in various countries have been interested in corporate social responsibility (CSR), as a growing number of companies commit to the Sustainable Development Goals (SDGs) and, consequently, opt for assurance of their sustainability reporting, as noted by Krasodomska et al. (2024). This literature review primarily covers publications from 2017 to 2024 due to significant changes in ESG reporting regulations during this period. These changes include the adoption of the Non-Financial Reporting Directive (NFRD) in 2014, followed by the Corporate Sustainability Reporting Directive (CSRD) in 2022, which led to the systematic and mandatory disclosure of environmental, social, and governance (ESG) aspects in corporate reporting.

Studies by Cuomo et al. (2022) and Christensen et al. (2021) demonstrate that the implementation of regulations like the NFRD positively impacted non-financial disclosure, enhancing corporate transparency and efficiency. Furthermore, non-financial disclosure benefits capital markets by improving liquidity, reducing capital costs, and optimizing capital allocation. Christensen et al. (2021) assert that larger companies tend to be more engaged in environmental practices compared to smaller ones. However, Cuomo et al. (2022) emphasize the positive impact of the NFRD's „comply or explain“ approach, which encouraged smaller companies to adopt more CSR-oriented practices, ultimately improving their environmental and social performance. Pizzi et al. (2024) noted that the overall effectiveness of the NFRD was limited by the absence of a dedicated reporting system and a high degree of flexibility. This shortcoming is expected to be addressed with the adoption of the CSRD, which provides a standardized set of indicators and extends NFRD requirements to small and medium-sized enterprises, according to Cuomo et al. (2022).

Breijer and Orij (2022) examined the annual reports and separate non-financial reports (sustainability reports) of listed companies covered by the STOXX Europe 600 index from 2012–2020. They concluded that the implementation of the NFRD led to an increased use of investor-oriented standards, such as SASB, which in turn increased information asymmetry. Conversely, standards aimed at a wide range of stakeholders, like GRI, are voluntarily applied by users, which helps to mitigate information asymmetry.

Other researchers discuss the quality of non-financial disclosure in sustainability reports, deeming it critical and essential because it affects factors such as the reliability of accountability and the formation of stakeholder trust in a company. Haji et al. (2023) confirmed the symbolic nature and low quality of sustainability reporting even after the introduction of mandatory disclosure requirements. At the same time, they observed positive capital market outcomes, such as reduced information asymmetry and

positive firm valuation, as well as CSR-related benefits, such as reduced carbon emissions, following CSR regulation. Krasodomska et al. (2024), after surveying 960 companies across 17 EU member states, noted that many companies fail to disclose material information on key sustainability topics. The lack of comparability and reliability in reports underscores the need for a robust and accessible reporting framework with effective assurance methods.

The integration of ESG factors into corporate strategies has increasingly drawn the attention of scholars and practitioners, as businesses are compelled to align their operations with sustainability principles to enhance competitive advantage and ensure regulatory compliance, as highlighted by Rabaya et al. (2022). Several studies have explored the multifaceted impact of ESG disclosure on firm performance, governance structures, and financial stability, emphasizing its role in risk mitigation and value creation, according to Nicolo et al. (2022). The growing prominence of ESG reporting has fueled extensive academic discourse on its implications for corporate performance, sustainability practices, and financial decision-making. A significant body of research has examined the evolving landscape of ESG disclosures, highlighting the challenges and benefits associated with regulatory frameworks, corporate transparency, and financial outcomes, as discussed by Gholami et al. (2022).

Studies indicate that large firms benefit from enhanced ESG disclosures due to greater stakeholder expectations, while SMEs often lack the necessary resources to comply with stringent reporting requirements, leading to discrepancies in reporting practices across different firm sizes, according to Gholami et al. (2022). Additionally, the role of sustainability reporting in fostering a circular economy has gained increasing attention, particularly in industries such as the agri-food sector, where regulatory pressures under the EU's Corporate Sustainability Reporting Directive (CSRD) and the EU Taxonomy Regulation are influencing corporate reporting strategies. These regulations have created new obligations for firms to report on circular economy initiatives, although inconsistencies and gaps in reporting practices persist, necessitating greater standardization and accountability measures, as noted by Falkenberg et al. (2023).

The relationship between environmental performance and financial performance has been widely explored in recent years, as businesses face increasing regulatory and stakeholder pressure to adopt sustainable practices. Empirical evidence suggests that ESG performance directly impacts corporate financial outcomes, influencing factors such as investor trust, financial irregularities, and regulatory compliance, as shown by Liu & Jin (2023). Firms with strong ESG performance exhibit lower financial irregularities, primarily due to enhanced corporate governance mechanisms and increased stakeholder scrutiny, according to Liu & Jin (2023). The financial constraints associated with green financing have also been examined in relation to ESG performance by Li et al. (2023).

Despite significant advancements in ESG research, several gaps remain. The heterogeneity in ESG measurement frameworks poses challenges for cross-sectoral and cross-regional comparisons, as noted by Arvidsson et al. (2022). Standardization efforts, such as those by the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB), aim to address these inconsistencies, yet widespread adoption remains limited, according to Arvidsson et al. (2022). Additionally, the causal relationship between ESG performance and financial outcomes warrants further investigation, particularly in the context of emerging markets and high-growth industries, as suggested by Zahid et al. (2023).

To better understand ongoing legislative changes in the EU, the research by Hummel and Jobst (2024) is crucial. They provide a structured overview of the five main sustainability reporting mandates in the EU—the NFRD, the CSRD, the Taxonomy Regulation, the SFDR, and the Pillar 3 ESG risk disclosures—and outline three key reporting standards: GRI Standards, ESRS, and IFRS sustainability disclosure standards, comparing their core characteristics and summarizing key differences. Considering that the CSRD took effect in 2024, with the first reports to be submitted in 2025, researchers like Odobaša and Marošević (2023) are exploring its historical, legal, and economic context, analyzing its objectives, scope, and expected benefits, and assessing the potential burdens and costs associated with its implementation. The CSRD is often perceived as a „burdensome regulatory act," especially for organizations with limited capabilities, requiring additional financial costs, particularly for attracting and training staff and for mandatory audits, as noted by Setyaningsih et al. (2024) and Krasodomska et al. (2024). This implies that firms not previously subject to NFRD may require additional support and resources to adequately prepare for and comply with the CSRD.

2.2 Regulatory Perspective

The regulatory landscape for Corporate Social Responsibility (CSR) and Environmental, Social, and Governance (ESG) across the European Union is undergoing a fundamental transformation, which carries

significant implications for companies operating in Czechia and Estonia. This shift is primarily driven by the Corporate Sustainability Reporting Directive (CSRD), a new regulation that replaces and substantially expands upon the previous Non-Financial Reporting Directive (NFRD). The CSRD aims to elevate sustainability reporting to the same level of importance as financial reporting, thereby increasing the transparency, credibility, and comparability of ESG data. This move is crucial for supporting the EU's sustainable finance goals and the broader objectives of the Green Deal. The directive dramatically expands the scope of companies required to report, from approximately 12,000 under the NFRD to an estimated 50,000 across the European Union.

The implementation of the CSRD is structured in two main phases. In Phase 1, companies that were already subject to NFRD obligations were required to publish their first CSRD-compliant sustainability report in 2025, covering their financial year 2024. Phase 2 focuses on large companies and listed SMEs. This phase has been significantly impacted by the EU's current „Omnibus" or „stop the clock" directive, which postpones the initial reporting deadlines for companies falling under Phase 2 by at least two years. This means that large companies originally set to report in 2026 (for the financial year 2025) will now report in 2028 (for the financial year 2027). Similarly, listed SMEs, initially slated to report in 2027 (for the financial year 2026), will now report in 2029 (for the financial year 2028). The Omnibus package also includes proposals to potentially increase company size thresholds, such as the employee count, which could further alter who is required to report.

This evolving regulatory landscape presents considerable challenges for EU-based companies. The staggered compliance deadlines and potential shifts in reporting requirements make strategic planning and resource allocation difficult, especially for companies near the reporting thresholds or those classified as large companies within Phase 2. These delays and the overall pressure from the EU also signal potential bottlenecks within the supporting ecosystem; auditors, consultants, and software providers need ample time to build the necessary capacity and expertise to handle the expanded scope and mandatory assurance requirements introduced by the CSRD.

Table 1. CSRD Implementation Roadmap Reflecting Post-Omnibus Delays

Company criteria	Original reporting		Post-Omnibus revised reporting	
	In year	For financial year	In year	For financial year
Companies previously subject to NFRD	2025	2024	2025	2024
Other large companies	2026	2025	2028	2027
Listed SMEs	2027 (2029)	2026 (2028)	2029 (2031)	2028 (2030)
Certain Non-EU parent companies with significant EU activity	2029	2028	2029	2028

Source: CSRD, Omnibus Directive (2025)

3. Research Design

To understand the current situation regarding ESG in Czechia and Estonia, this study employed a single-country approach, although there is also a recognized need for a broader regional perspective within Central and Eastern Europe. This focused approach is considered suitable for grasping the local context and the potential reactions of local stakeholders to changes in non-financial data reporting. The findings of this research are highly relevant for national-level policy-making.

A qualitative methodology was utilized, employing a perceptual instrument in the form of interviews with relevant stakeholders. Primary data was collected through in-depth, semi-structured interviews to gain insights into the perceptions of company representatives involved in ESG reporting. The interview questions covered topics such as companies' and their shareholders' current understanding of ESG, their existing ESG knowledge, investments made into gathering ESG reporting-relevant information, the use of AI for creating ESG reports, and what kind of support might be crucial for companies.

A total of 20 interviews were conducted between August and November 2024, with 10 company representatives in both Czechia and Estonia. Most interviewees possess extensive experience and often hold multiple positions within their companies, with some roles specifically focused on ESG-related issues. The average work experience for Czech company representatives was 16.8 years (ranging from 4

to 30 years), while for Estonian company representatives, it was 13.6 years (ranging from 8 to 20 years). All interviewees demonstrated a deep understanding of ESG principles and the context of ESG reporting.

All interviews were recorded and transcribed with the permission of the interviewees. The interviews were conducted in the native language of both the interviewers and interviewees to ensure a better understanding of the topics discussed. Research team members present during the interviews also took personal notes, which later proved significantly helpful in identifying relevant themes. Questions focused on these major topics: the role of ESG principles within the company, potential barriers to ESG adoption in the company, internal and external support received or needed for ESG reporting, and the identification of additional expenses associated with ESG reporting implementation.

Table 2. List of Corporate Interviewees

Interviewee	Characteristics of an Interviewee	Interview Period/Duration
I01-CZ	Person in charge of ESG topics in multinational company (SME) focused on parcel deliveries with 8 years of professional experience	October 2024 – 1 hour
I02-CZ	CFO of a multinational packaging company (SME) with more than 20 years of professional experience in finance and controlling	October 2024 – 50 minutes
I03-CZ	Head of the accounting department of the agricultural company (SMEs) with more than 30 years of professional experience in accounting and financial reporting	October 2024 – 50 minutes
I04-CZ	Person in charge of ESG topics in multinational company (SME) focused on education with 4 years of professional experience	October 2024 – 40 minutes
I08-CZ	Head of the accounting department in multinational retail company (SME) with 18 years of professional experience in financial reporting	November 2024 – 45 minutes
I09-CZ	Controller in a local start-up focused on sustainable food packaging (SME) with more than 20 years of professional experience in finance	November 2024 – 45 minutes
I10-CZ	Head of the accounting department in a local energy trading company (SME) with 19 years of professional experience in financial reporting	November 2024 – 50 minutes
I11-EE	Head of accounting department of the local retail trade company (SME) with 18 years of professional experience in financial reporting	September 2024 – 55 minutes
I12-EE	CFO of a multinational real estate company (SME) with 14 years of professional experience in controlling and reporting	September 2024 – 50 minutes
I14-EE	ESG specialist in multinational wholesale company (SME) with more than 15 years of professional experience in CSR and ESG related topics	September 2024 – 55 minutes
I15-EE	Controller in a multinational real estate company (SME) with 8 years of professional experience in controlling and reporting	September 2024 – 50 minutes
I16-EE	CSR specialist in a local energy company (SME) with 11 years of professional experience in CSR and now ESG	October 2024 – 45 minutes
I17-EE	CFO of a local retail trade company (SME) with more than 20 years of professional experience in reporting, controlling and budgeting	October 2024 – 50 minutes
I18-EE	CFO of a local software development company (SME) with more than 10 years of professional experience in finance and reporting	November 2024 – 45 minutes
I19-EE	Head of the accounting department of a multinational mechanical engineering company (SME) with 12 years of professional experience in accounting and reporting	November 2024 – 40 minutes
I20-EE	Controller in a local timber company (SME) with 9 years of the professional experience in reporting and budgeting	November 2024 – 40 minutes

Source: authors' research (2025)

*for the purpose of this paper focused on SMEs perception there were not taken into account information provided by interviewees I05-CZ, I06-CZ, I07-CZ and I13-EE who represent large companies

4. Results and Discussion

4.1 Perceptions of Czech and Estonian Representatives

Role of Leadership and Strategic ESG Integration

For many companies, particularly those with a parent company in the EU, ESG is moving beyond a secondary consideration to become a central part of their overall business strategy. A representative from a large manufacturing firm explicitly stated that their ESG strategy is deeply integrated into their company's core operations, receiving consistent attention and support from top management. Specific board members are even assigned to oversee sustainability initiatives across key areas like purchasing, production, and logistics. In companies that are part of larger international groups, ESG goals are often cascaded down from the parent company, with local leadership and the central office collaboratively making decisions on ESG-related investments and strategic direction.

Challenges in ESG Implementation

Companies face a variety of hurdles in effectively implementing ESG. These obstacles range from difficulties with information and methodologies to limited resources and internal cultural factors. A common challenge mentioned by company representatives was the struggle to access clear information. For instance, a logistics company representative highlighted the difficulty in finding reliable data for crucial metrics like emission factors and fuel consumption per ton-kilometer. They also noted a lack of detailed technical guidance for necessary calculations and uncertainty about what constitutes a relevant and credible data source. The CSRD standards are often perceived as overly complex, with references to other protocols like the GHG protocol whose methodologies can be difficult to interpret or are only partially explained.

Some interviewees also expressed concerns about an increased administrative burden and a general sense of uncertainty surrounding these new requirements. One representative mentioned waiting to learn from their parent company’s initial reporting cycle before their own obligations begin. The practicalities of data collection present a significant hurdle. An interviewee from an SME specifically pointed to an „insufficient data collection system and a lack of relevant data“ as primary barriers. The need for effective software to support robust ESG data collection, management, and evaluation was also emphasized by a representative of a larger manufacturer. Additionally, financial and human resource limitations were identified as significant barriers.

Support from the Parent

For companies operating as subsidiaries of larger multinational corporations, the nature and extent of support from their parent company is crucial. A representative from a large manufacturer described receiving strong informational support from their parent, particularly through the sharing of best practices across the group. Another interviewee mentioned initial informational training and presentations from their central headquarters. However, financial support from parent companies varies. A representative from a logistics company characterized the financial support received from their parent company as „sufficient“ for their current needs in implementing ESG reporting, while a representative from a parcel service company mentioned receiving „minimal“ support from its parent, primarily relying on its own internal resources for ESG initiatives.

Investments in ESG

The level of financial and operational investment in ESG initiatives differs considerably among interviewed company representatives, reflecting their sizes, sectors, operational footprints, and the maturity of their respective ESG strategies. An interviewee from a large automotive company reported ESG-related investments in the order of millions of EUR, primarily linked to the development and production of more sustainable products. These investments are complemented by numerous operational projects aimed at resource efficiency and broader support for various ESG-related initiatives. Another industrial representative noted that their ESG investments encompass a range of activities, including employee training and pilot programs for more environmentally friendly vehicles, such as testing HVO fuel. Some representatives from SMEs reported more modest investments.

Personnel and Financial Costs Related to ESG Reporting

Implementing and maintaining ESG reporting systems requires dedicated resources. Companies are at various stages of quantifying these requirements. The majority of companies mention dedicating two to

three individuals to ESG reporting, with some also engaging external consultants. The estimated financial costs related to ESG reporting vary mostly based on the size of the company, ranging from 5,000 EUR to tens of thousands of EUR.

Adequacy of ESG Reporting Training

The availability, accessibility, and perceived adequacy of training related to ESG principles and reporting are viewed differently across companies. Representatives of larger companies indicated access to a „wide range of training opportunities“ in the ESG domain. Some interviewees also mentioned initial training and informative presentations provided by their parent company, which were later supplemented with external ESG training to better understand expectations. There was a common sentiment that much of the available training tends to be „highly theoretical,“ lacking practical, hands-on guidance. It was also noted that the majority of information about ESG reporting is still not available in local languages.

Expected Benefits of ESG Reporting

Despite the challenges, companies also recognize and anticipate a range of potential benefits from systematic ESG reporting and the underlying commitment to sustainable practices. A primary advantage mentioned by a manufacturing representative is the ability to provide „transparent, verified non-financial information“ to a wide range of stakeholders, including investors, customers, employees, and regulatory bodies. Some interviewees also see robust ESG reporting as a way to prevent „greenwashing“ when communicating sustainability efforts. A representative from a parcel company noted that ESG reporting has evolved into an „important criterion for selection in tenders, particularly for German customers,“ highlighting its growing significance in international business relationships.

Expectations of Support from Supply Chain Partners

The degree to which companies expect support from their larger customers or partners within their supply chain varies. Some representatives „expect support“ from such partners in preparing their ESG reports, mentioning that such collaboration is „also in the partner’s interest to increase the accuracy of the supply chain report.“ Conversely, representatives from SMEs mostly stated that they „do not expect“ such support from their supply chain partners.

Expectations Regarding State Support

When it comes to the role of the state in facilitating the ESG transition, companies expressed a range of expectations and preferences, from calls for clear information and financial incentives to a desire for minimal intervention. An interviewee from a parcel company suggested that, for now, „clear instructions and information, a uniform scope, and consistent communication“ from state authorities would be sufficient. Manufacturing companies expressed a wish to „continue supporting companies in implementing green measures aimed at reducing emissions,“ citing examples like support for photovoltaic installations.

4.2 Valuable Insights from the Performed Interviews

Availability of ESG/ESG Reporting Related Information

Companies often bear the sole responsibility for gathering information related to ESG and ESG reporting. One Estonian interviewee, I17-EE, highlighted that because the directive hadn't yet been incorporated into Estonian law at the time of the interviews, there were no Estonian-language standards available. This forced them to rely entirely on English-language materials, which were written in complex legal English. In their opinion, smaller companies might lack the resources to properly process and understand these materials, presenting a significant challenge. The interviewee elaborated, *„Up to this point, most things have not been translated. The whole terminology surrounding this directive and its standards has only recently been established... for example, the concept of double materiality, which is actually the foundation of this new standard. They seem to have settled on this terminology just a couple of months ago. Meanwhile, we have been dealing with this for a couple of years already. So, we’re talking about significant double materiality. We can’t even agree on the terminology here. It’s a bit of a jumble, to be honest. In that regard, we don’t read Estonian-language materials in our company. We are solely dealing with the English-language directive materials issued by the European Union.“*

In contrast, I01-CZ, a Czech interviewee, believes that their management and employees are well-versed in ESG topics, regularly conducting various training sessions and providing updates on current situations. *„Yes, to be honest, I provide updates on the current situations at least once a quarter, and even more frequently to the board. I was never expected to be at the board table regarding ESG topics, but now I'm there all the time. We also do updates for all employees—at least 2-3 times a year. We have larger teams where different levels of the organization, both management and staff, can participate, and I provide these updates. The next one is scheduled for December, to summarize the year—where we stand with reporting and where we are heading. And then there are the training sessions. Yes, in the last couple of months, I have conducted more specific training sessions within the company, both for our finance department and now, in December, for the entire team of commercial leaders. Different departments have reached out and expressed a desire to gain additional knowledge on this topic. So I have developed my own small training program to give them an overview of what we are talking about when we discuss CSRD and ESRS, what is behind it all, and what we are currently collecting and doing, as well as how we are reporting. So yes, this has been a continuous effort, especially over the last year, as we have been waiting for support from our auditors, who conduct a lot of training on this topic for companies today. We thought that if we help train them, perhaps we could send our people there for free, but we have not been granted that opportunity.“*

Readiness for ESG Reporting

I11-EE, an Estonian interviewee, believes companies have been given sufficient time to prepare for ESG reporting. They commented, *„I believe that it is sufficient. If it had been said that it would start in 2030, we would have only made that agreement in 2030. Since it costs money and time, which is essentially also money... then we would have postponed it as far as possible. One cannot say that the legislator has suddenly done something; we always just do it, or, well, we do it at the last minute to make it cost-effective.“* Regarding their company's current readiness, I11-EE stated, *„We are simply mentally prepared that it needs to be done, and that’s it. But nothing more.“*

I12-EE identified the primary challenge as the accessibility and reliability of data from third parties, specifically subcontractors and small businesses. Explained, *„Because I have also seen small businesses in my life and how they are managed, it generally works like this: the business owner tells the accounting firm. Usually, they don’t even have an in-house accountant but purchase the service. They say to the accounting firm, 'Hey, they are asking for something, you see, the form is here, and write something here.' And so we get the data; I know that these are not measured data, they are originally estimated data, and the evaluator is not even an owner with an engineering degree but rather an employee from the accounting firm who was simply confronted with the fact and told, 'Hey, write something there.'„*

For I08-CZ, the main challenges are collecting all the necessary data, raising awareness about the directive and its objectives, and developing a shared understanding of the standards. Added, *„If we talk about Czech Republic, and those who operate in the Czech market or even in the Visegrad countries market, I think the majority of consumers there are primarily looking at price. So, in my opinion, it is not a selling point today, and it may not be for the next five years that you produce a product with a lower carbon footprint, and that you could ask consumers for more money for it in those markets. It takes time, but in the Nordic or German market, it might be a selling point.“*

I04-CZ's primary challenge is the sheer volume of data required, with all the demands seeming overwhelming when requested simultaneously. *„They should have mentioned the additional resource costs in the sense that the standard requires reporting waste in tons. I would say that at times the standard is very rigid—it specifies the units in which something must be reported. On the other hand, at times it is so vague that all the methodologies are open for interpretation—you figure it out yourself, see what and how you calculate; but regarding waste, yes, it is required to report waste in tons. Well, as a company, we collect and report waste in cubic meters. In response to that, we were told, 'Well, what’s the problem—just convert everything.' I said, 'Well, I don’t know, I need someone to sit down and do that, and I don’t have those people today who would constantly do that math in the background.' So, again, it’s just too rigid from that perspective. They don’t let you choose, so actually you have to do extra work in terms of those calculations here, and in response, we were simply told, 'Others have managed, so why can’t you?' To which I replied, 'Very well, let’s just exclude that waste, let’s not report it, let it be.'„*

Positive and Negative Impacts of ESG Reporting

I17-EE believes that a negative impact of ESG reporting is that it diverts attention from addressing real problems, as all time and energy are spent on reporting. *„I would say that what makes me a bit sad*

about all this is that before the workload from this directive came along, we were able to focus on real issues in the company and create a genuine impact, like dealing with real matters. We were able to implement various principles and activities of the circular economy, reduce waste, meet with startups to discuss how we could bring more emission reduction pilots on board and other initiatives. Today, to be honest, there's hardly any time for that. And I see this and hear from my colleagues as well: why aren't you focusing on those important projects that have a tangible impact today? The answer is that it's just that there's not enough time; right now, the priority is reporting. I feel that real impact is not a priority today." I17-EE also feels that a very significant negative impact is that the directive has created a negative atmosphere around what is actually a very important issue. „*You know, I think that perhaps the greatest harm of all this today is that it creates a negative atmosphere at the societal level regarding this actually very important issue. I don't know, mention 'green transition' to a person, and show me someone in Estonia who doesn't feel some kind of fear or discomfort about it. There is a risk with all these directives that they end up creating... the effect is the opposite, as it more likely generates a negative atmosphere, making it seem like it is pure bureaucracy that is being dealt with here.*"

Conclusions, Limitations and Future Research

Findings from this study indicate a mixed reception to sustainability, despite a general openness. Larger companies, especially those with international connections, are increasingly seeing ESG as a strategic opportunity. They view it as a way to improve their reputation, attract investments, manage risks, and gain a competitive edge. However, many businesses, particularly SMEs, primarily perceive ESG as a costly and complicated regulatory burden. This perception is made worse by uncertainty regarding the final scope and timeline of national laws that will implement the Corporate Sustainability Reporting Directive (CSRD).

A significant „preparedness gap" exists between larger and smaller companies. Larger firms are more likely to have ESG strategies already in place or under development, often benefiting from frameworks provided by their parent companies. In contrast, SMEs frequently lack even basic awareness of ESG concepts and face substantial limitations in terms of resources, expertise, and data management capabilities. This difference poses a systemic risk to supply chains as mandatory reporting requirements trickle down.

The primary obstacles to effective ESG implementation are considerable, including the financial costs involved, the inherent complexity of regulations and standards (like CSRD and the concept of double materiality), severe difficulties in managing ESG data (including its availability, quality, and suitable systems), and constraints on internal resources and expertise. Regulatory uncertainty, stemming from delayed transposition of directives and ongoing adjustments at the EU level, further complicates planning and discourages proactive investment for some businesses.

Despite these challenges, the influence of stakeholders, particularly from the financial sector, is creating a market-driven incentive for ESG adoption. The perceived link between ESG performance and financial success is strengthening, though quantifying the return on investment (ROI) remains a challenge, especially for SMEs.

Crucially, enabling a smooth and effective transition across the entire Czech and Estonian economy requires a coordinated effort. Government support, particularly for SMEs, clear guidance from regulators, knowledge sharing through industry associations, responsible engagement from the financial sector, and the development of practical solutions by service providers are all essential components for navigating the complexities and realizing the potential benefits of the evolving ESG agenda.

It's important to note that the limitations of this study include its sample size and geographical scope. For future research, we aim to conduct a more comprehensive study focusing on both the Baltic area and the Visegrad group countries to compare potential differences in ESG attitudes.

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Reducing Emissions through the Use of Renewable Energy and the Application of Environmental Taxes

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Abstract

Research background: The research builds on studies by Shindell D., Smith C.J. 2019; Shirizadeh, B., Perrier, Q., Quirion, P. 2022; Sen, S., Vollebergh, H. 2016.
Purpose of the article: The aim of the paper is to examine the share of renewable energy use in Slovakia, Germany and Sweden with a view to minimising emissions and the potential use of environmental taxes. The paper focuses on investigating the relationship between the share of renewables in the energy mix and the level of CO_2 emissions, also taking into account the introduction of environmental taxes. It provides an overview of their role in the framework of energy policies, greenhouse gas emissions and energy strategies of selected countries.
Methods: Using econometric methods to develop a regression model and analyse the variables - RES share, CO_2 emissions, GDP and environmental taxes. The coefficient of determination and the adjusted coefficient of determination of the econometric models are also evaluated.
Findings & Value added: The results of the paper show that the effectiveness of policies aimed at decarbonisation can vary significantly depending on the specific energy and economic conditions of individual countries.

Keywords: Renewable energy, Environmental tax, Energy mix, Emission, Decarbonisation

JEL classification: E23, F15, G18, H20, H26

1. Introduction

The topic of renewable energy sources and their impact on greenhouse gas emissions is a highly topical issue in the field of environmental protection as well as economic and energy policy. Reducing CO_2 emissions and the subsequent transition to sustainable and clean energy solutions are important for achieving global climate goals and preserving non-renewable natural resources.

The paper provides background information on renewable energy sources and their importance in the context of energy policies, greenhouse gas emissions and the surveyed countries Germany, Sweden and Slovakia. It gives an overview of important theoretical approaches exploring the issue of renewable energy and its impact on emission reductions. It focuses on an empirical analysis based on available data on variables such as the share of renewable energy sources, CO_2 emissions and economic indicators of these countries such as GDP or energy tax. Using an econometric model, it examines the relationship between these variables and then interprets the results. The most important findings and their potential implications for future developments in climate action and energy transition in Europe are presented in the conclusion.

Fossil fuels such as coal, oil and gas account for more than 75% of global greenhouse gas emissions and nearly 90% of all carbon dioxide emissions (United Nations, 2024). Renewable energy sources do not produce greenhouse gases to the same extent, thus contributing to climate change mitigation and air pollution reduction. They are considered as clean energy sources that minimise environmental impacts, or energy sources that offer cleaner alternatives to fossil fuels. They produce a minimum of secondary waste (European Parliament, 2024).

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Renewable energy sources include solar, hydro, wind, geothermal, biomass, biofuels and bioliquids. Solar thermal energy is one of the most important and rapidly growing energy sources. It produces no greenhouse gas emissions and thus has a positive impact on the environment (Britannica, 2024). As it is an inexhaustible resource, it has great potential not only from an environmental point of view, but also from an economic point of view. Due to the energy provided by water, it is possible to carry out electricity generation in hydroelectric power plants. In 2022, in the EU, hydropower accounted for approximately 29.9% of electricity generation from renewable sources and provided 12.3% of the total electricity consumed. In addition to renewable electricity, it also provides flexibility and storage, which is important to maintain the stability of the electricity grid and to integrate solar and wind power (European Commision, Hydropower, 2025). Thanks to new technologies, developments and research, the use of wind power has increased rapidly, not least because wind is accessible for free. Global onshore and offshore wind capacity has increased 98-fold in the last two decades. Between 2009 and 2019, wind power production increased 5.2-fold (IRENA, 2023). Geothermal energy sources are typically located near tectonically active areas, where hot water or steam subsequently reaches the Earth's surface through volcanic fissures in the rocks. It has a low cost, providing electricity throughout the year with high efficiency. In Iceland, it provides more than 90% of the heating needs (IRENA, 2023). Biomass includes biodegradable components of products and residues of animal and plant origin from forestry and agriculture, as well as biodegradable parts of industrial and municipal waste. Biomass is burned to produce energy from chemical bonds, which is then used to generate electricity, heat or produce transport fuels. Bioenergy, or biomass to energy, is one of the main sources of renewable energy in the European Union and accounted for around 59% of renewable energy consumption in 2021. Germany is considered the largest producer of solid biomass (European Commission, Biomass, 2025). Biofuels are liquid or gaseous transport fuels made from biomass and are classified as modern bioenergy technologies, such as biodiesel or bioethanol. In the transport sector, they serve as a renewable alternative to fossil fuels. Brazil is considered a leader in the use of liquid biofuels such as bioethanol. Bioethanol is produced by fermenting sugars or starches from crops such as sugar cane or maize (European Commission, Biofuels, 2025).

Figure 1 describes how renewables contribute to electricity consumption in the European Union in 2022. Wind accounts for the largest share of renewables at 37.5%, and is one of the most attractive energy sources due to the development of wind farms, the efficiency of wind turbines and the relative cheapness and environmental friendliness compared to, for example, hydropower. This is followed by hydropower with 29.9%, which is mainly produced by hydroelectric power plants. Solar energy has the third largest share with 18.2%, reflecting the continuous development of solar technologies and their spread across the EU. Solid biofuels, at 6.9%, make up a smaller but still significant part of renewables. Other renewable sources such as geothermal energy account for the remaining 7.5%.

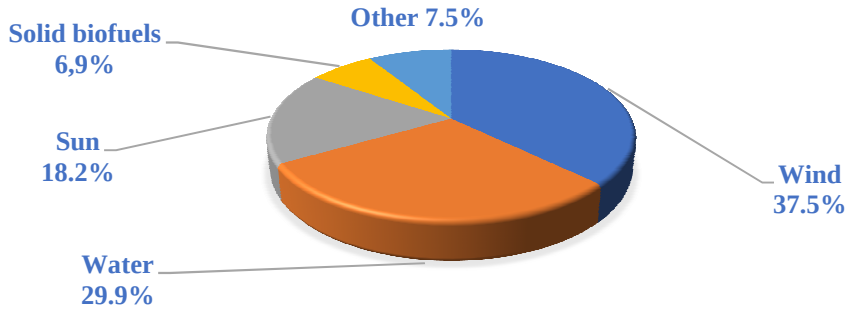

Figure 1. Renewable energy sources in EU gross electricity consumption in 2022
Source: own elaboration (2025), according to Eurostat (2022)

In terms of the share of renewable energy in gross electricity consumption, Sweden is the leading country with the largest share of RES with 83%, while Malta is on the tail with 10%. Sweden is one of the world leaders in the use of hydropower in particular. By comparison, Slovakia is at around 22% which is below the EU as a whole, which has a 41% share of renewable energy in gross electricity consumption. Interesting is the figure for Norway, which is not a member of the EU, with a very high share above 100%, which usually means that the country produces more renewable energy than it normally consumes.

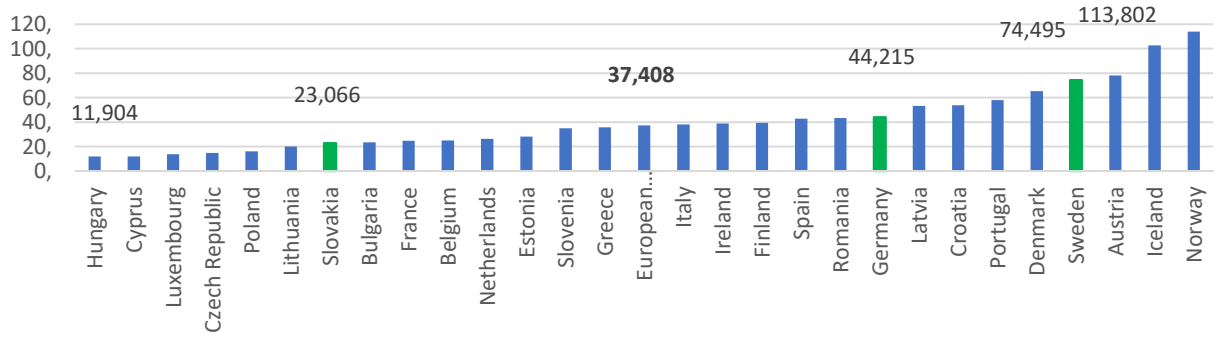

Figure 2. Share of renewable energy in gross electricity consumption in the EU and Norway, 2022
Source: own elaboration (2025), according to Eurostat (2022)

The EU is currently focusing on reducing seven gases that cause harmful emissions. These gases include non-fluorinated gases such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and fluorinated gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), nitrogen hexafluoride (NF3). (Eurostat, 2025) More than 75% of the EU's greenhouse gas emissions are due to energy production and use, and therefore emphasises the decarbonisation of the energy system, which it considers a key element for achieving the climate targets set. The European Green Deal is a growth strategy for a sustainable economy - a growth model based on a clean and circular economy. Its most important objective is to achieve carbon neutrality by 2050 (ACER, 2025).

Countries' energy systems are shaped by a combination of natural resources, technological advances or political factors. Although EU countries often commit to the same rules and standards, each country has different specificities and approaches to energy systems. The countries studied - Germany, Sweden and Slovakia - represent different levels of maturity in the use of renewable energy. Sweden is one of the leaders with a high share of renewables in its energy mix, Germany has ambitious green transformation targets. Slovakia, as a country with a lower share of renewables, provides an opportunity to explore the challenges in this area. It thus allows to analyse different approaches to integrating renewables and their impact on emission reductions, reflecting a wide range of energy policies.

Sweden is the best performing in the EU, in terms of renewable electricity generation and decarbonisation. Most of its electricity comes from hydro and nuclear power plants. In 2022, up to 68% of the electricity generated came from renewable energy sources. Hydropower accounted for the largest share with 40% and wind power with 20%. Sweden has set a target to reduce greenhouse gas emissions by 59% by 2030 compared to 2005 and to be a carbon neutral country with zero emissions by 2045. The transport sector, which produces the majority of greenhouse gas emissions, is still dependent on oil, so the plan is to reduce emissions in the transport sector by 70% by 2030. This transformation is being implemented through the promotion of electrification, industrial decarbonisation and advanced biofuels. It was the first country to introduce carbon pricing and currently has the highest carbon price in the world. This strategy has proven to be very effective in promoting decarbonisation. The carbon tax was introduced in 1991 along with the already existing energy tax. Over time, the importance of the carbon tax has increased, contributing to a wide range of environmental and climate goals. For example, the carbon tax provides incentives to reduce energy consumption, improve energy efficiency and increase the use of renewable energy alternatives (International Energy Agency, Sweden, 2024).

In Germany, the bulk of the energy mix comes from renewables, up to 44%. Of this, 27% comes from wind power, around 12% from solar power and the remaining 5% from hydropower. Coal accounts for 26.6% of electricity generation. The Energy Transition is an ambitious policy aimed at a low-carbon economy and a transition away from nuclear and fossil fuels towards a more sustainable energy mechanism based mainly on renewable energy sources such as wind, biomass and solar. The aim is to achieve carbon neutrality. In 2023, a reform of the Climate Protection Act was adopted to achieve net zero emissions by 2045. To achieve this, up to 80% of all electricity supply will have to come from renewable sources by 2030 and 100% by 2035. Germany was an early leader in offshore wind and solar photovoltaics and phased out nuclear power in 2023. According to the Energy Efficiency Act, it is making efforts to reduce its energy consumption by about 500 TWh by 2030, which is equivalent to about one-fifth of its energy consumption in 2022 (International Energy Agency, Germany, 2024).

In Slovakia, in 2005, the production and sale of electricity at the wholesale level was liberalised, which means that prices are not regulated and are set on the basis of bilateral contracts between the

consumer and the supplier. The largest producer and supplier of electricity to regional companies such as Západoslovenská energetika (ZSE), Stredoslovenská energetika (SSE) and Východoslovenská energetika (VSE) is Slovenské elektrárne, with a 66% share (Slovenské elektrárne, 2025). The main source of electricity production is nuclear power plants, which accounted for almost 62% of electricity produced in 2023. Hydroelectric power plants came in second place with about 16%. Coal mining, which was also once important for electricity generation, was phased out in 2023 and another nuclear unit was commissioned (International Energy Agency, Slovak Republic, 2024). The main objectives of the energy policy agenda include increasing efficiency in the energy sector and end-use, reducing energy intensity, reducing dependence on energy imports, expanding the use of nuclear energy, increasing the share of renewable sources in heating and electricity, and promoting the use of alternative fuels in transport.

Energy taxation plays a key role in shaping energy policies and promoting sustainable practices in different EU countries. Introducing higher levels of taxation for polluting and inefficient fuels can reduce greenhouse gas emissions, encourage investment in renewable energy technologies and facilitate the transition from fossil fuels to cleaner energies in order to achieve the EU's carbon neutrality under the Paris Agreement. The current Taxation Directive allows Member States to partially or fully exempt renewable energy sources, such as biofuels, from energy taxes and to fully exempt electricity produced from renewable energy sources (European Court of Auditors, 2022). In Figure 3 we can see a comparison of how different EU countries contribute to environmental financing through taxation.

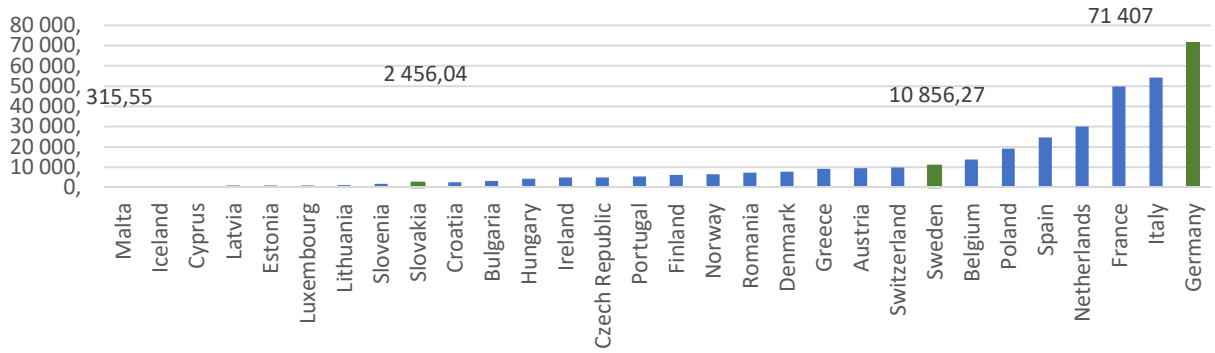

Figure 3. Environmental tax revenues in 2023 in millions of euros
Source: own elaboration (2025), according to Eurostat (2023)

1.1 Overview of theoretical approaches to renewable energy and the impact on emission reduction

The relationship between fossil fuel combustion, CO_2 emissions and the transition to renewables, with a focus on how the phasing out of fossil fuels affects climate and air quality, is addressed by economists Shindell and Smith. Their theory uses different climate scenarios to understand the implications of the transition from fossil fuels to renewables, detailing both direct and indirect emissions impacts to highlight the potential climate outcomes of different mitigation strategies and the necessity to reduce emissions. In their study, they used a model that is consistent with the 1.5 °C climate target. The climate model, FaIR (Finite Amplitude Impulse Response), is used to simulate the effects of different emission pathways. The emissions that enter the model are divided into CO_2 emissions associated with fossil fuels and other greenhouse gases from different sources, such as methane from agricultural activities. By isolating emissions from fossil fuels, the study highlights the specific impacts of fossil fuel phase-out. In scenario 1, where fossil fuel emissions remain constant at 2018 levels, the study projects a temperature increase of around 2.3 °C by the end of the century. This continued temperature rise trend would lead to severe climate impacts such as ecosystem disruption and various natural disasters with a loss of approximately $2.9 trillion. Conversely, under Scenario 2, where fossil fuel emissions such as CO_2 and SO_2 are gradually reduced by a phase transition of about 85% by 2100, billions of dollars in future costs associated with climate-related disasters can be saved. While phasing out fossil fuels, as opposed to immediate shutdown, leads to more continuous reductions in both CO_2 and SO_2. In the short term, phasing out fossil fuels causes a modest increase in warming, the so-called "climate penalty", but does not cause a sharp increase in warming (Shindell, Smith, 2019).

A study by economists Shirizadeh, Perrier and Quirion analyses the feasibility of switching to purely renewable energy systems in terms of cost. Cost scenarios were constructed where they observed key technologies and simultaneously modeled and examined the optimal renewable energy system. Once the

optimal energy mix was constructed, they examined the sensitivity of that mix to changing costs of energy technologies. The optimal energy mix includes the distribution of renewable energy sources that would be ideal in terms of economic efficiency and technical feasibility. The mix is predominantly made up of wind energy, which accounts for up to 80% (62% onshore and 18% offshore), followed by photovoltaics at 15% and hydropower at 5%. The current energy mix reflects the current state of the energy sector, with fossil fuels accounting for the largest share at 57%. The study demonstrates that a fully renewable system is economically and cost competitive compared to existing fossil fuel based systems (Shirizadeh, Perrier, Quirion, 2022).

Sen and Vollebergh's research examines the long-term effectiveness of carbon taxation as a political and economic tool for reducing CO_2 emissions in OECD countries. It highlights the need for a broader understanding of the economy-wide impacts of carbon taxes. Using advanced econometric techniques, the research aims to provide empirical evidence on the impact of energy taxes on energy consumption and emissions reductions. Carbon taxation is a policy instrument that charges for the carbon content of fossil fuels with the main objective of limiting greenhouse gas emissions. This creates incentives for producers and consumers to reduce energy consumption and encourages a shift to low-carbon fuels or renewable energy sources through investment or behaviour. The findings of the study underline the effectiveness of carbon taxes as a policy tool. In the long run, a €1 increase in energy taxes is estimated to reduce CO_2 emissions by around 0.73%, implying a significant negative correlation between carbon taxation and emissions. The analysis of the elasticity of energy consumption with respect to carbon taxes, which is 0.28, is slightly sensitive to changes in carbon taxes. That is, a 10% increase in carbon taxes would lead to a 2.8% reduction in energy consumption. This demonstrates the ability of policy to influence consumption patterns and drive emissions reductions (Sen, Vollebergh, 2016).

2. Methods

The object of investigation is the analysis of the use of renewable energy sources in Slovakia, Germany and Sweden with a focus on their role in reducing emissions. The thesis monitors the emission rates and the representation of renewables in the country's energy mix. The impact of renewables on emission reductions was analysed in each country using an econometric model in Gretl, and the results of each country were compared with each other. The data for the econometric models and the analysis of the impact of renewables on emission reductions in Slovakia, Germany and Sweden were obtained from the Statistical Office of the European Union (Eurostat) and the International Energy Agency (IEA). Data on emissions production, share of renewables, GDP and energy tax of the countries were examined for the construction of the models.

Three econometric models were constructed, each corresponding to one of the three countries studied. The dependent variables were CO_2 emissions, the independent variables were the share of renewables in the energy mix, and the control variables were GDP per capita and energy tax, of which the carbon tax is a part. GDP is a standard indicator in many econometric analyses, chosen because higher GDP per capita often leads to higher energy consumption and CO_2 emissions, especially in fossil fuel dependent countries. Higher GDP can also lead to technological innovations that improve energy efficiency and reduce emissions. The inclusion of a carbon-intensive energy tax as a control variable in the model is important because it can affect energy consumption and CO_2 emissions. This inclusion provides more accurate results and better interpretation of the effects of other variables. The data for all variables are between 2004 and 2022.

3. Results and Discussion

The first variable analysed is the dependent variable CO_2 emissions. The CO_2 emissions per capita for the countries studied, in tonnes in 2022, allow to assess the environmental burden of an individual. Germany has the highest per capita emissions of 7 303 tonnes of CO_2 per person, followed by Slovakia with 5 125 tonnes of CO_2 and Sweden with the lowest of 3 095 tonnes of CO_2. The differences may be due to better energy efficiency and a higher share of RES (IEA, 2022).

The independent variable is the share of renewables in the energy mix of the selected countries. This variable directly influences the amount of CO_2 emissions produced. A higher share in the energy mix leads to greener energy production and lower emissions. The importance of this variable is also highlighted by the theoretical approach of Shirizadeh, Perrier and Quirion (2022), who emphasize the optimal energy mix in their study. Therefore, the inclusion of an analysis of the share of renewables in the energy mix is important, not only from an environmental point of view, but also for the assessment of economic sustainability and long-term climate stabilisation. In 2022, Sweden achieves a share of renewables in the

energy mix of 66%, Germany achieves a share of 20.7% and Slovakia 17.5% (Eurostat, Share of energy from renewable sources, 2022).

The next variable, the control, is real GDP per capita. The inclusion of GDP in the model allows us to take into account how economic development affects CO_2 emissions and energy consumption, as more developed and wealthier countries have the opportunity to invest in technological innovation, which contributes to more efficient ways of producing energy. In 2022, real GDP per capita in Sweden was €48,890, in Germany €43,260 and in Slovakia €18,360. The differences are due to the more advanced and diversified economies of Sweden and Germany, their strong exports, high labour productivity and investment in research and development (Eurostat, Real GDP per capita, 2022).

The second control variable, the energy tax, has been included in the model because the carbon tax is an important part of it. Its implementation would allow a more accurate representation of the costs associated with CO_2 emissions, which directly affect the energy mix of countries. This variable follows the theoretical approach of Sen and Vollebergh (2016), who in their study highlight the importance of a carbon tax as an effective tool to reduce emissions and manage energy consumption. The consideration of an energy tax rather than a direct carbon tax was chosen because Germany only adopted a carbon tax law in 2023 and Slovakia has not yet implemented a direct carbon tax. Although there is no direct carbon tax in Slovakia, the costs of carbon emissions are still reflected in energy taxes and the trading system, thus these costs are taken into account in the energy policy framework. Germany shows the highest energy tax revenue (€56,054.31 million in 2022), which grew by €7,358.85 million between 2013 and 2022. The largest year-on-year increase of €10,366.65 million in 2020 is due to the introduction of new climate measures, including a carbon tax in the transport and heating sectors. These measures were part of the comprehensive "Energiewende" plan, which aims to modernise the German energy system with an emphasis on the transition to RES and increased efficiency. (IEA, 2020) The development of Sweden's energy tax (in 2022 the revenue was EUR 4,285.58 million) in the reporting period 2013 to 2022 has been fairly constant until 2020. Subsequently, a decline was observed when the Swedish government introduced temporary tax cuts to reduce the financial burden on households and businesses, especially in sectors that were heavily affected by the COVID-19 pandemic, such as energy-intensive industries. Energy tax revenues in Slovakia (in 2022 the revenue was EUR 1 951.70 million) increased by EUR 309.42 million in the 10 years under review (Eurostat, Environmental taxes by economic activity, 2022).

A total of 3 models were created, each representing one of the countries analysed - Slovakia, Germany and Sweden. In each model, emissions are the dependent variable and RES, GDP and energy tax are the independent variables, the so-called explanatory variable, with GDP and energy tax being the control variables. To estimate the parameters of the equations, we use the least squares method, which ensures that the parameters obtained best capture the relationship between the explained and the explanatory variables. The coefficients represent the direction and magnitude of the relationship between the dependent variable and the independent variables. A positive coefficient indicates a direct relationship, while a negative coefficient indicates an inverse relationship.

Table 1 shows the estimation of the model equation for Slovakia and its interpretation. The negative coefficient for renewables (-1.37e+03) indicates that increasing their share leads to a reduction in emissions, which is in line with expectations. The positive coefficient for GDP (0.22) shows that economic growth is associated with a slight increase in CO_2 emissions, which may be related to higher energy consumption. The high coefficient on the energy tax (12.20) suggests that an increase in energy taxes may not reduce emissions sufficiently. This signals that the energy tax is associated with economic activities that are emissions-intensive despite the higher tax, or the tax may not be high enough to change consumer behaviour. Rather, they are fiscal in nature.

Table 1. Estimation of the model equation for Slovakia and its interpretation

Estimated equation
^Emissions = 2.67e+04 - 1.37e+03*RES + 0.22*GDP + 12.20*Energy_tax
Interpretation
- If the share of renewable energy sources (RES) is increased by 1 unit, emissions are reduced by 1.37e+03 thousand tonnes CO_2 on average.
- If GDP per capita increases by 1 unit, emissions increase by 0.22 thousand tonnes of CO_2 on average per year.
- If the energy tax is increased by 1 unit, emissions will increase by 12.2 thousand tonnes of CO_2 on average.

Source: own elaboration (2025)

Table 2 shows the estimation of the model equation for Germany and its interpretation. The negative coefficient for renewables (-3.12e+04) indicates that an increase in their share leads to a more significant decrease in CO_2 emissions. The positive coefficient for GDP (1.68) indicates that the increase in emissions is associated with economic growth, which may be the result of intensive manufacturing activity and higher energy consumption. As in the case of Slovakia, Germany also has a positive coefficient on the energy tax (3.87). It can be argued that the tax may not be high enough or effectively set to incentivise firms and households to change their consumption behaviour and switch to cleaner energy sources.

Table 2. Estimation of the model equation for Germany and its interpretation

Estimated equation
Emissions = 1.09e+06 - 3.12e+04*RES + 1.68*GDP + 3.87*Energy_tax
Interpretation
- If the share of renewable energy sources (RES) is increased by 1 unit, emissions are reduced by 3.12e+04 thousand tonnes of CO_2 on average.
- If GDP per capita increases by 1 unit, emissions increase by 1.68 thousand tonnes of CO_2 on average per year.
- If the energy tax is increased by 1 unit, emissions will increase by 3.87 thousand tonnes of CO_2 on average.

Source: own elaboration (2025)

The estimated model equations for Sweden and its interpretation are shown in Table 3. The highly negative coefficient for renewables (-322.00) confirms their significant impact on emission reductions, due to their above-average share in the energy mix and low dependence on fossil fuels. Despite the use of a large amount of renewables, the positive coefficient for GDP (3.90) indicates that industries, transport still generate emissions, as not all processes are fully decarbonised. As for the positive coefficient on the energy tax (2.50), despite the high taxes in place, some industrial sectors may have long-term contracts for fossil fuel energy supply. Increasing taxes in the short term may not immediately lead to a change in the fuel mix.

Table 3. Estimation of the model equation for Sweden and its interpretation

Estimated equation
^Emissions = -1.77e+05 - 322.00*OZE + 3.90*GDP + 2.50*Energy_tax
Interpretation
- If the share of renewable energy sources (RES) is increased by 1 unit, emissions will be reduced by 322.00 thousand tonnes of CO_2 on average.
- If GDP per capita increases by 1 unit, emissions increase by an average of 3.90 thousand tonnes of CO_2 per year.
- If the energy tax is increased by 1 unit, emissions will increase by 2.50 thousand tonnes of CO_2 on average.

Source: own elaboration (2025)

In econometric models, the statistical significance of variables is crucial for analysing and understanding the relationships between different economic factors and for making accurate predictions. Independent variables are tested for statistical significance to verify that their relationship with the dependent variable is not due to chance. In the model, we observe the significance levels of the variables, which can be at the 1%, 5% or 10% level. Emphasis is also placed on the p-value, which indicates the probability that the observed relationship is due to chance. A low p-value, less than 0.05, means that the variable is statistically significant. A statistical significance of three asterisks in Table 4 indicates significance at the 1% level, two asterisks indicate significance at the 5% level, and one asterisk indicates significance at the 10% level. The higher the statistical significance of a variable, the more relevant and reliable it is in explaining the dependent variable.

After processing the data in econometric models, we found that our models contain statistically significant variables that reach statistical significance at the 1% and 5% level, as well as variables that are not statistically significant. In the case of Slovakia and also Germany, the renewable energy variable is statistically significant at the 1% level (marked with three asterisks), while GDP and energy tax do not show statistical significance. In the model for Sweden, GDP is significant at the 5% level (marked with two asterisks), indicating that economic activity has an impact on emissions in this country, while energy tax together with renewables are not statistically significant. The statistical insignificance may be due to

the fact that if the share of renewables itself is already high, its further growth may not have a substantial additional effect on emissions.

Table 4 shows the p-values of the independent variables, which confirm the previous conclusions of statistical significance/insignificance. The assumption for statistical significance of a variable is its p-value less than 0.05. In the case of Slovakia and Germany, the RES variable is below this level, the remaining two variables exceed this level. Sweden's GDP is just below this level, while the remaining variables are statistically insignificant.

Table 4. P-value of independent variables

P-value of independent variables						
	RES		GDP		Energy tax	
Model of Slovakia	0,0044	***	0,8396	-	0,1346	-
Model of Germany	0,0003	***	0,8422	-	0,2143	-
Model of Sweden	0,6347	-	0,0279	**	0,3725	-

Source: own elaboration (2025)

The different results in the country models suggest that the impact of individual variables on emissions varies depending on the specific energy and economic conditions of each country, such as the level of renewable energy deployment, historical dependence on fossil fuels, or the level of industrialisation. In Germany, for example, the impact of renewables may be more pronounced due to large investments in wind and solar energy, while in Slovakia the effect is influenced by a lower initial share of these sources. In Sweden, GDP has a more significant impact as the country has long been using low-carbon sources such as hydropower and nuclear power.

In the next part of the paper, we analyze the relationship between the dependent and explanatory variables through the correlation coefficient, which expresses the linear dependence between the variables. The correlation coefficient takes values ranging from -1 to +1, with +1 indicating the strongest positive correlation, -1 the strongest negative correlation and 0 representing the absence of a relationship. Correlation coefficient values ranging from 0.8 to 1 (or -0.8 to -1) indicate a very strong correlation, values ranging from 0.4 to 0.8 (-0.4 to -0.8) are moderately strong, and a correlation ranging from 0 to 0.4 (-0.4 to 0) is considered weak. There are two types of relationships between correlated variables - direct and indirect. If the values of one variable increase at the same time as the values of the other, we speak of a direct, or positive, correlation. In the case of the opposite movement, when the value of one variable increases and the value of the other decreases, this is a negative correlation, the so-called indirect correlation. If there is no correlation between two variables, it means that their values do not affect each other. Changes in one variable do not systematically lead to changes in the other.

Table 5. Correlation coefficients of Slovak, German and Swedish variables

	emissions Slovakia	emissions Germany	emissions Sweden
renewable energy sources	-0,75	-0,96	0,19
GDP	-0,41	-0,62	0,55
energy tax	-0,35	-0,59	-0,12

Source: own elaboration (2025)

All correlation coefficients between the variables in Slovakia and Germany are negative, indicating an inverse relationship between the dependent and independent variables. The difference is that the coefficients in the case of Germany show stronger correlation relationships.

The strong negative correlation between emissions and the use of renewables means that emissions tend to fall more sharply as their use increases. Slovakia, in response to the commitments of the European Green Deal, has taken a number of measures to promote RES and modernise its industry. An important measure was the introduction of feed-in tariff support for photovoltaic and wind power plants. It also implemented the Renewable Energy Directive and promoted the introduction of modern biogas and biomass technologies. The strong correlation in the case of Germany may be due to the systematic substitution of fossil fuels by renewable energy sources, promoted by the 'Energiewende' policy. This policy includes the phasing out of coal and nuclear power plants and various financial and economic incentives. The aforementioned switch to RES promotes the electrification of transport and industry, thus further contributing to decarbonisation. The weak positive correlation between emissions and renewables

in the case of Sweden at 19% suggests that increasing the share of renewables does not necessarily lead to immediate emission reductions. The weak correlation may be due to the fact that the share of renewables in the energy mix itself is already currently above average compared to other countries, so further increases may not immediately and directly reduce emissions.

There is also a linear negative relationship between the other two explanatory variables and emissions. In the case of Slovakia, it ranges between moderate and weak levels. For GDP, this may be due to more efficient technologies and a shift to lower-emission services compared to traditional industry. GDP with a moderately strong correlation at 55% for Sweden is related to economic activity. As the economy grows along with industrial activities such as transport, energy consumption usually increases, leading to higher emissions. For example, in 2021 GDP grew by 16.9% and carbon emissions increased by 4.5% over the same period. The low negative correlation coefficient between emissions and the energy tax of -12% may signal modest changes in the behaviour of individuals and businesses. Increases in energy taxes may lead to a reduction in fossil fuel consumption as individuals and businesses seek to reduce their costs (Boyle, R. 2024).

3.1 The coefficient of determination and the corrected coefficient of determination

The determination of the coefficient of determination and the corrected coefficient of determination is one of the main steps of the analysis. The coefficient of determination, referred to as R^2 , indicates how well the independent variables explain the variability in the dependent variable. It expresses what percentage of the total variability of the dependent variable can be explained by the regression model. The rest of the variability is attributed to random effects. The coefficient also helps in assessing the predictive power of the model. A model with a high value of R^2 is generally considered to be better and more reliable in making forecasts. The adjusted coefficient of determination, denoted $\overline{R}^2$, takes into account the number of variables in the model and corrects the R^2 value so that it is not overestimated. This is because the value of R^2 can increase by gradually adding irrelevant variables; if we add an irrelevant variable, the adjusted coefficient of determination will not increase; on the contrary, it may even decrease.

The coefficient of determination for the regression model of Slovakia is 0.81, this means that 81% of the variability of the dependent variable is attributed to the regression model and the remaining 19% of the variability is influenced by random factors or unobserved influences that are not captured by the model under analysis. This relatively high coefficient of determination indicates that the model has a relatively strong predictive ability, although there is still some variability that remains unexplained by the model. As expected, the adjusted coefficient of determination is 10% lower compared to R^2 . In the case of Germany, the regression model accounts for up to 94% of the variability in the dependent variable, with the remaining 6% attributed to random disturbances. The very high coefficient of determination may be due to the choice and type of data for Germany. These data can be very stable and consistent over time, which the model captures very efficiently. The German model captures the relationships between variables very well and can be considered the best and most reliable in making predictions. The adjusted coefficient of determination differs only slightly fromR^2 , which also indicates a very good predictive performance of the model. A less diversified energy mix, weaknesses in statistical tracking, less robust historical data, or the volatility of policy decisions may lead to a lower$\bar{R}^2$ of Slovakia compared to Germany. Sweden has 61% of the variability in the dependent variable and the remaining 39% is attributed to random effects. The coefficient of determination at the 61% level still indicates a moderate to strong econometric model. It is possible to observe a significant difference betweenR^2 and$\bar{R}^2$. We are talking about a difference of up to 20%, this may indicate that one of the variables does not improve the ability of the model to explain the dependent variable. However, this can also be explained by dynamic policy. The introduction of new renewable energy reforms and policies creates a more dynamic environment. Frequent changes in carbon taxes, subsidies and support for innovation can create volatility that affects the stability and accuracy of models assessing the impact of these policies. Dynamic and constantly changing policies can have unpredictable effects on technological innovation, especially in clean transport technologies, increasing the random factors in these types of models.

Conclusion

The paper examined the relationship between the use of renewable energy sources, their representation in the energy mix and their correlation with the share of emissions in three selected countries - Slovakia, Germany and Sweden. The use of renewable energy sources is a statistically significant factor in reducing emissions in Slovakia and Germany, with a strong negative correlation

confirming that a higher share of renewables leads to a decrease in emissions. In Germany, their stronger impact can be explained by large investments in wind and solar energy. Through the energy transition, these investments are directed towards a low-carbon economy and a gradual shift away from nuclear power and fossil fuels towards a more sustainable energy system based on renewable sources such as wind, biomass and solar energy. In response to the EU's 2050 carbon neutrality commitments, Slovakia has taken a number of measures to promote renewable energy and modernise its industry, such as introducing feed-in tariffs for photovoltaic and wind power plants and supporting the deployment of advanced biogas and biomass technologies. Such measures can lead to a more significant reduction in emissions compared to countries where the share of renewables is already high and the additional contribution to emission reductions is smaller. This is also documented by research carried out in Sweden. Where renewables do not show statistical significance and have only a weak positive correlation with emissions. GDP has only been shown to be a statistically significant variable in the case of Sweden, where its growth is correlated with the increase in emissions, which is due to the growth of the country's industrial and economic activities, such as the transport of goods and people. The energy tax, of which the carbon tax is a part, has not been statistically significant in any of the countries analysed, suggesting that its current level and implementation may not be high enough to change consumer behaviour. This may also be confirmed by the fact that these taxes are primarily fiscal in nature, with the main objective of generating revenue for the state budget, not reducing CO_2 emissions. Based on the adjusted coefficient of determination, the German model proved to be the best and most reliable model for making projections, which may have been helped by the long-term consistency of environmental policy and the availability of detailed data. In contrast, the Swedish model, which showed relatively low explanatory power, may be affected by dynamic changes in carbon taxes, subsidies and various support mechanisms for innovation.

The results show that the effectiveness of decarbonisation policies can vary considerably depending on the specific energy and economic conditions of individual countries. While in some countries the promotion of renewable energy may be the key strategy for reducing emissions, in other countries it may be more effective to combine different measures such as regulations, technological innovation or changing consumer behaviour. In the long term, it is also important to consider their sustainability. Expansion and intensive use brings with it new challenges, such as efficient recycling and disposal of solar panels, ensuring reliable operation of the electricity grid in the event of variable weather, or the availability of critical raw materials. The future of development will depend not only on political support and strategic investment, but above all on technological progress, flexible and efficient energy management and the ability to create an environmentally and economically sustainable framework for the energy transition. The work provides valuable insights for energy and climate policy makers, highlighting that the specificities of each country need to be taken into account when developing effective strategies. Further research could extend the analysis to include factors such as energy efficiency, infrastructure investment or technological progress and examine the long-term effects of these variables on CO_2 emissions.

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8. Quantitative Methods and Applied Informatics in Management and Business

A Novel Hybrid IBA-OSCD Approach for Multi-Criteria Inventory Classification

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Abstract

Research background: Inventory management plays a crucial role in manufacturing organizations as it enables continuity of production, adequate response to customer demand, financial optimization of inventory and overall adequate organizational liquidity. Inventory management is highly dependent on inventory classification as it allows simplification of the inventory management process by assigning inventory management policies based on categories rather than individual items.
Purpose of the article: In this article, a novel hybrid approach for multi-criteria inventory classification is proposed. The approach considers two groups of logically related criteria: One group focuses on inventory ordering dynamics, i.e., lead time, average demand, current inventory quantity, and coefficient of variation, while the other focuses on inventory quantity and value, including average demand, unit price, and dollar usage value. The method follows the ABC classification convention and is used to categorize 290 inventory items into three classes.
Methods: The classification process is conducted in two steps. First, each set of criteria is evaluated and aggregated using logical aggregation based on Interpolative Boolean Algebra, allowing for the integration of both logic-based and statistical relationships within the data during aggregation. The resulting values are then further aggregated using ordinal sums of conjunctive and disjunctive functions to perform upward or downward reinforcement , depending on the input values.
Findings & Value added: This study demonstrates the novel logic-based approach to multi-criteria inventory classification, which aims to explore a different perspective on inventory management by considering multiple sets of logically related criteria.

Keywords: Inventory management, Inventory classification, Hybrid multi-criteria approach, Interpolative Boolean algebra, Ordinal sums of conjunctive and disjunctive functions

JEL classification: M11, C38, C00

1. Introduction

Inventory is defined as the stored instances of transformed resources within a production or service operation (Slack et al., 2010, p. 368) due to timing mismatches between supply and demand (Slack et al., 2010, p. 368). It is essential for ensuring smooth production or service availability, enabling the company to meet the needs of customers in an appropriate manner (Nowotyńska, 2013). For manufacturing-oriented companies, inventory and its appropriate management play a crucial role in maintaining ongoing production and meeting customer needs (Nowotyńska, 2013). This includes maintaining an adequate inventory of raw materials, work in progress and finished goods to achieve cost efficiency and reliable

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supply (Pandya & Thakkar, 2016), while controlling stock levels to accommodate any fluctuations in demand (Priniotakis & Argyropoulos, 2018). Inventory management has a significant financial impact as it directly affects an organisation's performance through its influence on procurement, sales and logistics. Due to this financial impact, inventory management is of great importance from both a theoretical and practical perspective, as it is both capital-intensive and time-consuming (Razavi Hajiagha et al., 2021).

For organizations that may have up to several thousand different inventory items, it is both economically inefficient and logistically impractical, if not impossible, to devote equal and maximum attention to each individual item. For this reason, inventory classification is often recommended in the literature as a strategy to address this issue (Rakicevic et al., 2024). Instead of managing each item individually, this approach involves companies grouping their inventory items into categories and applying appropriate management policies to each individual item (Mohammaditabar et al., 2012).

Numerous numerical methods have been proposed in the literature to improve inventory classification. Probably the most important and widely used method is the ABC method, which classifies inventory into three categories (Ramanathan, 2006). For classification, ABC analysis primarily considers the inventory value of each item or the variability of demand, i.e. a single criterion. Over the years, more advanced multi-criteria ABC analysis approaches have been developed (Ravinder & Misra, 2014). However, these approaches are mainly based on simple aggregation functions, i.e. weighted sums, and more sophisticated aggregations, i.e., logic-based aggregations, are yet to be explored.

In this paper, we present a novel approach to multi-criteria inventory classification that combines Interpolative Boolean Algebra (IBA) and its logic-based aggregation capabilities with Ordinal Sums of Conjunctive and Disjunctive (OSCD) functions. Specifically, we use the IBA framework for Boolean consistent modeling and the computation of lower-level partial logical requirements defined by a domain expert. In addition, OSCD functions with three different parameter settings are applied to aggregate values at a higher level to make a clear distinction between inventory classes. With the proposed approach, we incorporate both logical and statistical dependencies in the data to obtain more credible results.

The rest of the article is organized as follows: In the literature review section, three distinct topics are discussed. First, inventory classification and its importance to the inventory management process as well as the most common approaches to inventory classification are presented. Next, the basis of IBA and its logical aggregation capabilities are discussed. Finally, the basis of OSCD functions are presented. In the methodology section, a step-by-step explanation of the item classification process is presented. There is an explanation given for each individual step and its necessity for adequate classification of items. In the fourth section, the explained methodology is implemented in a real-world scenario to better understand each individual step of its implementation. The results obtained are presented, discussed and a general recommendation is given on how the model can help and be interpreted by the expert. The final section concludes the paper. Implications of the research and further research perspectives are outlined.

2. Literature review

The literature review section is divided into three sections: inventory classification, logical aggregation based on Interpolative Boolean Algebra and Ordinal Sums of Conjunctive and Disjunctive functions. Each section provides an overview of the most important concepts and relevant research in the respective area.

Inventory classification

Inventory classification serves as a fundamental step in inventory management and forms the basis for the selection of appropriate inventory control policies tailored to their respective categories (Razavi Hajiagha et al., 2021). The reason for using classification is the observation that in most situations it is not possible to develop a separate strategy for each individual item due to the large number of items in stock (Teunter et al., 2010). One of the fundamental components of effective inventory management is precisely this process of classifying items, which helps companies allocate their limited resources more strategically and determine appropriate inventory control policies (Anđelić et al., 2024). By classifying inventory, companies can prioritize those items that contribute the most to achieving their operational and financial goals (Mohammaditabar et al., 2012).

The first approach to inventory classification was the original ABC analysis of inventory, a name that has become synonymous with the process of inventory classification (Ramanathan, 2006). The original ABC analysis classifies items into categories A, B, and C based on their importance, which is measured solely by dollar usage value (Nallusamy et al., 2017). Conventional ABC analysis is based on the Pareto

principle (Park et al., 2014), which states that a small proportion of items usually account for the majority of inventory value, while the majority of items make only a small contribution. Accordingly, Class A items are considered very important, Class B items are considered moderately important and Class C items are considered relatively insignificant (Douissa & Jabeur, 2016). The traditional ABC classification is still one of the most commonly used methods for categorizing items by importance (Nallusamy et al., 2017), mainly because of its ease of use and understanding.

While the aforementioned reliance on a single criterion (Teunter et al., 2010) is what makes the method so intuitive and easy to use, it is also its main source of criticism (Muller, 2019), where it is often pointed out that the method does not adequately reflect the different priorities of different departments within an organization and completely disregards non-financial factors. Therefore, inventory classification is increasingly being explored in a multi-criteria framework (Razavi Hajiagha et al., 2021), a direction supported by many scholars (Lolli et al., 2019). Muller (2019) suggests that at least two criteria should be considered. These could be ordering cost, item criticality, lead time, shelf life, substitutability and demand variability, paving the way for a multidimensional approach to inventory classification (Park et al., 2014).

Taking all this into account, more advanced multi-criteria approaches have emerged, incorporating both financial and non-financial variables that reflect the greater complexity of real-world inventory systems (Silver et al., 1998). Over time, three general methods for implementing multi-criteria ABC analysis have emerged (Ravinder & Misra, 2014). The first is based on subjective weighting and scoring of criteria, where a decision maker assigns weights and methods such as the Analytic Hierarchy Process (AHP), often enhanced by fuzzy logic, are used to combine the scores (Paredes Rodríguez et al., 2023). The second approach is based on linear optimization, which bypasses subjectivity by deriving the weights directly from the data so that a predefined cost function is minimized. Data Envelopment Analysis (DEA) is often used in this context (Xu & Xu, 2020). The third approach uses artificial intelligence such as clustering techniques, genetic algorithms and neural networks that learn from existing data provided by experienced managers (Zhang et al., 2019).

Logical aggregation based on Interpolative Boolean Algebra

One of the distinct approaches that aim to incorporate logical and statistical dependencies into aggregation and decision-making is logical aggregation based on IBA (Radojevic, 2008). LA combines individual inputs based on user-defined logical rules to obtain a consistent and interpretable collective outcome. This procedure is both multi-valued and Boolean consistent, since IBA (Radojevic, 2000) serves as the foundation of this approach.

From the technical point of view, LA consists of two steps:

i) Normalization of attributes' values to the unit interval;
ii) Aggregation of normalized values by means of a logical/pseudo-logical function.

In the general case, the aggregation function may be pseudo-logical, i.e. weighted sum of partial logical demands $\underset{i=1}{\overset{m}{LA}}(x_i) = \sum_{j=1}^{m} w_j \cdot \varphi_j^{\otimes}(x_1,...,x_m)$, where *m* is number of attributes, φ_j is a logical function of attributes $x_1,...,x_m$, and w_j are corresponding weights.

Before making a final aggregation, each logical expression φ should be treated within IBA framework on symbolic and valued level. First, on the symbolic IBA level, any logical function φ of attributes $x_1,...,x_m$, is transformed to the generalized Boolean polynomial (GBP) $\varphi^{\otimes}$.

$$\varphi \text{ a } \varphi^{\otimes}, \quad \varphi(x_1,...,x_m) = \varphi^{\otimes}(x_1,...,x_m) \qquad (1)$$

The transformation procedure (Radojevic, 2000) is performed according to the IBA transformation rules, either manually or using a software solution (Milošević et al., 2014). Variables in GBP are observed attributes, while the operators are standard +, standard – and generalized product (GP). The structural transformations of the expression ends with obtaining the shortest form of GBP.

On the valued level, the GP is considered a subclass of *t*-norms that satisfy an additional non-negativity condition, i.e. GP may be realized as any *t*-norm that produces the result from the following interval (Radojevic, 2008):

$$\max(x+y-1,0) \le x \otimes y \le \min(x,y) \qquad (2)$$

According to the nature of attributes to be aggregated and their and statistical dependencies, three realizations of GP are distinguished in practice (Čolić et al., 2024; Milošević et al., 2021). Attributes of the same/similar nature and high statistical dependency should be aggregated with the min function. For

independent, uncorrelated attributes, the product is used as a suitable operator. GP is realized as Lukasiewicz t-norm if the attributes are negatively correlated. Attributes of the same nature should be aggregated first, followed by negatively correlated attributes if more attributes are to be aggregated using GP. The choice and application of GP together with the final value calculation completes the valued level of the IBA framework.

In the general case, LA is not monotonic and therefore does not satisfy all the properties required to be considered an aggregation operator. On the one hand, this can be seen as an opportunity to model unusual situations, e.g. similarity or dissimilarity. On the other hand, certain special cases of logical aggregation are monotonic and can be used in a conventional way as they generalize the arithmetic mean, the weighted sum, the minimum function and both the discrete and the generalized Choquet integrals. This approach is utilized both in practice and in the literature, e.g. (Anđelić et al., 2024; Milošević et al., 2024), because it is transparent, well-defined, easy to use and has numerous mathematical properties.

Ordinal Sums of Conjunctive and Disjunctive functions

Mixed aggregation functions are appropriate when one category of elements is to be emphasized as crucial, e.g. class A, the second category as more or less relevant (class B) and the third category downplayed as the least relevant (class C). The ordinal sum of conjunctive and disjunctive functions could be the solution to this exact problem (De Michele & Pierri, 2020; Hudec et al., 2021). One form of ordinal sums is as follows:

$$A(x,y) = A_1(a \wedge x, a \wedge y) + A_2(a \vee x, a \vee y) + a \qquad (3)$$

where x and y are intensities of satisfying categories, and $a \in [0,1]$ expresses the separation between upward and downward reinforcements. Then holds the following observations:

$$\text{for } x,y \in [0,a]^2 \text{ we get } A(x,y) = A_1(x,y) \qquad (4)$$
$$\text{for } x,y \in [a,1]^2 \text{ we get } A(x,y) = A_2(x,y) \qquad (5)$$

The key observation is that if A1 is a conjunctive function (downward renifircement) and A2 is a disjunctive function (upward renforecmeent) (Durante and Sempi, 2005), the remaining two sub-areas are covered by the averaging function, since:

$$\text{for } x,y \in [0,a] \times [a,1] \text{we get } A(x,y) = A_v(x,y) = x + y - a \qquad (6)$$
$$\text{for } x,y \in [a,1] \times [0,a] \text{we get } A(x,y) = A_v(x,y) = x + y - a \qquad (7)$$

These functions are depcted in Figure 1.

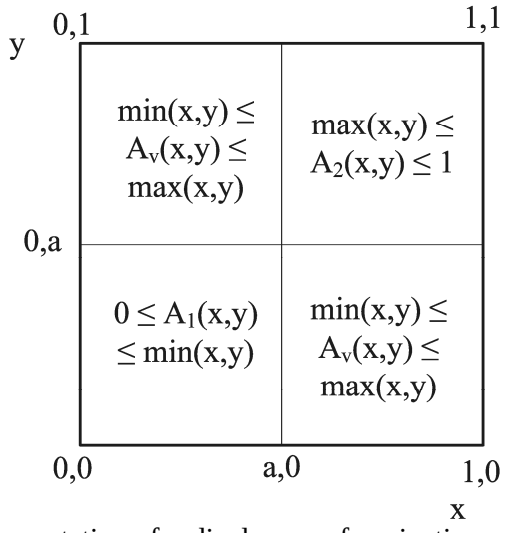

Figure 1. Graphical representation of ordinal sums of conjuctive and doisjunctve functions

For the aggregation function, we should keep the borderline cases, i.e., $A(0, 0) = 0$ and $A(1, 1) = 1$. It holds for averaging functions, but if the functions are conjunctive, we should keep $A(a, a) = a$, because this is the borderline case of the lower left sub-square. It is solved by adjusting strict conjunctive function (e.g., product t-norm $T(x, y) = xy$) through transformation (Beliakov et al., 2007)

$$A_1(x, y) = aT\left(\frac{x}{a}, \frac{y}{a}\right) \qquad (8)$$

or $A_1(x, y) = \frac{1}{a}xy$ (Figure 1). When the space is divided into equal sized subsquares we get $A_1(x, y) = 2xy$. Analogously, for nilpotent conjunction (e.g., Lukasiewich t-norm $T(x, y) = \max(0, x + y - 1)$) we get $A_1(x, y) = \max(0, x + y - a)$ (Hudec et al., 2021).

In the same way, we adopted the disjuctive functions as $A_2(x, y) = -1 + \frac{1}{a}x + \frac{1}{a}y - \frac{1}{a}xy$ for strict probabilistic sum t-norm and $A_2(x, y) = \min(0, x + y - a)$ for Lukasiewicz t-conorm. For the averaging part, we can keep the neutral arithmetic mean $A_v = (x + y - a)$ or adjust the inclination toward conjunctive or disjunctive behaviour (Hudec et al., 2022).

3. Methodology

Figure 2 displays all the steps necessary for appropriate inventory item classification, which further allows the definition of appropriate inventory management strategies.

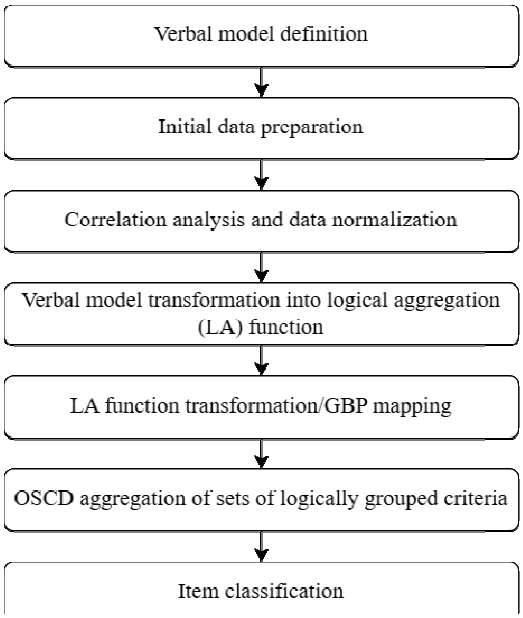

Figure 2. Graphical representation of methodological steps for item classification
Source: own processing

In the first step, an expert from the field verbally defines the considerations as to which criteria influence the perceived importance of a particular inventory item. The expert also provides information on how these criteria are interconnected, i.e. what logical connections, if any, exist between certain criteria.

During data preparation, the raw data is transformed on the basis of the verbal model so that it is suitable for further analysis. The data is cleaned, potential errors are handled accordingly, duplicates are removed and, if necessary, composite metrics are calculated based on multiple input parameters.

In the third step, a correlation analysis is performed between the individual criteria, as this later influences the transformation of the generalized Boolean polynomial into a corresponding mathematical expression. The data is also normalized to ensure a proportional and meaningful contribution to the final classification results.

In the fourth step, the verbal model previously defined by the expert is transformed into appropriate logical functions. This step is crucial as it enables the subsequent logical and mathematical operations to adequately reflect the expert's input and opinions.

In the fifth step, the logical expressions are translated into a generalized Boolean polynomial according to the IBA transformation rules. This step essentially provides a mathematical representation of the previously defined logical groupings.

In the sixth step, the individually modeled groups of criteria are further aggregated using ordinal sums of conjunctive and disjunctive functions. In this step, the input of an expert is not as crucial, as this class of functions naturally emphasize and rank key items with high values when both categories are high (class A), downplay non-crucial items resulting in low values when both categories are low (class C) and averages the feature ranks the other itmes (class B).

The final result of this aggregation is the individual groupings of the inventory items into corresponding classes.

4. Results and discussion

In a **verbal model definition**, an expert gives his opinion on how certain criteria influence the importance of an item. In this case, the expert has given two general indications that an inventory item is of high importance. One reason has to do with order dynamics. If an item has a long lead time and the average ordering demand is high, combined with the fact that the inventory level is high, which means that a lot of capital is tied up in inventory, the expert believes that this item is of high importance. Even if this is not the case, if the average ordering demand is high, but the individual demand quantities fluctuate greatly from case to case, an item is of high importance, as an appropriate demand forecast can be extremely difficult in this case. The second line of reasoning concerns the financial aspects of inventory management. An item is of high importance if it is expensive and the demand for this item is high. Even if this is not the case, an item is still of high importance if a lot of capital is “trapped” in this item and the value of the total item stock is high. This expert input forms the basis for further implementation steps.

During **data preparation**, the raw data, i.e. the item-level data on prices, inventory quantities, demand, etc., is cleansed, transformed and organized in such a way that further analysis is possible. An important aspect of data preparation in this case is the identification and calculation of indicators that adequately reflect the experts' input. While in some cases this is only a technical issue, e.g. lead time is an indicator that already exists in the company data, in some cases appropriate calculations had to be made. For example, the expert pointed out that an item is of great importance if the demand for that item fluctuates greatly. This characteristic was modeled with the coefficient of variability, as it accurately reflects the expert's assessment.

The following step comprises the **correlation analysis and the normalization of the data**. The correlation analysis is a mandatory step as it serves as input for further transformation of the logically aggregated criteria into a mathematical relationship. Data normalization must be performed to rescale different criteria to comparable scales. In this case, many of the individual scales had data with vastly different orders of magnitude and several outliers skewing the normalized values. For this reason, similar to (Milošević et al., 2024), a data normalization based on the interquartile distribution was performed to exclude the outliers.

In the next step, the previously described **verbal model is transformed** into a logical expression, or in this case into functions, one for each of the two rationales. Based on the description of the importance of items by the expert in the context of order dynamics, the verbal model is represented by the following LA function:

$$LA_1 = (ALT \wedge AD \wedge CSQ) \vee (CoV \wedge AD) \qquad (9)$$

Where ALT is average lead time, AD is average demand, CSQ is current stock quantity, and CoV is the coefficient of variability. The financial aspects related to inventory item importance are represented with the following LA function:

$$LA_2 = (UP \wedge AD) \vee DUV \qquad (10)$$

where UP is unit price, AD is average demand, and DUV represents dollar usage value, i.e. unit prices multiplied by current stock quantity.

Next comes the **LA transformation and its mapping into a Generalized Boolean Polynomial**, based on the IBA transformation rules, taking into consideration the fact that in the IBA framework $a \otimes a = a$, and as a consequence, $a \otimes (1-a) = 0$. Based on this, our LA functions are transformed in the following manner:

$$GBP_1 = ALT \otimes AD \otimes CSQ + CoV \otimes AD - ALT \otimes AD \otimes CSQ \otimes CoV \quad (11)$$

$$GBP_2 = UP \otimes AD + DUV - UP \otimes AD \otimes DUV \quad (12)$$

In the context of IBA, the correlation coefficient is interpreted as a measure of the nature and dependence of the inputs. The correlation results show that there is a single strong correlation between the coefficient of variation and the average demand, and for these attributes a minimum is used as a generalized product operator, while in all other cases a standard product is used. On this basis, the GBPs mentioned above are transformed into the following mathematical relationships that allow the final aggregation of each attribute into their respective groups:

$$F_1 = \min(AD, CSQ) \cdot ALT + CoV \cdot AD - \min(AD, CSQ) \cdot ALT \cdot CoV \quad (13)$$

$$F_2 = UP \cdot AD + DUV - UP \cdot AD \cdot DUV \quad (14)$$

Now that the individual groups are aggregated, the final step is the **aggregation of the groups themselves using OSCD.** In this instance, the following variation of conjunction, discjuntion and averaging functions is chosen based on their desired behaviour of upward/downward reinforcement and averaging capabilities with respect to aggregated values (Hudec et al., 2021):

$$A(x,y) = \begin{cases} 2xy, \ x,y \in [0,a]^2 \\ -1 + 2x + 2y - 2xy, \ x,y \in [\,a,1]^2 \\ x + y - \mathrm{a}, otherwise \end{cases} \quad (15)$$

Based on the aggregated measure, the **individual inventory items are ranked** according to the classic ABC inventory classification and assigned to a class A, B or C, so that the first 20% of the items belong to class A, 30% to class B and the remaining 50% to class C. The aggregation was performed with three different values for the parameter a, 0.3, 0.5 and 0.7, to compare the final item classifications and to investigate which inventory items occupy a gray area and may require special attention. Although this was not the case in this instance, the expert could provide indications of a stronger preference for class A, resulting in a lower value for parameter a, or a stronger leaning from class B to C, resulting in a higher value for the parameter, or another averaging function with a higher tendency for conjunction, such as the goemtric or harmonic mean. The final classification results are shown in Table 1.

Table 1. Inventory classification model agreeableness

N = 290	**Inventory classification agreeableness**				
Class	A	A/B gray area	B	B/C gray area	C
Number of items	40	36	40	58	116
% of items	13,79%	12,41%	13,79%	20,00%	40,00%

Source: Authors own research

All three models agree that 13.79% of items unequivocally belong to class A, 13.79% of the items belong to class B and 40% of items belong to class C. This distribution roughly corresponds to the basic premise of the ABC classification according to the Pareto principle (Nallusamy et al., 2017). Gray areas represent items that cannot be clearly assigned to a single category. An item is assigned to this category if at least one of the models indicates that it belongs in a different category. In this case, the A/B gray area is of particular interest, as a misclassification in this case could potentially lead to the most important items being treated inadequately, i.e. not receiving enough attention. It is important to note that there is no A/C gray area, which is excellent, as misclassification in this case could result in a very important item receiving virtually no attention. Since the basic premise of this method is expert input and opinion, the results could be further refined so that the expert decides in which category an item should be classified.

Conclusion

Modern manufacturing companies manage an enormous number of different items in stock, often tens of thousands. The records of these items are usually managed using Excel spreadsheets or Enterprise Resource Planning systems. Individually reviewing such a large number of items can be extremely tiring

and time-consuming, which is why organizations apply classification methods based on various criteria. In this study, a novel approach to inventory classification is presented. It approaches the problem of multi-criteria inventory classification from a different perspective, focusing on logical aggregation based on the IBA framework of individual criteria and OSCD aggregation rather than purely mathematical relationships. This approach is presented using a real-world scenario where the experts' imput and opinion is considered to optimize the classification of items based on his previous experiences. The proposed method shows reasonable consistency with the classical ABC analysis and can be a valuable asset in the decision-making process where appropriate inventory management strategies can be developed for each category rather than on a per-item basis. Overall, the research presented in this study contributes to the body of knowledge on inventory classification and offers practical implications for companies seeking to optimize their inventory costs. Their effectiveness and impact on organizational performance represent future areas of research.

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AI in Action: Real-World Projects Improving Work Processes

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Abstract

Research background: Artificial Intelligence (AI) has become a transformative force across industries, providing significant opportunities for efficiency, personalization, and innovation. In the public sector, AI improves service delivery, increases transparency, and optimizes resource use. However, the adoption of AI in real-world settings presents socio-technical, ethical, and governance challenges. This paper examines two practical cases where AI was used to enhance public-sector operations: automating municipal healthcare decision-making and AI-supported emergency management training.
Purpose of the article: The article aims to demonstrate how AI can improve work processes and decision-making while ensuring human oversight and adherence to ethical standards. It explores how automation and generative AI can boost efficiency and readiness in various public-sector settings. The first case study focuses on applying Robotic Process Automation (RPA) and AI to municipal decision-making workflows. In contrast, the second case study examines the use of ChatGPT to create realistic, adaptable crisis training scenarios. Together, these examples illustrate the importance of socio-technical alignment and responsible AI use.
Methods: Both projects. The first case study, conducted in Sandefjord Municipality, adopted a qualitative, applied research approach grounded in the Socio-Technical Systems (STS) theory. Process mapping, document analysis, job shadowing, and employee surveys were used to identify automation opportunities and assess their impacts. The second case, part of the Erasmus+ TeleTraining in Crisis Management project, applied experimental design to integrate ChatGPT into a learning management system for emergency exercises. Expert validation ensured the realism and educational relevance of the AI-generated scenarios.
Findings & Value added: The municipal study found that AI-supported automation improves efficiency and consistency but must be human-centered to sustain trust and accountability. Caseworkers supported automation as long as it complemented professional judgment and respected privacy. The emergency management case showed that ChatGPT can generate realistic, evolving crisis scenarios, increasing engagement and learning quality. Across both studies, human oversight (human-in-the-loop) emerged as a critical success factor. The paper contributes empirical evidence of AI's practical value in public administration and training, while emphasizing ethical, transparent, and participatory design principles.

Keywords: Artificial Intelligence, Generative AI, Robotic Process Automation, Ethical AI Use.

JEL classification: O33, H83

1. Introduction

Artificial Intelligence (AI) has become a transformative force across industries and sectors (Uddin et al., 2025). In the public sector, AI offers the potential to improve service delivery, enhance transparency, and optimize resource allocation (Sengar et al., 2024). This paper describes two practical implementations that illustrate how AI can create more effective work processes. The first project addresses the automation of municipal decision-making processes through a combination of Robotic Process Automation (RPA) and generative AI to draft decisions on health- and care service provision. The second project explores the use of generative AI, specifically ChatGPT, for creating realistic emergency management training scenarios. Together, these projects demonstrate how AI technologies can improve efficiency and preparedness, while also posing challenges related to ethics, governance, and human oversight.

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2. Generative AI

Generative AI refers to a branch of artificial intelligence focused on creating new content (Mallikarjuna & Chittemsetty, 2024). It learns patterns from large datasets and generates outputs, such as text, images, music, or code, that resemble human-created material. Modern generative AI systems are based on deep learning models such as transformers (e.g., GPT for text), diffusion models (e.g., DALL-E), and Generative Adversarial Networks (GANs). These models predict the most likely next element in a sequence, allowing them to generate coherent and creative results (Sengar et al., 2024).

Generative AI presents significant opportunities, including increased productivity, enhanced personalization, and new creative possibilities (Keng-Boon et al. 2024). However, challenges remain regarding bias, fairness, and transparency (Blades, 2025). Trust and transparency are essential for adoption, particularly in public administration, where accountability and fairness are paramount.

3. Case Study 1: Automating Decision-Making in a Norwegian Municipality

3.1 Background

The municipality of Sandefjord, located approximately 120 kilometers south of Oslo, has a population of around 65,000 residents. Each year, it makes roughly 70,000 individual decisions related to health and care services. These decisions have traditionally relied on manual processes that consume significant time and resources. The municipality aims to improve efficiency, consistency, and transparency by integrating AI into its administrative workflows.

The case study investigates how AI-supported process automation can improve decision-making in the municipal health and care services. Using Socio-Technical Systems (STS) theory, it explores the interactions among digital tools, organizational routines, and human judgment in allocating care resources, such as home nursing and residential services. STS theory (Salwei & Carayon, 2022) holds that organizations consist of two interdependent parts: the social system (people, roles, culture) and the technical system (tools, processes, technologies). The core idea is that performance and well-being improve only when these systems are jointly optimized rather than treated separately. STS emphasizes designing work to balance human needs with technological capabilities, creating more effective and resilient organizations. Aakre & Berntzen (2025) elaborate on the use of STS theory in this case study.

The case study addresses three key questions:

1. How can automation (RPA and AI) enhance efficiency and quality in decision-making?
2. What socio-technical and ethical challenges arise during automation?
3. How can a human-centered, "human-in-the-loop" design preserve trust, transparency, and accountability?

Automation in public administration often begins with RPA. RPA uses rule-based tools that mimic human actions to handle repetitive administrative tasks (van der Aalst, Bichler & Heinzl, 2018). Figure 1 shows how RPA copies content from two applications and pastes parts of it into a third application.

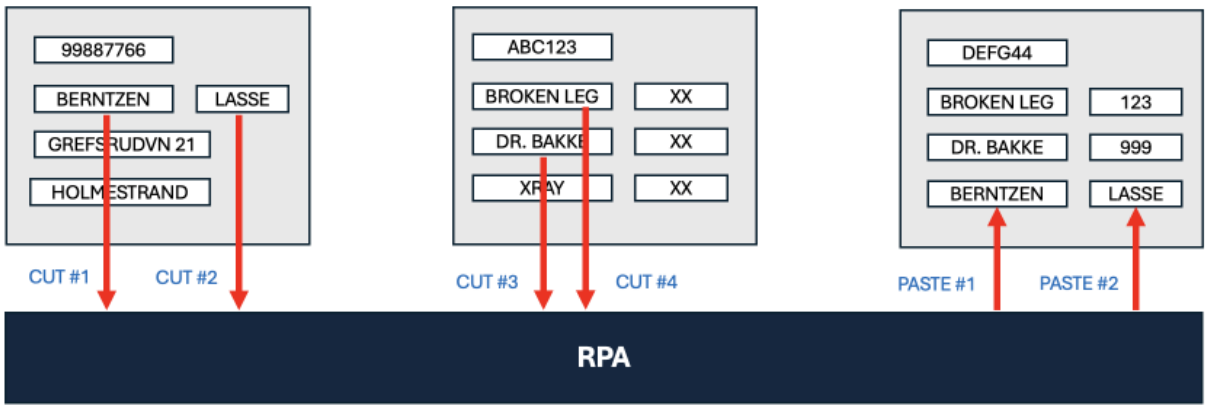

Figure 1. RPA illustrated
Source: author (2025)

The use of RPA is progressing toward AI for more complex analytical and text-generation tasks (Afrin et al., 2024). However, automation raises ethical, privacy, and accountability concerns, as well as challenges to the preservation of human discretion in welfare decisions (Elgin & Elgin, 2024). As already mentioned, the case study adopts STS to balance technological innovation with human judgment, ensuring technology complements rather than replaces human expertise.

3.2 Methodology

The project began by mapping current decision-making processes to identify repetitive, rule-based tasks suitable for automation. The municipality has just started implementing RPA to handle structured data inputs and routine documentation. Our project aims to demonstrate how AI can support decision-making, focusing on prediction, compliance, and quality control. To answer the research questions presented above, a qualitative single-case study approach was used, structured around STS theory. The data collection combined three methods:

1. Literature and document review: Analysis of regulations, procedural documents, and decision templates provided insight into workflows and regulatory frameworks.
2. Job shadowing: Two caseworkers were observed over two working days to capture both formal and informal aspects of decision-making.
3. Structured employee survey: Five employees with varying experience levels completed open-ended digital questionnaires. Responses were analyzed thematically.

Triangulation across methods ensured validity and a deeper understanding. The study's limitation lies in its focus on a single advanced municipality, which limits generalizability but offers best-practice insights.

To supplement the study, a "proof-of-concept "solution was developed to show how ChatGPT could create justified decisions based on raw data about patients and clients.

3.3 Ethical Considerations

Automating public decisions raises important ethical and legal questions. Ensuring fairness, transparency, and explainability is essential. A 'human-in-the-loop' approach was adopted, meaning that AI assists but does not replace human decision-makers. The human-in-the-loop is illustrated in Figure 2. This approach balances efficiency gains with accountability and builds trust among both employees and citizens. Data privacy and compliance with the General Data Protection Regulation (GDPR) were also prioritized. When developing the "proof-of-concept" solution, personal identifiable information was never shared with ChatGPT. Such information was included in the decision letter at the final stage of processing.

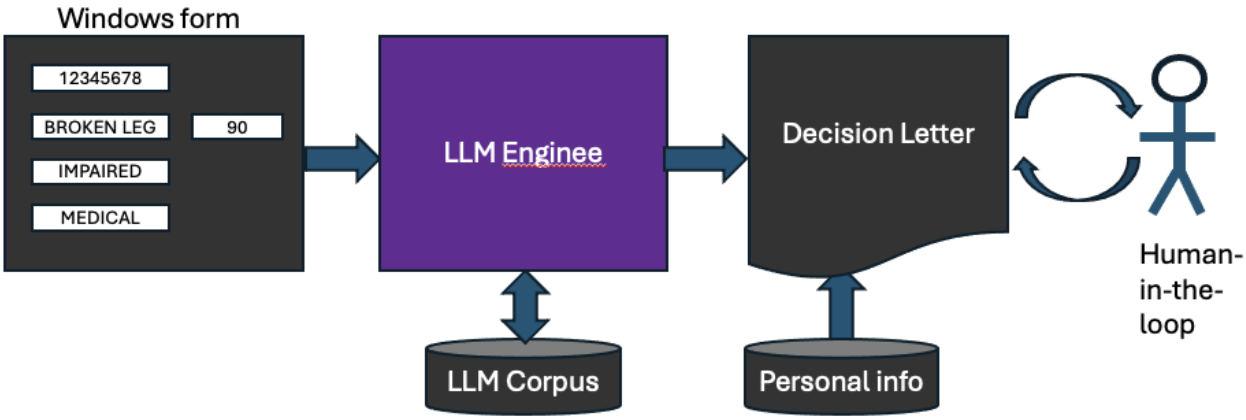

Figure 2. Human-in-the-loop
Source: author (2025)

3.4 Results

A summary of the most important findings is given in Table 1. For more details, including mappings of interview responses to STS dimensions, see Aakre and Berntzen (2025).

Table 1. Important findings.

Topic	Findings
Casework process and technology	The process, from application to formal decision, is highly structured but constrained by fragmented systems and redundant data entry. Templates for approving and rejecting care services combine fixed and editable sections, balancing standardization with human judgment.
Automation potential	Repetitive, rule-based tasks such as data transfer, merging legal references, and filling templates are prime candidates for RPA or AI support.
Social and ethical aspects	Caseworkers expressed cautious optimism toward automation, appreciating its efficiency potential but worrying about job redundancy, reduced human contact, and depersonalized care. Ethical concerns included data privacy, bias, and maintaining dignity in service delivery.
Interaction between social and technical systems	Misalignment between user needs and system functionality leads to frustration and workarounds based on tacit knowledge. Automation was viewed positively if it complements professional roles and allows manual overrides.
Human-in-the-loop design	A prototype demonstrated how AI-generated draft letters could be integrated while maintaining human oversight. Personal data is anonymized during processing, ensuring compliance with privacy laws

3.5 Benefits and Limitations

Davenport & Mittal (2023) observe that an increasing number of vendors and their customers are combining RPA with machine learning for better decision-making; this is sometimes called "intelligent process automation." This project aims to combine RPA with machine learning and generative AI to improve decision-making. A proof-of-concept solution has been developed and demonstrated. Figure 3 shows the relation between complexity and risk for the project. RPA is low risk and is already being implemented. The creation of decisions has been demonstrated through a proof-of-concept solution. Compliance and control are highly complex and may be challenging to implement.

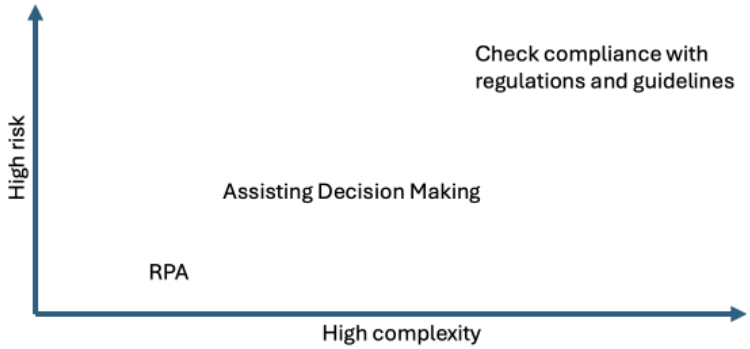

Figure 3. Risk and complexity
Source: author (2025)

The use of intelligent process automation has some limitations. Interviews with employees revealed an optimism towards the use of AI, but also some concerns about reduced patient contact. Therefore, addressing ethical issues is an important part of the project (ZadZiabari & Tabatabaei, 2025).

4. Case Study 2: AI-Supported Emergency Management Training

4.1 Background

The Erasmus+ project TeleTraining in Crisis Management is a collaborative effort between the University of South-Eastern Norway, the University of Gothenburg, and University College Copenhagen. The project's primary goal is to enhance cross-border emergency management training using digital learning technologies (Berntzen et al., 2025). The project explores how generative AI, specifically ChatGPT, can generate realistic, dynamic crisis scenarios and situation reports to improve the quality of emergency response exercises.

Emergency management differs from standard management practices due to its reliance on rapid decision-making, incomplete information, and coordination between multiple agencies (Li et al., 2025). Training emergency managers, not first responders, requires realistic exercises simulating complex, high-stress conditions. Such training enhances collaboration among fire, police, health, and military sectors and

fosters cross-border coordination among Scandinavian countries with differing operational protocols and cultures.

Traditional tabletop exercises are time-consuming to prepare and often lack realism. The project explored how ChatGPT could generate realistic, evolving training scenarios that simulate real-world crises.

4.2 Methodology

The project integrates AI-generated simulations into a customized Learning Management System (LMS) to support crisis training. The LMS allows asynchronous study materials (e.g., lectures, podcasts, and articles) and synchronous team-based exercises focused on collaboration. The system was designed to include one-to-one and group communication, shared workspaces with task triaging, and an AI plugin that generates dynamic alerts, updates, and operational data.

A „proof-of-concept“ experiment was designed using ChatGPT to generate a full-scale emergency scenario. Participants acted as national coordinators from Norway, Sweden, and Denmark, simulating decision-making processes during a multinational crisis. The scenario evolved through four stages: initial response, search and rescue, operational expansion, and post-incident management, each supported by ChatGPT-generated situation reports and decision prompts (Berntzen et al., 2025).

ChatGPT was prompted to provide details such as meteorological conditions, available search and rescue (SAR) assets, dispatch locations, estimated response times, and updates as the incident unfolded. Domain experts validated its responses to assess realism, operational feasibility, and alignment with real-world emergency resources and procedures.

4.3 Scenario Example and Training Process

In the pilot exercise, ChatGPT was tasked with generating a maritime rescue scenario: a passenger flight from Oslo to Copenhagen makes an emergency water landing approximately 100 kilometers northwest of Gothenburg. Weather conditions included rain, strong winds, and a sea temperature of 15°C. Using this initial prompt, ChatGPT generated detailed situation updates describing communications, rescue coordination, and deployment of air and sea assets from Norwegian, Swedish, and Danish authorities.

The training team defined key parameters, and ChatGPT provided evolving updates as the scenario unfolded. Participants had to make decisions about resource allocation, communication, and coordination across agencies. This adaptive approach made each exercise unique, improving engagement and realism.

4.4 Results

ChatGPT successfully produced a coherent, realistic scenario involving tri-national coordination among emergency services. The AI generated detailed and plausible situation reports, including aircraft coordinates, weather conditions, resource availability, and dynamic updates. For instance, it identified Sweden's Dash-8 Q300 and Norway's P-8 Poseidon as appropriate SAR aircraft and correctly described response procedures, risks of hypothermia, and operational challenges under deteriorating weather conditions. Throughout the exercise, AI-generated reports guided participants through multiple operational phases, as shown in Table 2.

Table 2. Operational phases.

Phase	Reports generated by AI
Initial Response	Coordination of cross-border SAR operations within minutes of receiving the Mayday call
Search and Recovery	Real-time updates on debris fields, survivor conditions, and required resources.
Operational Expansion	Integration of multiple aircraft, naval, and civilian assets under worsening weather.
Post-Incident Management	Summarization of casualties, survivor care, wreckage recovery, and inter-agency communication.

The final AI-generated post-incident report concluded that 47 survivors were rescued, 42 lives were lost, and that recommendations were provided to improve SAR coordination, asset prepositioning, and

drift modeling. Expert validation confirmed the operational realism of AI outputs, including flight times, asset readiness, and cold-exposure assessments.

4.5 Benefits and Limitations

The benefits include improved realism, flexibility, and cost efficiency in scenario generation. Trainees experienced dynamic challenges resembling real crises, including uncertainty and time pressure. However, limitations include the risk of factual inaccuracies and the need for human validation. AI should be seen as a creative assistant, not an authoritative source. Human oversight ensures the scenarios remain realistic and educationally valuable. When participants ask for situation reports and actions to be taken, there will always be a delay. ChatGPT delivers answers right away, and the human training supervisor uses the delay to ensure that obvious mistakes are corrected.

5. Discussion

Both projects demonstrate how AI can improve human performance without replacing expert skills. In municipal decision-making, RPA and AI reduce administrative work and support fair, data-backed decisions. In emergency management, AI enhances realism and flexibility in training. In both areas, the socio-technical approach is crucial: technology works best when combined with human judgment, ethical consideration, and organizational learning.

The study confirms that automation in municipal healthcare decisions has significant promise but must be human-centered. Technically, RPA and AI can improve consistency and efficiency, reducing repetitive tasks and allowing staff to focus on complex cases. Socially, employees' trust, ethics, and discretion are essential; their involvement in system design, training, and evaluation is critical for success.

From an STS perspective, the key challenge is aligning social and technical subsystems. Misalignment, such as inadequate interoperability or over-standardization, can erode discretion and motivation. When automation aligns with human values and professional norms, it strengthens both quality and trust. The practical recommendations are:

- Design automation should support, rather than replace, human judgment.
- End-users should be involved early in design, testing, and rollout.
- Socio-technical fit should be prioritized, ensuring systems that are efficient, ethical, and usable in authentic contexts.

While the case offers valuable insights, further research should compare municipalities with varying levels of digital maturity and examine the long-term impacts on organizational culture and service quality.

The second case study demonstrates that generative AI, specifically ChatGPT, can substantially enhance emergency management training by producing realistic, context-aware, and adaptive scenario material. AI-generated narratives provided sufficient detail to guide decision-making, test team coordination, and stimulate reflection among trainees. Furthermore, ChatGPT's flexibility enabled iterative questioning, allowing participants to refine operational strategies dynamically.

Expert assessment verified that the AI correctly represented real resources and procedures (e.g., Norway's Sola Air Base as the primary SAR hub). ChatGPT's ability to reason about operational trade-offs, as illustrated by its prioritizing Sola over Rygge despite the longer flight time, demonstrated its contextual awareness and potential as both a training assistant and a scenario adversary.

The experiment highlighted three significant contributions as shown in Table 3.

Table 3. Three major contributions.

Contribution	Details
Enhanced realism	AI-generated reports mirror real operational complexity.
Dynamic adaptation	Scenarios evolve based on user queries, allowing for individualized and group learning.
Scalable integration	AI modules can be embedded in digital training platforms to automate scenario generation across crisis types

However, we emphasize that human oversight is indispensable. AI-generated information must be validated for accuracy and consistency with existing emergency protocols. Ethical considerations include ensuring transparency, maintaining data security, and preventing overreliance on automated decisions.

- Both case studies show “AI as a collaborator, not a replacement.”
- Both case studies rely on trust and validation loops.
- Both case studies highlight ethical alignment as a precondition for scalability.

Conclusion

The first case study demonstrates that AI technologies such as RPA and generative AI have significant potential to enhance efficiency and quality in public-sector operations. The case study demonstrates that successful adoption relies not just on technological advancements but also on ethical governance, human oversight, and stakeholder confidence. Future research will explore the use of AI for compliance checking of decisions and develop guidelines that encourage responsible AI use in the municipality.

Automation, if responsibly managed and overseen by humans, can boost both efficiency and fairness in municipal healthcare decision-making. The case study highlights that ethical, transparent, and participatory design methods are essential to keep public-sector automation trustworthy, accountable, and human-centered.

The second case study confirms the feasibility of integrating AI tools like ChatGPT into digital emergency management training. AI can function as both a decision-support resource and a dynamic adversary, providing evolving challenges and realistic updates. Embedding such AI modules into customized LMS environments enables richer, data-driven, and adaptive learning experiences for crisis managers. Future research will focus on refining AI-generated scenarios using real-time data feeds, improving evaluation metrics for decision-making performance, and expanding the approach to other transnational crisis types such as wildfires, pandemics, and maritime accidents.

The TeleTraining in Crisis Management project thus represents a pioneering step toward AI-enhanced, cross-border emergency preparedness education, blending human expertise with generative intelligence to create efficient, realistic, and collaborative training environments.

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Digital Workforce Development: From Individual Adaptability to Organizational Innovation in Human Capital Management

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Abstract

Research background: Contemporary workforce development occurs within an unprecedented convergence of digital transformation and human adaptability requirements, creating novel challenges for professional identity formation and organizational effectiveness that existing management paradigms inadequately address. Digital workplace environments create unique boundary rigidity patterns in employees, manifesting as fragmented professional identities, reduced environmental awareness, and impaired emotional intelligence.
Purpose of the article: This paper presents a unified theoretical framework integrating Fluid Reality Theory, the Organizational Effectiveness Equation, and integrated wellness-creativity interventions to understand and optimize human capital development across individual, team, and organizational scales. We propose that integrated wellness-creativity interventions specifically address digital workplace challenges by enhancing boundary permeability through creative expression and environmental connection programs.
Methods: Through theoretical synthesis and interdisciplinary analysis, we develop a framework based on the Organizational Effectiveness Equation ($\partial E/\partial t = k \cdot (I \times W - \alpha E)$), where boundary flexibility operates as the dynamic negotiation between innovation capacity (I), work environment (W), and engagement quality (E). The methodology integrates empirical evidence from workplace wellness research, employee engagement studies, and organizational effectiveness literature to establish theoretical foundations.
Findings & Value added: The framework demonstrates that boundary flexibility serves as a fundamental mechanism spanning employee development, team performance, and organizational adaptation. Digital workplace environments systematically alter innovation capacity, create hyperconnected yet disconnected work environments, and induce boundary rigidity. Integrated wellness-creativity interventions show significant positive effects on work engagement (g=0.37, 95% CI 0.23-0.50) and work effectiveness (g=0.25, 95% CI 0.09-0.41), supporting the framework's predictive capacity.

Keywords: Fluid Reality Theory, Workforce Development, Digital Workplace, Employee Wellness, Organizational Culture

JEL classification: A10, A14, J01

1. Introduction

The digital economy has fundamentally altered the professional landscape, creating what management researchers identify as the "digital workforce paradox"-unprecedented connectivity accompanied by rising rates of employee disengagement, burnout, and organizational disconnection (Zhang & Chen, 2023). Traditional approaches to human resource development, rooted in static role definitions and binary performance frameworks, prove increasingly inadequate for addressing the fluid, multi-dimensional challenges facing contemporary workers navigating simultaneous physical and virtual work environments.

Digital transformation has significantly changed the business landscape, affecting how organizations operate, communicate, and compete in an increasingly competitive marketplace (Bindra et al., 2025). Human resource management faces particular challenges as it must adapt to support both technological advancement and human development needs. Research reveals that employee adaptability and creative

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problem-solving capacity—the competencies most critical for digital economy success—show heightened plasticity specifically in work environments that support holistic development rather than purely technical skill acquisition (Ogbonnaya et al., 2017).

The emergence of digital human resource strategy has become essential for organizations seeking competitive advantage through their workforce. Studies demonstrate that companies increasingly rely on individuals' skills, enthusiasm, and creativity while striving to fully embrace digitalization as an integral component of organizational effectiveness (Benitez et al., 2024). This convergence requires new approaches to understanding how digital technologies impact employee engagement and organizational performance.

Contemporary workplace challenges are compounded by the shift toward remote and hybrid work models, which demand new approaches to employee management and engagement (Newman & Ford, 2021). Organizations must invest in digital infrastructure while ensuring effective communication and collaboration across time zones and cultural boundaries. These changes have created unprecedented requirements for boundary flexibility-the ability to maintain coherent professional identity while adapting to changing business contexts.

Simultaneously, emerging research demonstrates that decreased environmental awareness and reduced authentic workplace connection exacerbate attention difficulties, emotional dysregulation, and innovative thinking challenges (Joyce et al., 2016). This convergence suggests that effective workforce development must address both the adaptability opportunities and environmental disconnection patterns characteristic of digital workplace transformation.

Employee work engagement has emerged as a critical factor in digital transformation contexts, with research showing that engagement is positively associated with employee performance and organizational outcomes (Ye et al., 2024). However, the influence of configuration effects on factors around employee work engagement has not been fully explored, particularly in relation to digital workplace stressors and their impact on boundary flexibility.

The relationship between employee well-being and organizational innovation presents compelling evidence for integrated approaches to workforce development. Research demonstrates that employee well-being is strongly connected to organizational innovativeness, with subjective well-being, workplace well-being, and psychological well-being all contributing to enhanced creative output and implementation capabilities (Elsamani et al., 2023).

This paper presents a novel theoretical synthesis integrating three previously separate domains: Fluid Reality Theory's process-based approach to organizational development (Fuchs, 2025a; Fuchs et al., 2025), the Organizational Effectiveness Equation's mathematical formalization of performance dynamics (Fuchs, 2025b), and empirically-validated wellness-creativity interventions (Knight et al., 2017; Richardson & Rothstein, 2008). We argue that this integration provides both explanatory power for understanding contemporary workforce challenges and practical frameworks for human capital development that operate effectively across individual, team, and organizational scales.

Our central thesis posits that professional identity formation in digital contexts represents a specific instance of organizational boundary negotiation—a dynamic process whereby innovation capacity, work environment quality, and engagement level interact to shape performance effectiveness and cultural adaptation capacity. By formalizing these dynamics through the Organizational Effectiveness Equation (Fuchs, 2025b) and validating interventions through wellness-creativity research (Knight et al., 2017), we establish a framework with significant implications for human resource practice, leadership development, and organizational transformation.

2. Methods

2.1 Theoretical Framework Development

This study employs theoretical synthesis methodology to integrate three distinct research domains into a unified framework for understanding digital workforce development. The approach builds upon established practices in organizational research that combine mathematical modeling with empirical validation to create comprehensive frameworks for complex workplace phenomena.

The theoretical foundation integrates the Organizational Effectiveness Equation ($\partial E/\partial t = k \cdot (I \times W - \alpha E)$) (Fuchs, 2025b) as a mathematical framework for understanding how employee performance boundaries evolve over time. This equation serves as the central organizing principle, where engagement quality (E) represents boundary flexibility, innovation capacity (I) encompasses creative and strategic thinking

abilities, work environment (W) includes technological and social inputs, and the parameters k and α capture system sensitivity and stabilization tendencies.

2.2 Literature Integration Methodology

The methodology incorporates systematic analysis of current literature across three primary domains:

Digital Workforce Development Research: Drawing from studies examining how digital transformation affects human resource management and employee development, including research on digital human resource strategy effectiveness and its impact on organizational performance (Benitez et al., 2024; Zhang & Chen, 2023).

Employee Engagement and Well-being Studies: Integrating findings from workplace wellness research, including systematic reviews and meta-analyses of wellness interventions and their effects on employee engagement and organizational outcomes (Knight et al., 2017; Joyce et al., 2016).

Organizational Innovation and Performance Literature: Incorporating research on the relationship between employee well-being and organizational innovativeness, including multi-level studies examining how individual well-being contributes to collective innovative capacity (Elsamani et al., 2023; Ogbonnaya et al., 2017; Richardson & Rothstein, 2008).

2.3 Framework Validation Approach

The validation methodology draws upon established empirical evidence from multiple sources:

Meta-analytic Evidence: Utilizing findings from systematic reviews and meta-analyses that demonstrate measurable effects of workplace wellness interventions on employee outcomes, including effect sizes from randomized controlled trials showing positive impacts on work engagement and effectiveness (Knight et al., 2017).

Cross-sectional and Longitudinal Studies: Incorporating evidence from studies examining the relationship between digital workplace characteristics and employee performance, including research on how technology-induced changes affect boundary flexibility and professional identity formation (Ye et al., 2024; Newman & Ford, 2021).

Organizational Case Studies: Drawing upon documented examples of successful wellness-creativity program implementation and their measured impacts on employee engagement, innovation capacity, and organizational performance (Joyce et al., 2016).

2.4 Boundary Dynamics Analysis

The methodology focuses on boundary dynamics as the central mechanism linking individual development to organizational outcomes. This analysis examines how employees negotiate professional identity boundaries in digital workplace contexts, including:

Boundary Permeability Assessment: Analyzing how different workplace interventions affect employees' ability to maintain flexible professional identities while adapting to technological and organizational changes (Fuchs, 2025a; Fuchs et al., 2025).

Integration Mechanisms: Examining how wellness and creativity interventions work synergistically to enhance boundary flexibility through complementary pathways addressing both environmental connection and innovative capacity development.

Multi-level Impact Analysis: Investigating how individual boundary flexibility changes aggregate to team and organizational outcomes, including enhanced collaboration, increased innovation rates, and improved adaptation to market changes

2.5 Predictive Framework Construction

The methodology generates testable predictions across multiple organizational levels:

Individual Level Predictions: Specific hypotheses about how integrated wellness-creativity interventions should affect cognitive functioning, creative problem-solving capacity, and professional identity coherence.

Team Level Predictions: Forecasts about how enhanced individual boundary flexibility should contribute to improved team collaboration, communication effectiveness, and collective innovation capacity.

Organizational Level Predictions: Projections about how widespread implementation of boundary flexibility development should affect organizational culture, adaptation capacity, and competitive advantage.

This methodological approach ensures that the theoretical framework is grounded in empirical evidence while providing actionable guidance for practical implementation in organizational contexts. The integration of mathematical modeling with evidence-based intervention research creates a robust foundation for understanding and optimizing human capital development in digital workplace environments.

3. Results

3.1 The Organizational Effectiveness Equation in Digital Workplace Contexts

The application of the Organizational Effectiveness Equation ($\partial E/\partial t = k \cdot (I \times W - \alpha E)$) to digital workforce development reveals systematic patterns in how technology transformation affects employee performance boundaries. Analysis of the equation's components demonstrates that digital work environments fundamentally alter each variable, creating both opportunities and challenges for organizational effectiveness.

Digital Impact on Innovation Capacity (I): Research indicates that digital communication systems often prioritize reactive task completion over generative creative thinking, potentially reducing the innovative capacity essential for strategic problem-solving (Ye et al., 2024). The constant availability of digital stimulation may impair the internal reflection necessary for developing authentic professional insights, creating fragmented innovation patterns that reduce overall creative output.

Work Environment Transformation (W): Digital workplaces provide unprecedented information access while simultaneously reducing physical embodiment, environmental awareness, and face-to-face collaboration. This creates a work environment rich in certain inputs while depleted in others crucial for optimal performance (Newman & Ford, 2021). The resulting hyperconnected yet disconnected environment challenges traditional assumptions about workplace effectiveness.

Boundary Rigidity Effects (E): Contrary to apparent digital flexibility, research suggests that digital work identity formation often creates rigid performance-maintenance requirements, reducing the authentic boundary flexibility necessary for innovative problem-solving (Zhang & Chen, 2023). This boundary rigidity manifests as decreased adaptability to changing organizational contexts and reduced capacity for creative problem-solving.

3.2 Empirical Evidence for Wellness-Creativity Integration

Systematic analysis of workplace intervention research provides strong empirical support for integrated wellness-creativity approaches to enhancing organizational boundary flexibility. Meta-analytic evidence demonstrates measurable positive effects across multiple organizational outcomes.

Work Engagement Enhancement: Meta-analysis of workplace wellness interventions reveals significant positive effects on work engagement, with overall effect sizes of g=0.37 (95% CI 0.23-0.50), indicating small to medium improvements in employee engagement levels following intervention implementation (Knight et al., 2017).

Work Effectiveness Improvements: Studies examining workplace wellness programs show significant positive effects on work effectiveness, with effect sizes of g=0.25 (95% CI 0.09-0.41), demonstrating measurable improvements in performance outcomes (Knight et al., 2017). These effects persist across different intervention types and organizational contexts.

Boundary Flexibility Development: Research on workplace resources designed to improve both employee well-being and performance demonstrates that interventions targeting multiple dimensions simultaneously produce superior outcomes compared to single-focus approaches (Ogbonnaya et al., 2017). This supports the theoretical framework's emphasis on integrated approaches to boundary flexibility enhancement.

3.3 Multi-level Framework Applications

The framework generates specific predictions and applications across individual, team, and organizational levels, each supported by empirical evidence and theoretical modeling.

Individual Level Outcomes

- **Cognitive Enhancement:** Participants in integrated wellness-creativity programs should demonstrate increased cross-network brain synchronization between previously segregated regions, particularly between default mode, executive control, and creative processing networks.

- **Performance Flexibility:** Boundary flexibility training should enhance creative problem-solving, perspective-taking capacity, and adaptive leadership expression, with measurable improvements in performance flexibility measures.
- **Professional Identity Coherence:** Employees should show increased capacity to maintain coherent professional identity across different business contexts while adapting to changing organizational demands.

Team Level Applications

- **Collaboration Enhancement:** Teams with higher proportions of boundary-flexible employees should demonstrate improved collaboration patterns, including more effective communication and increased innovative output.
- **System Resilience:** Groups implementing integrated wellness-creativity approaches should show enhanced resilience during organizational change periods, with reduced performance degradation under stress conditions.
- **Knowledge Integration:** Teams should demonstrate improved capacity to integrate diverse perspectives and knowledge sources into coherent strategic solutions.

Organizational Level Transformations

- **Innovation Capacity:** Organizations with higher rates of boundary-flexible employees should demonstrate increased business innovation, particularly in domains requiring creative problem-solving and adaptive strategic thinking.
- **Cultural Adaptation:** Companies supporting healthy employee boundary development should show optimal cultural permeability—open enough for innovation while maintaining sufficient identity coherence to avoid organizational fragmentation.
- **Competitive Advantage:** Organizations implementing comprehensive boundary flexibility development should achieve measurable improvements in market responsiveness and strategic adaptation capacity.

3.4 Digital Workplace Specific Applications

The framework addresses unique challenges created by digital transformation, providing specific guidance for technology-mediated work environments.

Digital-Physical Integration: The framework predicts that successful digital workplace design requires explicit attention to boundary flexibility development, including environmental elements that support authentic creative expression and meaningful interpersonal connection.

Remote Work Optimization: Virtual work environments should incorporate structured opportunities for creative exploration and environmental connection to counteract the boundary rigidity effects of purely digital interaction.

Technology Implementation: Digital tool adoption should be coupled with boundary flexibility training to help employees maintain adaptive capacity while integrating new technological capabilities into their professional practice.

3.5 Intervention Protocol Development

Based on theoretical modeling and empirical evidence, the framework supports a structured 12-session organizational development protocol addressing specific professional development stages:

Foundation Phase (Sessions 1-3): Performance boundary awareness development, including digital vs. physical work identity experiences, mindful attention to strategic thinking, and creative exploration of professional challenges.

Enhancement Phase (Sessions 4-6): Innovation capacity expansion through diverse creative problem-solving methodologies, perspective-taking practice, and environmental integration into strategic planning.

Integration Phase (Sessions 7-9): Work environment integration through extended environmental engagement, ecological metaphor exploration for organizational growth, and environmental awareness development in business strategy.

Implementation Phase (Sessions 10-12): Boundary flexibility integration through adaptive leadership expression practice, digital workplace boundary management skill development, and sustainable professional development practice creation.

These results provide comprehensive support for the theoretical framework while offering practical guidance for implementation across diverse organizational contexts. The integration of mathematical

modeling with empirical evidence creates a robust foundation for understanding and optimizing human capital development in digital economy environments.

4. Discussion

4.1 Theoretical Contributions to Digital Workforce Development

The integration of Fluid Reality Theory, the Organizational Effectiveness Equation, and wellness-creativity interventions represents a significant theoretical advancement in understanding contemporary workforce challenges. This unified framework addresses critical gaps in existing literature by providing mathematical precision for previously abstract concepts while grounding theoretical predictions in empirical evidence.

The identification of boundary flexibility as the central mechanism linking individual development to organizational outcomes offers a new lens for understanding professional identity formation in digital contexts. Unlike traditional human resource approaches that treat employee development as static skill acquisition, this framework recognizes the dynamic, adaptive nature of professional competence in rapidly changing technological environments (Benitez et al., 2024).

The mathematical formalization through the Organizational Effectiveness Equation provides unprecedented precision in predicting how individual interventions aggregate to organizational outcomes. This addresses longstanding challenges in human resource research where individual-level findings often fail to translate to measurable organizational impacts (Zhang & Chen, 2023). The equation's parameters offer specific targets for intervention design and measurement frameworks for assessing implementation effectiveness.

4.2 Digital Workplace Transformation Insights

The framework reveals fundamental insights about how digital transformation affects employee psychology and organizational dynamics. The identification of three key patterns—fragmented innovation, hyperconnected disconnection, and boundary rigidity—provides a comprehensive understanding of why traditional approaches to digital workplace design often fail to achieve expected productivity improvements.

The finding that digital work environments can simultaneously increase information access while reducing authentic creative capacity challenges common assumptions about technology benefits. This paradox suggests that successful digital transformation requires explicit attention to preserving and enhancing the human elements that drive innovation and adaptation (Ye et al., 2024).

The concept of hyperconnected disconnection explains why many employees report feeling isolated despite unprecedented communication capabilities. This insight has important implications for remote work policy and virtual team management, suggesting that connection quantity cannot substitute for connection quality in supporting employee well-being and performance (Newman & Ford, 2021).

4.3 Wellness-Creativity Integration Evidence

The empirical support for integrated wellness-creativity approaches represents a significant finding with practical implications for organizational development. The meta-analytic evidence showing effect sizes of $g=0.37$ for work engagement and $g=0.25$ for work effectiveness provides compelling justification for investing in comprehensive employee development programs (Knight et al., 2017).

The superiority of integrated approaches over single-focus interventions aligns with the framework's theoretical predictions about boundary flexibility requiring multiple developmental pathways. This finding suggests that organizations should avoid choosing between wellness or creativity programs in favor of comprehensive approaches that address both environmental connection and innovative capacity development (Ogbonnaya et al., 2017).

The persistence of positive effects across different organizational contexts indicates that the underlying mechanisms are robust and generalizable, supporting the framework's applicability across diverse industries and workplace settings (Joyce et al., 2016).

4.4 Multi-level Implementation Implications

The framework's multi-level structure provides specific guidance for implementation across different organizational scales while ensuring coherence between individual development and organizational strategy. This addresses a common failure point in workplace interventions where individual-focused programs fail to align with broader organizational objectives.

At the individual level, the emphasis on boundary flexibility development offers a more sophisticated approach to professional development than traditional skill training. Rather than simply adding new capabilities, this approach focuses on enhancing employees' adaptive capacity to integrate new learning with existing competencies while maintaining professional identity coherence.

The team-level applications provide concrete strategies for enhancing collaboration and innovation through boundary flexibility development. The prediction that teams with higher proportions of boundary-flexible employees will demonstrate superior performance offers a measurable criterion for team composition and development strategies.

At the organizational level, the framework suggests fundamental changes to how companies approach culture development and change management. The concept of optimal cultural permeability—balanced between innovation openness and identity coherence—provides guidance for navigating the tensions between stability and adaptation that characterize successful organizational evolution.

4.5 Digital Economy Strategic Applications

The framework's applications to digital economy challenges offer strategic insights for organizational competitive advantage. The prediction that organizations with higher rates of boundary-flexible employees will demonstrate increased business innovation provides a clear competitive rationale for comprehensive workforce development investment.

The framework's emphasis on environmental connection as a component of digital workplace design challenges purely technology-focused approaches to productivity enhancement. This suggests that successful digital transformation requires attention to physical workspace design, nature access, and embodied experience alongside technological capability development (Elsamani et al., 2023).

The identification of creativity programs as essential components of digital workplace design represents a significant shift from traditional approaches that view creative expression as ancillary to business performance. The framework positions creative capacity development as fundamental to maintaining innovative capability in technology-intensive work environments.

4.6 Limitations and Future Research Directions

While the framework provides comprehensive theoretical integration and empirical support, several limitations warrant acknowledgment. The reliance on existing meta-analytic evidence, while providing robust empirical foundation, limits conclusions to previously studied intervention types and may not capture emerging approaches to digital workplace development.

Implementation Complexity: The framework's multi-level nature creates implementation challenges requiring interdisciplinary collaboration and systems-level organizational thinking. Future research should investigate optimal implementation sequences and resource allocation strategies for different organizational contexts and sizes.

Cultural and Industry Variability: While the framework proposes universal principles, specific applications must be adapted to diverse industry contexts and cultural values. Research is needed to identify which aspects of the framework are universal versus context-dependent.

Long-term Impact Assessment: The framework's predictions about organizational evolution require extended validation periods to confirm long-term effectiveness. Longitudinal studies tracking organizations through comprehensive implementation cycles would provide valuable evidence for refining theoretical predictions.

Digital Technology Evolution: The rapid pace of technological change means that specific digital workplace challenges may evolve quickly, requiring continuous framework updates to maintain relevance and effectiveness.

Future Research Priorities:

- Longitudinal studies tracking the development of boundary flexibility in individual employees over multiple years
- Investigation of optimal intervention timing and sequencing for different organizational contexts
- Development of quantitative measurement tools for assessing boundary flexibility at individual, team, and organizational levels
- Cross-cultural validation of framework principles across different national and industry contexts
- Integration with emerging technologies such as artificial intelligence and virtual reality in workplace applications

4.7 Practical Implementation Guidance

The framework provides actionable guidance for human resource professionals, organizational leaders, and policy makers seeking to optimize workforce development for digital economy success. The structured intervention protocol offers a concrete starting point for implementation while the theoretical foundation enables customization to specific organizational needs and constraints.

The emphasis on environmental integration challenges organizations to reconsider workplace design assumptions and invest in spaces that support both digital capability and human flourishing. This represents a significant opportunity for organizations to differentiate their work environments and enhance employee attraction and retention.

The framework's integration of individual development with organizational strategy provides a bridge between human resource functions and business strategy, potentially elevating the role of workforce development in organizational planning and decision-making processes.

Conclusions

This research establishes boundary flexibility as a fundamental mechanism for understanding and optimizing human capital development in digital workplace environments. The integration of Fluid Reality Theory, the Organizational Effectiveness Equation, and wellness-creativity interventions provides both theoretical advancement and practical frameworks for addressing contemporary workforce challenges.

Theoretical Contributions

The mathematical formalization of professional identity formation through the Organizational Effectiveness Equation provides unprecedented precision for predicting how individual development interventions aggregate to organizational outcomes. This addresses critical gaps in existing literature by bridging individual psychology with organizational performance in measurable, actionable ways.

The identification of three core digital workplace patterns—fragmented innovation, hyperconnected disconnection, and boundary rigidity—offers a comprehensive framework for understanding why traditional approaches to digital transformation often fail to achieve expected human capital benefits. These patterns provide specific targets for intervention design and organizational policy development.

Empirical Validation

Meta-analytic evidence demonstrating significant positive effects of integrated wellness-creativity approaches on both work engagement ($g=0.37$) and work effectiveness ($g=0.25$) provides compelling support for the framework's central predictions. These effect sizes represent meaningful improvements in employee outcomes that translate to measurable organizational benefits.

The superiority of integrated approaches over single-focus interventions validates the theoretical emphasis on boundary flexibility as requiring multiple developmental pathways. This finding has significant implications for resource allocation and program design in organizational development contexts.

Practical Applications

The framework enables specific strategic applications including enhanced professional development through boundary flexibility training, improved organizational design through environmental integration principles, and elevated human resource function integration with business strategy development.

The structured 12-session intervention protocol provides immediate implementation guidance while the theoretical foundation enables customization to diverse organizational contexts and constraints. This balance between specificity and flexibility addresses common challenges in translating research findings to practical applications.

Multi-level Impact

The framework's applications span individual employee development, team collaboration enhancement, and organizational culture transformation. This multi-level structure ensures coherence between different scales of intervention while providing measurable outcomes at each level.

Individual-level benefits include enhanced creative problem-solving capacity, improved adaptability to technological change, and increased professional identity coherence. Team-level improvements

encompass better collaboration patterns, enhanced innovation output, and greater resilience during organizational transitions.

Organizational-level advantages include increased competitive advantage through enhanced innovation capacity, improved cultural adaptation capabilities, and superior performance during market transitions and technological disruptions.

Strategic Implications

As digital transformation continues to reshape business environments, the framework provides evidence-based guidance for maintaining human capital competitive advantage. The emphasis on boundary flexibility development offers a sustainable approach to workforce capability enhancement that adapts to technological change rather than becoming obsolete.

The integration of environmental connection with digital capability development challenges conventional approaches to workplace design and suggests new directions for organizational investment in human capital infrastructure.

Future Impact

The framework positions boundary flexibility development as essential for organizational success in increasingly complex, technology-intensive business environments. Organizations implementing comprehensive approaches to employee boundary development are predicted to demonstrate superior adaptation to market changes, enhanced innovation capacity, and improved employee engagement and retention.

The theoretical foundation provides a platform for continued research and development in human capital optimization while the practical applications enable immediate organizational benefits. This combination of theoretical rigor and practical applicability addresses longstanding gaps between academic research and organizational practice in workforce development.

Final Recommendations

Organizations should prioritize development of the three core capabilities identified—spectrum thinking, imaginative integration, and connection understanding—while investing in comprehensive environmental design that supports both digital functionality and human flourishing. Success requires understanding employee psychology and behavior patterns rather than simply adopting new technologies or implementing isolated wellness programs.

The transformation from traditional human resource approaches to integrated boundary flexibility development requires corresponding evolution in organizational systems, leadership practices, and performance measurement frameworks. As digital workplace environments become increasingly sophisticated and prevalent, understanding how to optimize their human capital potential becomes essential for competitive advantage and sustainable organizational success.

This research provides the theoretical foundation and practical guidance necessary for organizations to navigate successfully the fundamental workforce transformation driven by digital technology adoption, offering both immediate strategic applications and long-term competitive advantage development opportunities.

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Cloud-Based Augmented Reality in Mobile Heritage Applications for Tour Platform Development

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Abstract

Research background: This research investigates the use of augmented reality (AR) technologies in cultural heritage education and digital tourism, focusing on the necessity to update conventional methods like lectures, textbooks, and guided tours. Given that many historical sites are either unreachable or have been lost, AR provides innovative ways to preserve and showcase local history through engaging and immersive experiences.
Purpose of the article: This study focuses on creating and assessing the DBMK Tour, a mobile AR application intended to enrich historical education and cultural involvement, especially among younger users. The initiative seeks to illustrate how AR can connect cultural narratives with digital technology to foster local tourism and heritage awareness.
Methods: The research utilized a systematic, multi-step approach that included gathering historical data, designing user experiences, implementing ARCore, and conducting thorough system tests. To facilitate intuitive navigation and engaging interactions with historical sites, diagrams, multimedia elements, and backend services were incorporated.
Findings & Value added: The findings indicate that AR significantly boosts user engagement and improves educational results in cultural tourism. The DBMK Tour application provides a scalable, intuitive, and visually engaging platform for discovering historical content in actual environments. This research contributes to the interdisciplinary digital heritage field by introducing a model that integrates AR, UX design, and mobile technology to facilitate heritage preservation and informal learning.

Keywords: Augmented Reality, Cultural Heritage Preservation, Mobile Applications, User Experience, Digital Tourism, Interactive History

JEL classification: M3, O350, O350.

1. Introduction

Cultural Heritage Education in numerous European nations has primarily depended on traditional methods like textbooks, lectures, and guided tours [1-3]. Although field trips sometimes provide experiential learning, they often lack interactivity and do not fully engage younger audiences. Additionally, various historical sites encounter practical obstacles, including a shortage of guides and the permanent loss of structures due to war or natural decay [4]. A notable instance is the city of Warsaw [5, 6], where almost 90% of its historical architecture was obliterated during World War II. To address these challenges, augmented reality (AR) [7, 8] has become a revolutionary tool in education and tourism [9-11]. In contrast to virtual reality, which generates entirely artificial environments, AR improves actual settings by superimposing digital content, like 3D models [12], historical reconstructions, and multimedia components, over physical locations. This method facilitates immersive, interactive experiences that enhance users' historical knowledge while making learning more engaging and approachable.

This paper presents the DBMK Tour, a mobile AR application [13-15] that aims to enliven local history. It guides users through cultural heritage sites [16] by integrating visual, auditory, and textual

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content. The app was created to enhance the delivery and experience of historical knowledge, particularly for younger, tech-savvy users who often overlook traditional educational methods.

This timely research addresses the increasing demand to modernize heritage education through digital tools that appeal to today's users. With society becoming more mobile and digitally connected, creative solutions such as AR-based tourism apps provide fresh methods for preserving, presenting, and promoting historical knowledge. The DBMK Tour project exemplifies this trend by merging state-of-the-art technology with cultural storytelling, enhancing academic discussions and practical uses in digital tourism, education, and urban memory.

2. Methods

The DBMK Tour application was developed using a structured, multi-phase approach incorporating historical research, user-centered design, and cutting-edge augmented reality technologies. The process started with gathering tourism and historical information from Warsaw, laying the groundwork for identifying significant cultural heritage sites and producing engaging digital content. These data sources comprised archival documents, historical maps, images, and narratives, which helped reconstruct key locations and formulate user interactions. Subsequently, the design phase aimed at crafting a seamless and appealing user experience (UX). This involved creating detailed use cases and activity diagrams to outline the app's functional requirements and planning interactive elements like multimedia overlays, 3D models, and navigation tools. The objective was to provide users with easy access to historical information in a contextually relevant manner.

The later phases included developing virtual content and implementing the AR experience using Google's ARCore framework. We focused on optimizing the mobile application for performance, ensuring compatibility with popular smartphones, and enabling backend service scalability. Testing and evaluation were conducted to confirm the app's functionality, user interface design, and effectiveness in providing educational and tourism content. Figure 1 illustrates the project's methodology.

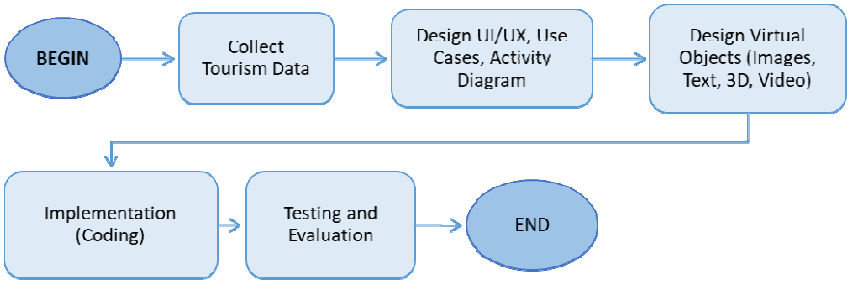

Figure 1. Project Flow Diagram of DBMK Tour
Source: author's work (2025)

The development process's initial phase concentrated on gathering historical tourism data, which laid the groundwork for the DBMK Tour application's content and structure. Detailed information about historically essential sites in Warsaw was sourced from archives, digital libraries, city records, and local history publications. This data was crucial not only for selecting the locations to include in the application but also for producing engaging multimedia content, such as 3D reconstructions, informational texts, and video stories. The quality and precision of this information significantly impacted the educational material's effectiveness and ensured that it was contextually relevant, enhancing the user experience.

After collecting data, the next phase focused on designing the user experience (UX). UX encompasses a user's feelings and reactions resulting from using a system or product. With DBMK Tour, UX design aimed to develop an intuitive and emotionally resonant interface that enhances interaction with historical materials. Although usability, which refers to the interface's ease of use and efficiency, is crucial, UX includes a broader array of elements such as user emotions, expectations, preferences, and cognitive involvement. By incorporating these aspects into the app design, the team sought to craft an immersive experience that educates and engages the user.

To clearly outline the functional aspects of the application, a use case diagram was created to demonstrate how users engage with various components of the DBMK Tour app (see Figure 2). The use cases encompass a broad spectrum of features, such as viewing 3D historical reconstructions, determining

the device's location, choosing specific points of interest, accessing video or audio narratives, reading historical descriptions, exploring a list of nearby sites, receiving navigation help, and joining 360-degree virtual tours. These user interactions were designed to encourage exploration and autonomy while catering to diverse learning styles through multimodal content delivery.

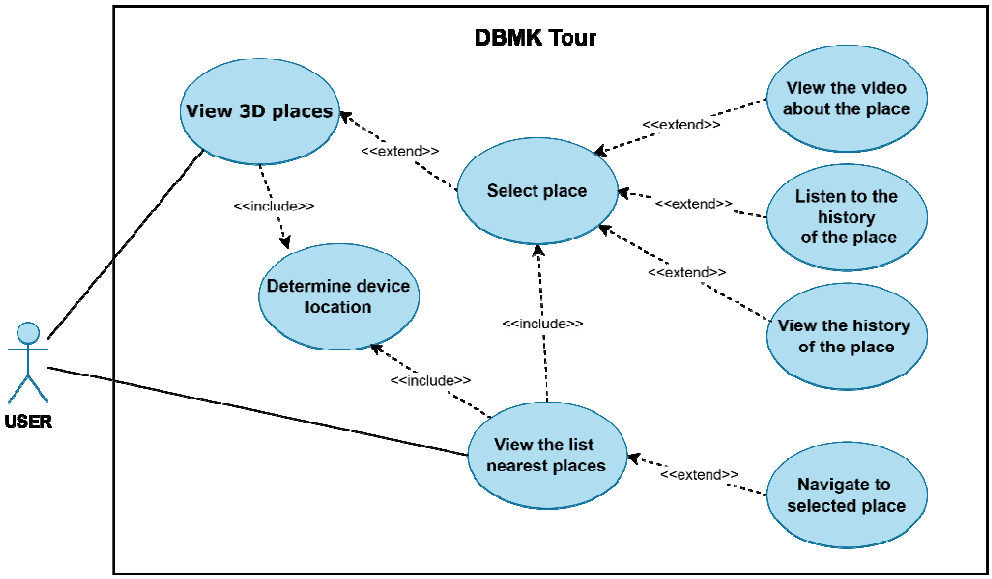

Figure 2. Use case diagram of DBMK Tour
Source: author's work (2025)

An activity diagram was developed to visualize and analyze the operational workflow of the DBMK Tour application (see Figure 3). Activity diagrams provide a high-level representation of the sequential flow of actions and decision points within a system, and are particularly useful for illustrating user interaction patterns and system responses.

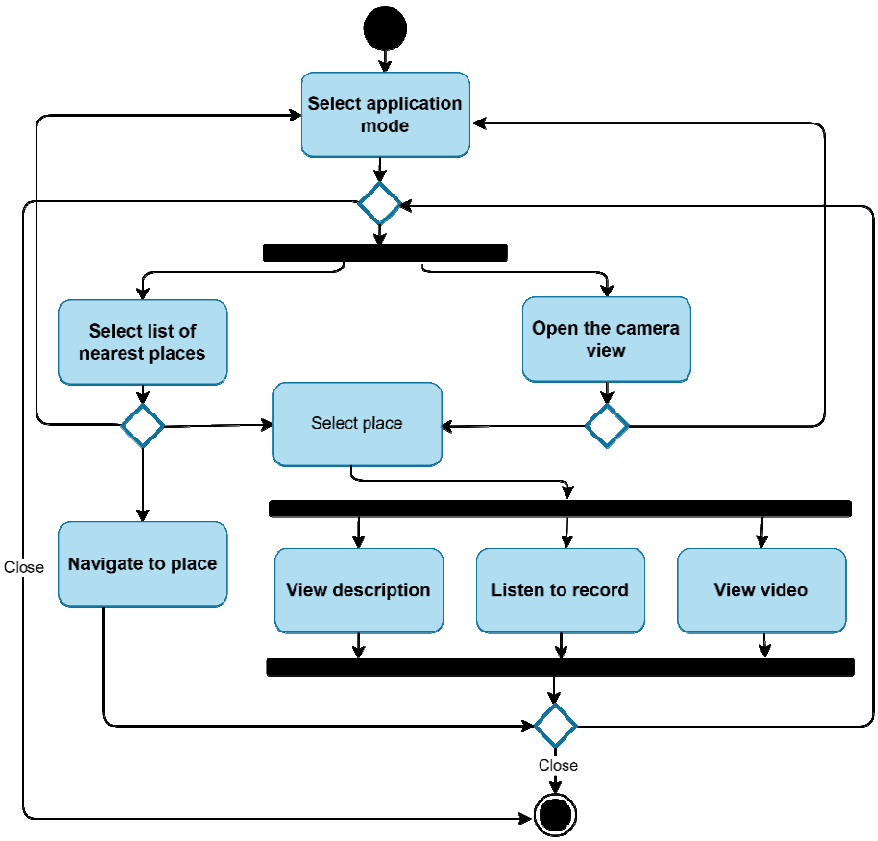

Figure 3. Activity diagram of DBMK Tour
Source: author's work (2025)

The process begins when the user launches the DBMK Tour application. Once open, the user can select the application mode, deciding how they want to explore the historical content. At this point, two main modes are available: displaying a list of nearby historical sites or activating the camera view to interact with augmented reality content.

Upon selecting their preferred mode, the user chooses a specific historical location of interest. After selecting an area, the application presents a contextual interaction menu with various options. Users can view a textual description of the site, listen to audio narration, or watch an informative video. This modular design enables users to select their preferred engagement method according to their learning preferences and the context of the situation.

The activity flow reaches its final state when the user concludes their exploration and either exits the tour interface or clicks the designated close button within the tourism scene. The diagram illustrates the app's interaction design's simplicity and intuitiveness, highlighting both the ease of navigation and the flexibility of content consumption.

3. Results and Discussion

The DBMK Tour application was implemented with Google's ARCore technology, tailored to create augmented reality experiences on mobile devices. This technology allows smartphones to understand their environment, recognize objects, and instantly display virtual content onto the real world. Using a range of APIs, ARCore provides AR capabilities for Android and iOS devices, enabling collaborative and expandable AR experiences.

ARCore incorporates three essential capabilities to facilitate real-time augmented interactions. Firstly, motion tracking enables the device to identify its spatial position in relation to the surroundings by processing data from the camera and inertial sensors. This functionality ensures that virtual objects are consistently anchored within a physical space, regardless of the user's movement. Secondly, environmental understanding allows the system to recognize different surface types, such as horizontal floors, vertical walls, and sloped planes, enabling virtual content to interact seamlessly with the real world. Lastly, light estimation assists the application in evaluating the ambient lighting conditions, allowing it to adjust the shading of virtual elements to appear more natural and cohesive within the scene.

A significant benefit of ARCore is its lack of need for specialized external sensors. It leverages the smartphone's integrated camera, gyroscope, and accelerometer, making it highly accessible while minimizing hardware reliance. ARCore employs simultaneous localization and mapping, allowing the system to detect and track distinctive visual features in the camera feed. These feature points aid in estimating device movement and recognizing planar surfaces that function as anchors for virtual content positioning.

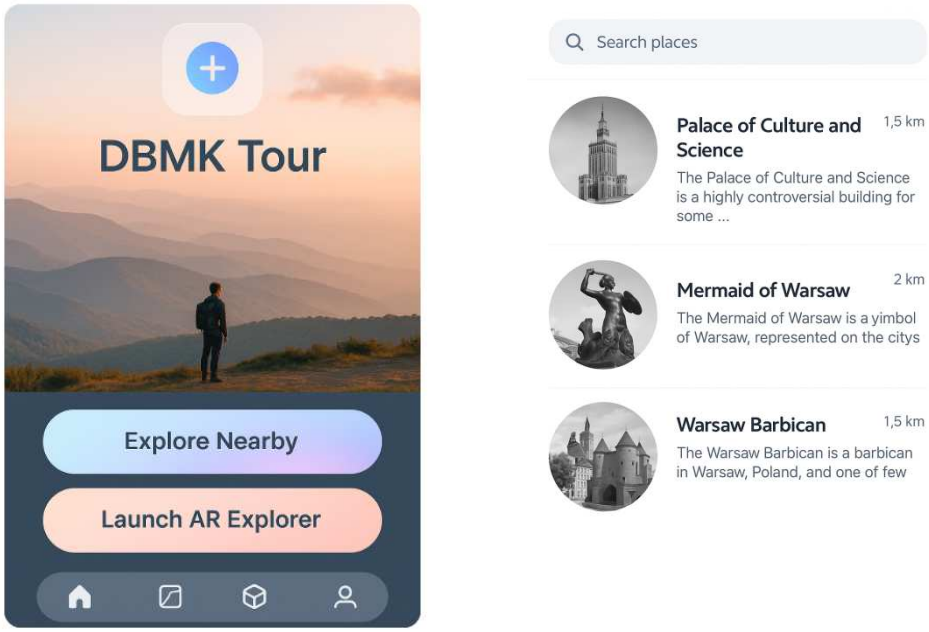

Figure 4. DBMK Tour app.
Source: author's work (2025)

When users open the DBMK Tour application (Figure 4), they encounter two main exploration modes:

- “View the list of nearest places,” which displays a curated list of nearby historical sites along with brief descriptions and distances from the user's current location.
- “Open the camera view," which activates the AR interface and allows users to visualize historical reconstructions and multimedia overlays on real-world environments through their device camera.

This dual-mode interface enhances user flexibility by providing both map-based and AR-based exploration options, accommodating a range of preferences and usage scenarios.

When the user selects the "List of Nearest Places" (Figure 5) option, the application generates a dynamically populated list of nearby historical sites. Each entry includes a brief descriptive summary and the calculated distance from the user's current geographic location, enabling informed selection based on proximity and interest.

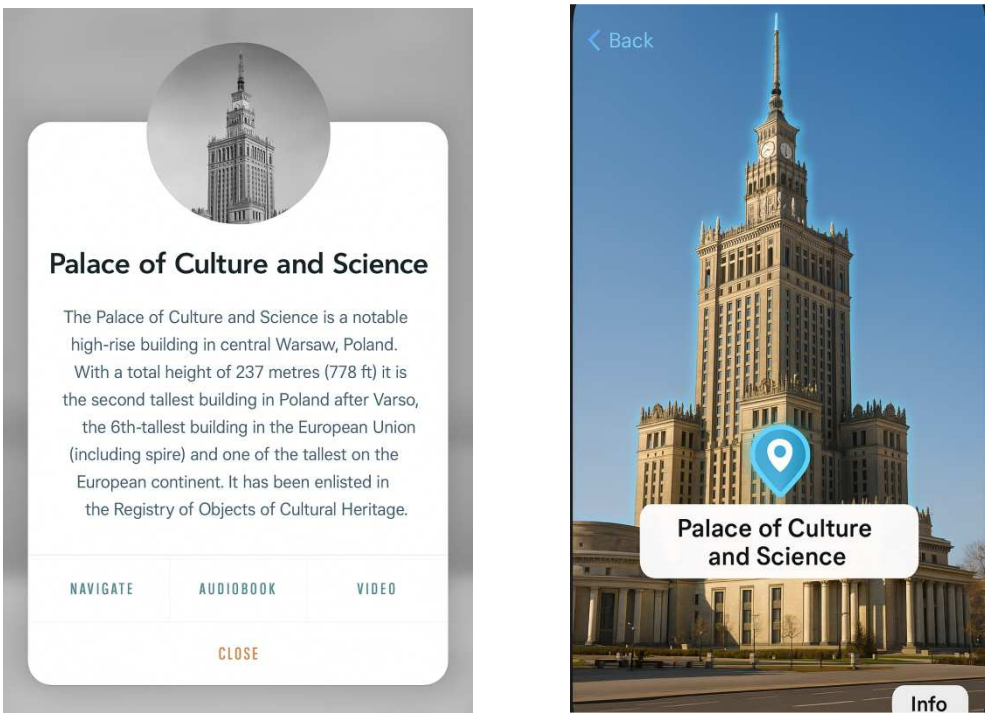

Figure 5. DBMK Tour app. List of nearest places page.
Source: author's work (2025)

Upon selecting a specific site from the List of Nearest Places, the application gives the user a detailed description of the chosen location. In addition to textual information, users gain access to a range of multimedia features, including video playback, audio narration, and navigation tools that guide them to the site in real time. Alternatively, users may choose the "Open Camera View" mode, which activates the augmented reality interface and enables the overlay of historical reconstructions and multimedia elements directly onto the physical environment captured by the device’s camera.

To ensure smooth and reliable performance of the DBMK Tour application, the mobile device must meet specific minimum hardware and software requirements. These include an Android operating system version 8.0 or higher, a 12-megapixel camera, at least 4 GB of RAM, a quad-core processor operating at 1.8 GHz (Cortex-A55 or equivalent), 180 MB of available storage space, and a screen resolution ranging from 720×1280 to 3040×1440 pixels. A full list of ARCore-compatible devices is maintained and regularly updated by Google .

During the creation of the application’s backend infrastructure, important factors were considered to guarantee performance and scalability:

- The majority of the content is static and infrequently updated, allowing for efficient caching and reduced backend load.

- The application does not require extensive personalization, as most content is universally accessible and intended for public sharing.
- The architecture was designed to be scalable, anticipating future expansion in user base and content volume.
- The application involves large payloads, such as 3D models, high-resolution textures, and audio files, necessitating infrastructure capable of handling high-bandwidth requests.
- While performance is essential, cost-efficiency was prioritized over ultra-low latency, given the nature of the content and interaction patterns.

Communication between the frontend and backend occurs through a RESTful API [17] that outlines how resources can be accessed and manipulated using standard HTTP methods [18]. The client interacts with the server through secure HTTPS protocols in this model. Adhering to REST principles, the server is stateless, indicating that it does not keep session information between requests, which streamlines scalability and minimizes server-side memory usage.

The DBMK Tour app utilizes JSON Web Tokens (JWT) for user authentication and authorization [19]. Given that the backend is stateless and aims to reduce operational overhead, JWT effectively verifies user identity without keeping session data. Authentication occurs at login; afterward, tokens facilitate further authorization, thereby minimizing database read operations. A JWT consists of three parts: the header, which specifies the signing algorithm and token type; the payload, which holds claims like the issuer, expiration, and user roles; and the signature, created using a secret key unique to the server. This design guarantees data integrity and supports secure, role-based access control in a stateless environment, adhering to RESTful principles.

Caching mechanisms for static elements like 3D models, images, and audio files were introduced to enhance bandwidth efficiency and server performance. The HTTP Cache-Control headers outline caching policies for clients and intermediaries. The system embraces public caching, which permits responses to be stored in both private caches (on the client-side) and shared caches (such as ISPs or CDNs).

Private caching allows quick retrieval of previously accessed resources, while shared caching enhances load distribution and scalability. This method is suitable due to the static characteristics of the application’s content, aiding in cost reduction and faster response times. The frontend was built using TypeScript, a statically typed extension of JavaScript. TypeScript enables asynchronous programming and compile-time type checking, which aids in creating dependable, maintainable codebases.

The backend infrastructure utilizes Amazon Web Services (AWS) due to its scalability, cost efficiency, and capability for high-volume content delivery. AWS allows for secure and adaptable endpoint deployment and effective integration of JWT-based authentication and caching strategies.

4. Model Testing

Backend Testing

The DBMK Tour application's backend underwent unit, integration, and security testing methods. Unit testing emphasized verifying individual functions in isolation, using stubs for dependencies to maintain test specificity. The Jest testing framework [21, 22] facilitated this by enabling parallel execution and code coverage analysis, which supported rapid development and reliability evaluation. Integration testing confirmed the interoperability of system components, especially the interaction between application logic and cloud services on Amazon Web Services (AWS). This involved sending predefined requests to the system and assessing response accuracy and the integrity of related AWS resources.

Security testing encompasses various procedures to evaluate the strength of authentication and infrastructure setups. This involved:

- Examining input validation to guard against injection attacks;
- Assessing vulnerability to cache poisoning, a significant concern due to widespread public caching;
- Confirming the effectiveness of authorization logic, including identifying invalid JWT tokens (e.g., those utilizing the none algorithm, which could circumvent signature verification);
- Evaluating rate-limiting measures, essential in a cloud environment to avert misuse and manage related expenses.

Frontend Testing

Snapshot testing is used to maintain visual consistency during application updates. Also known as screenshot testing, this technique captures and compares the UI state against a reference image. When discrepancies arise, the test fails, indicating a potential visual regression. This method is more cost-effective than traditional UI testing frameworks (like Mockito and Espresso), particularly for applications with dynamic content and frequent dependency updates.

Thousands of UI images were obtained from internal components and external libraries to ensure layout stability throughout the development lifecycle. Snapshot testing played a crucial role in identifying unintended UI changes that could impact the user experience.

UI Testing with Meta's Screenshot Plugin

The open-source screenshot testing plugin from Facebook (Meta) [23] was incorporated into the Android development process to enhance visual regression testing. This tool includes:

- A core plugin that offers APIs for taking screenshots during automated testing;
- A Gradle plugin that extracts screenshots from the emulator or device and compares them according to the chosen mode.

Two operational modes were utilized:

- Record mode, designed to capture screenshots and save them in a specific project directory for version control;
- Verify mode assesses the current UI state against the reference screenshots and initiates test failures if a mismatch occurs.

This configuration allowed for accurate image rendering, placement, and cropping validation, especially for UI components created by third-party libraries. This method ensured that essential visual elements were consistently displayed as intended.

Conclusion

The growing computational power of mobile devices has positioned augmented reality (AR) as a powerful tool in various fields, notably in cultural heritage preservation. This research seeks to tackle the increasing disconnect between younger generations and historical knowledge by utilizing AR for interactive and immersive educational experiences. The DBMK Tour application was created to support this objective by turning ordinary urban exploration into an educational journey through history. By merging historical data with ARCore technology, the app provides users with multimedia experiences that reconstruct lost or unreachable historical sites. This method boosts user engagement and makes local heritage more relatable and accessible to modern audiences. Designed for scalability and cost-effectiveness, the system architecture allows for the smooth delivery of static cultural content via mobile interfaces. The application exemplifies how AR can connect historical content with present-day user expectations, fostering informal learning and enhancing cultural tourism. Its user-friendly interface, low resource demands, and unobtrusive design make it ideal for broad adoption.

Future development will prioritize expanding content by incorporating crowdsourced historical narratives, especially regarding lesser-known or undocumented local events. Planned additional features will include a discovery mode connected to Google Maps, enhancing route-based exploration and allowing users to find nearby points of interest easily. These enhancements aim to boost user engagement, foster cultural awareness, and advance the broader goal of heritage conservation through digital innovation.

Acknowledgments

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Multiple Nonlinear Regression and Quantile Regression Analysis of Sustainable Height of Tax Evasion in the EU Socioeconomic Area

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Abstract

Research background: Tax evasion poses a serious economic and societal challenge that threatens the sustainability of public finances. Increasing the tax burden does not always lead to higher revenues and may instead encourage undesirable behavior such as underreporting and excessive deductions. Traditional linear modeling often fails to capture the nonlinear dynamics of tax systems, especially during crises like COVID-19 or the 2022 energy crisis.
Purpose of the article: This paper aims to analyze the sustainability of tax collection in the context of tax evasion (measured by the VAT Gap) across EU countries. It seeks to demonstrate the limitations of linear regression and highlight the advantages of nonlinear and quantile regression methods when assessing the impact of global socioeconomic indicators.
Methods: The study uses nonlinear and quantile regression analysis based on data from 24 EU countries between 2012 and 2019. The VAT Gap is modeled in relation to global indices such as SEDA, DBI, EFI, GII, CPI, Basel AML, WCI, GSCI, and SII. Interaction terms and nonlinear transformations are included to enhance explanatory power.
Findings & Value added: Results show that nonlinear models outperform linear ones in explaining tax evasion behavior. The third power of the SEDA index is the most influential predictor (7.407% variance explained). At lower VAT Gap levels, EFI plays a key role 5.104%, while GII dominates at higher levels 6.303%. The study offers a novel analytical approach to modeling tax evasion and underlines the risks of misinterpretation when relying solely on linear methods.

Keywords: Nonlinear regression, Response surface model, Quantile regression, VAT gap, Tax evasion

JEL classification: H26, E37, C31

1. Introduction

The EU member states are losing billions of euros in value-added tax (VAT) reve-nues because of tax fraud and inadequate tax collection systems. To provide an estimation of revenue loss due to tax fraud, tax evasion and tax avoidance, (but also due to bankruptcies, financial insolvencies or miscalculations), the term VAT Gap is used. (Butu & Brezeanu, 2021)

The VAT Gap, as an estimate of unpaid VAT in the economy, is calculated as the difference between the theoretical VAT and the VAT actually transferred to the state budget. It is often expressed in relative terms as a percentage of unpaid VAT of the theoretical VAT that would be collected if all VAT payers reported and paid in full. (Zídková & Pavel, 2016)

Thus, it seems reducing the VAT Gap will be more relevant for countries with higher share of VAT in total taxes. (Thomas, 1992) The purpose of applying VAT is to increase budget revenues, purely from a revenue point of view the VAT is probably the best tax ever invented – as is stated in. (Borselli, 2011)

However, fraud is only a fraction of the VAT Gap – the estimation of its volume is the subject of expert discussion. Other factors such as errors, bankruptcies and insolvency that prevent businesses from paying VAT are also included in the VAT Gap. (European Commission, 2021)

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It is also assumed that the increase in unemployment is related to higher levels of VAT shortfall. Another study that focused on 25 EU countries between 2000 and 2006 indicated a positive relationship between the VAT Gap and administrative costs related to VAT collection. (Omodero, 2022)

The VAT Gap is estimated using two main approaches. In both cases, it is the so-called the top-down method, which is based on macroeconomic aggregates. (Kowal & Przekota, 2021)

Also in Slovakia, the VAT gap (defined as the difference between the potential revenue of the tax that should have been collected if all economic entities behaved in accordance with the law and the tax actually collected) represents a threat to the sustainability of the most important income for the state budget. (Korauš et al., 2021)

In Slovak Republic, according to a preliminary estimate, the tax gap for VAT in 2018 reached the value of 26.9% of the potential VAT revenues (VAT total tax liability according to the law). (Krzikallová & Tošenovský, 2020)

2. Methods

We consider the problem of modeling a response variable *y* (the amount of VAT Gap) as a function of *k* input variables $x_1, x_2, ..., x_k$ (*k*=10) based upon a data set consisting of the *n* sets of values $(y_{it}, x_{1it}, x_{2it}, ..., x_{kit})$, $i = 1,2,\text{L}\ ,n$; *n* = 24 refers number of destination EU countries under consideration, $t \in \left[2012, 2019\right]$ represents the observed time period.

Input variables are labeled as follows: x_1 – Basel AML, x_2 – WCI, x_3 – CPI, x_4 – EFI, x_5 – GII, x_6 – SEDA, x_7 – DBI, x_8 – GSCI, x_9 – HDI, x_{10} – GDP. The given nine global indices and GDP per capita has been collected during August 2022 from the official world indicators websites. Cyprus, Malta, Lithuania, and Latvia were excluded because of missing index values. All indices are already aggregated according to each institution's own methodology. Before modeling, each variable was standardized (zero mean, unit variance). To achieve the main goal (mathematically modeling the relationship between tax evasion – the VAT Gap – and selected input factors in the context of sustainability), we analyzed the development of the VAT Gap value for 24 EU countries over the period 2012–2019.

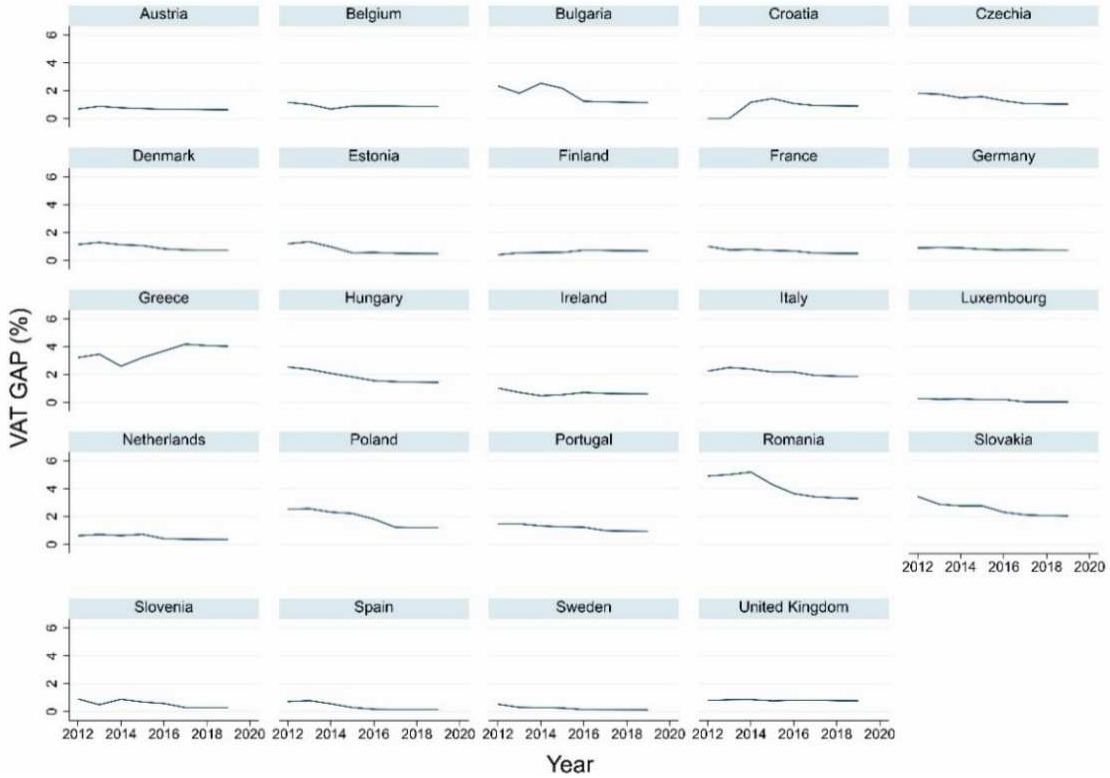

Figure 1. Development of VAT GAP across 24 EU countries in the monitored period 2012 to 2019
Source: Compiled by the authors (2025)

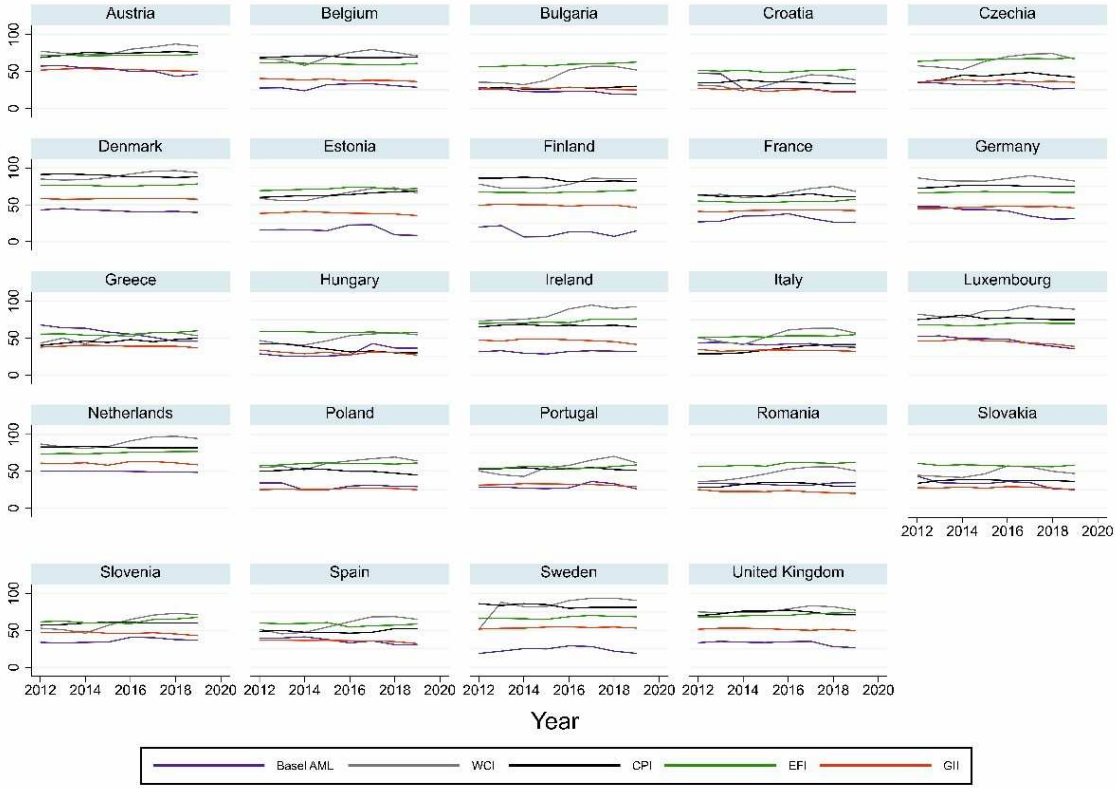

Figure 2. Changes in the values of the Basel AML, WCI, CPI, EFI and GII in 24 EU countries during the monitored period 2012–2019
Source: Compiled by the authors (2025)

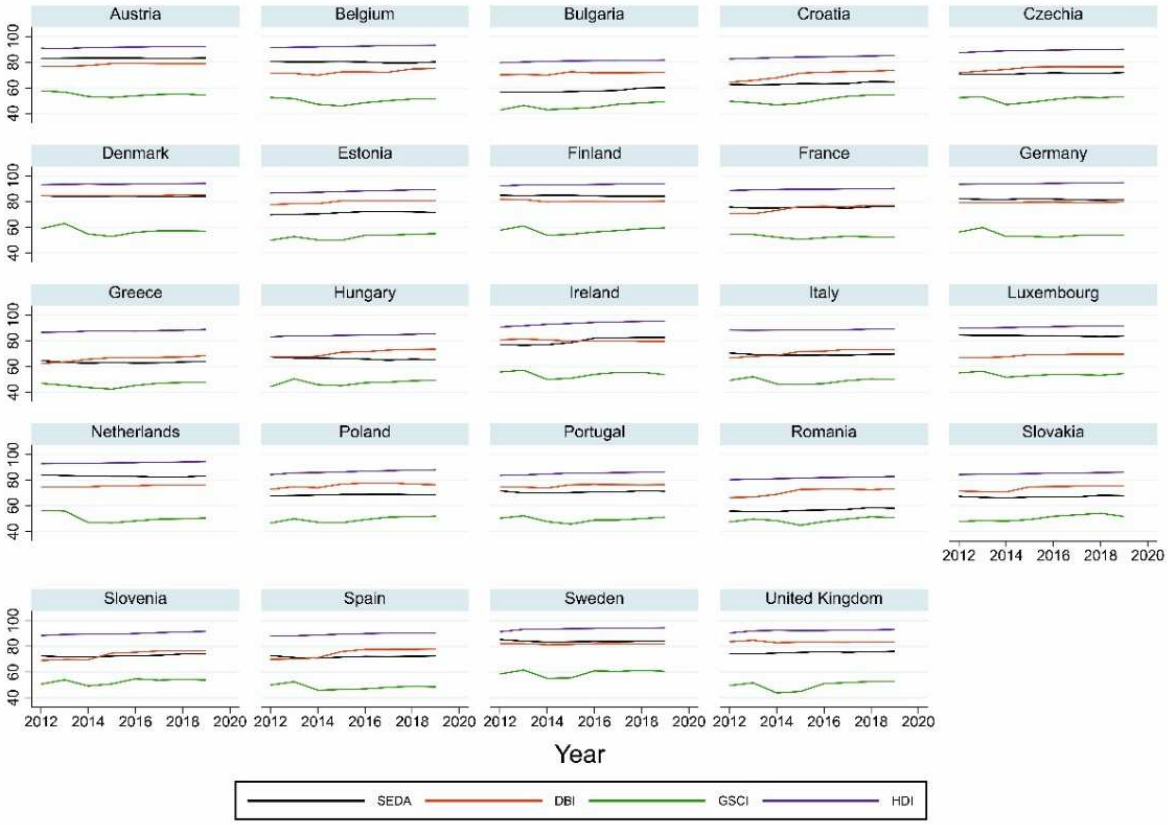

Figure 3. Changes in the values of the SEDA, DBI, GSCI and HDI indices in studied 24 EU member coun-tries during the monitored period 2012–2019
Source: Compiled by the authors (2025)

3. Results

Multiple Linear Regression Model

The multiple linear regression model $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k$ (1) is employed and estimation of the unknown regression parameters $\beta_0, \beta_1, ..., \beta_k$ is performed based on the corresponding statistical analysis of the observed data by using software of Statistica 13.5, MATLAB 2019b and JPM11, most software packages provide many possibilities when evaluating big data analysis. Model fitting has been performed (combination of the backward and forward selection procedures) and based on the analysis of variance (ANOVA) for multiple linear regression problem, analysis of the fitted model and residuals analysis – a final model has been decided upon. The estimations of the regression coefficients are reported in Table 1.

Table 1. The estimates of the regression coefficients of the multiple linear regression model.

Effect	Estimate	Std.Err	t Ratio	Prob>|t|	Lower 95%	Upper 95%
Intercept	0.012525	0.000512	24.47210	0.000000*	0.011516	0.013535
x_1	0.002317	0.000659	3.51911	0.000548*	0.001018	0.003617
x_2	-0.000844	0.001404	-0.60093	0.548636	-0.003614	0.001926
x_3	0.005220	0.001824	2.86115	0.004718*	0.001620	0.008820
x_4	0.001385	0.000997	1.38900	0.166538	-0.000583	0.003353
x_5	-0.003703	0.001337	-2.76886	0.006211*	-0.006342	-0.001064
x_6	-0.010473	0.002154	-4.86194	0.000003*	-0.014724	-0.006223
x_7	-0.001851	0.001087	-1.70301	0.090282	-0.003996	0.000294
x_8	0.000694	0.000772	0.89874	0.369984	-0.000830	0.002217
x_9	0.003405	0.001484	2.29432	0.022920*	0.000477	0.006333
x_{10}	-0.001438	0.001173	-1.22576	0.221880	-0.003752	0.000877

*— regressor is significant at level of α = 0.05, x_1 – Basel AML, x_2 – WCI, x_3 – CPI, x_4 – EFI, x_5 – GII, x_6 – SEDA, x_7 – DBI, x_8 – GSCI, x_9 – HDI, x_{10} – GDP per Capita.
Source: Calculated by the authors using Statistica 13.5, Matlab 2019b and JPM 11 (2025)

Based on the obtained empirical results of the performed statistical analysis (computer outputs of descriptive and multivariate statistics) and having used the outputs presented in Table 1, the final fitted model is:

$$VAT_{GAP} = 0.012525 + 0.002317 \cdot Basel\ AML + 0.005220 \cdot CPI - 0.003703 \cdot \mathrm{GII} - 0.010473 \cdot SEDA + 0.003405 \cdot HDI \quad (2)$$

These model (only significant standardized regressors) is highly significant (F = 23.401; p < 0.001) and explains 53.98 % of VAT Gap variance (Adj R^2 = 0.5398). Average prediction error is 1.252 % (SD = 0.177 %), with normally distributed residuals (Shapiro–Wilk p = 0.115). The intercept accounts for 52.251 % of explained variance, leaving over half unexplained by included regressors. Among predictors, SEDA (10.434 % negative effect) is most influential, followed by Basel AML (7.553 % positive), CPI (6.140 %), GII (5.942 %), and HDI (4.924 %). To capture interaction and nonlinear effects, model (2) will be extended into a nonlinear regression with interaction terms.

Multiple Nonlinear Regression Model

In Stage 2, recognizing curvature and interactions among predictors, we fit a nonlinear regression model (RSM) to better capture each variable's impact on VAT Gap. Using Statistica 13.5, MATLAB 2019b, and JMP 11, Model fitting has been performed in the manner of combination of the backward and forward selection procedures, based on the analysis of variance (ANOVA) for multiple nonlinear regression problem The final nonlinear model's coefficient estimates appear in Table 2.

Table 2. The estimates of the regression coefficients of the nonlinear multiple regression model

Term	Estimate	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%
Intercept	0.01118	0.00074	15.19000	0.00010*	0.00973	0.01263
x_1	0.00266	0.00074	3.61000	0.00040*	0.00120	0.00411
x_4	0.00443	0.00063	7.06000	0.00010*	0.00319	0.00567
x_5	-0.00633	0.00097	-6.52000	0.00010*	-0.00825	-0.00441
x_6	0.00773	0.00220	3.52000	0.00060*	0.00339	0.01207
x_7	-0.00431	0.00101	-4.29000	0.00010*	-0.00630	-0.00233
x_9	-0.00490	0.00125	-3.92000	0.00010*	-0.00737	-0.00243
x_{10}	-0.00224	0.00109	-2.06000	0.04110*	-0.00439	-0.00009
$x_1 \cdot x_1$	-0.00135	0.00044	-3.09000	0.00240*	-0.00221	-0.00049
$x_1 \cdot x_3$	-0.00869	0.00113	-7.72000	0.00010*	-0.01091	-0.00646
$x_5 \cdot x_3$	0.00477	0.00099	4.81000	0.00010*	0.00281	0.00673
$x_3 \cdot x_3$	-0.00291	0.00122	-2.37000	0.01880*	-0.00532	-0.00049
$x_6 \cdot x_9$	-0.00879	0.00206	-4.27000	0.00010*	-0.01285	-0.00473
$x_9 \cdot x_9$	0.00388	0.00123	3.17000	0.00180*	0.00146	0.00630
$x_6 \cdot x_7$	0.00822	0.00120	6.85000	0.00010*	0.00585	0.01058
$x_1 \cdot x_7$	0.00422	0.00080	5.29000	0.00010*	0.00264	0.00579
$x_1 \cdot x_{10}$	0.00590	0.00119	4.95000	0.00010*	0.00355	0.00825
$x_3 \cdot x_2$	0.00318	0.00136	2.34000	0.02060*	0.00049	0.00587
$x_7 \cdot x_2$	-0.00297	0.00104	-2.85000	0.00500*	-0.00503	-0.00091
$x_2 \cdot x_2$	-0.00185	0.00077	-2.40000	0.01760*	-0.00337	-0.00033
$x_6 \cdot x_6 \cdot x_6$	-0.00777	0.00130	-5.98000	0.00010*	-0.01034	-0.00520
$x_6 \cdot x_1 \cdot x_5$	0.00378	0.00083	4.59000	0.00010*	0.00215	0.00541
$x_6 \cdot x_6 \cdot x_3$	0.00883	0.00206	4.28000	0.00010*	0.00476	0.01289
$x_3 \cdot x_3 \cdot x_3$	-0.00180	0.00082	-2.21000	0.02880*	-0.00342	-0.00019
$x_1 \cdot x_1 \cdot x_9$	0.00131	0.00046	2.84000	0.00500*	0.00040	0.00222
$x_6 \cdot x_6 \cdot x_7$	-0.00599	0.00145	-4.14000	0.00010*	-0.00885	-0.00314
$x_5 \cdot x_3 \cdot x_7$	-0.00300	0.00128	-2.34000	0.02040*	-0.00553	-0.00047
$x_6 \cdot x_9 \cdot x_7$	0.00620	0.00117	5.31000	0.00010*	0.00390	0.00851
$x_5 \cdot x_7 \cdot x_7$	0.00266	0.00080	3.32000	0.00110*	0.00108	0.00425
$x_6 \cdot x_1 \cdot x_{10}$	-0.00470	0.00096	-4.91000	0.00010*	-0.00659	-0.00281

*— factor is significant at level of $\alpha = 0.05$, x_1 – Basel AML, x_2 – WCI, x_3 – CPI, x_4 – EFI, x_5 – GII, x_6 – SEDA, x_7 – DBI, x_8 – GSCI, x_9 – HDI, x_{10} – GDP per Capita.
Source: Calculated by the authors using Statistica 13.5, Matlabm 2019b and JPM 11 (2025)

Based on the obtained empirical results of the performed statistical analysis (computer outputs of descriptive and multivariate statistics) and having used the outputs presented in Table 2 (the estimations of the regression coefficients), the final fitted model (3) has been developed as follows:

$$\begin{aligned}\hat{y} = {} & 0.01118 + 0.00266 \cdot x_1 + 0.00443 \cdot x_4 - 0.00633 \cdot x_5 + 0.00773 \cdot x_6 - 0.00431 \cdot x_7 - \\ & -0.00490 \cdot x_9 - 0.00224 \cdot x_{10} - 0.00135 \cdot x_1^2 - 0.00869 \cdot x_1 \cdot x_3 + 0.00477 \cdot x_3 \cdot x_5 - \\ & -0.00291 \cdot x_3^2 - 0.00879 \cdot x_6 \cdot x_9 + 0.00388 \cdot x_9^2 + 0.00822 \cdot x_6 \cdot x_7 + 0.00422 \cdot x_1 \cdot x_7 + \\ & +0.00590 \cdot x_1 \cdot x_{10} + 0.00318 \cdot x_3 \cdot x_2 - 0.00297 \cdot x_7 \cdot x_9 - 0.00185 \cdot x_2^2 - 0.00777 \cdot x_6^3 + \\ & +0.00378 \cdot x_1 \cdot x_5 \cdot x_6 + 0.00883 \cdot x_3 \cdot x_6^2 - 0.00180 \cdot x_3^3 + 0.00131 \cdot x_1^2 \cdot x_9 - 0.00599 \cdot x_6^2 \cdot x_7 - \\ & -0.00300 \cdot x_3 \cdot x_5 \cdot x_7 + 0.00620 \cdot x_6 \cdot x_7 \cdot x_9 + 0.00266 \cdot x_5 \cdot x_7^2 - 0.00470 \cdot x_1 \cdot x_6 \cdot x_{10}\end{aligned} \quad (3)$$

All variables were standardized and only significant regressors were included in model (3). This nonlinear model is highly significant ($F = 44.465$; $p < 0.001$) and explains 86.84 % of VAT Gap variance (Adj $R^2 = 0.8684$). Notably, SEDA (x_6) exhibits both a main effect 2.55 % and a cubic effect 4.39 %, underscoring its strongly nonlinear impact on the VAT Gap (Figure 4).

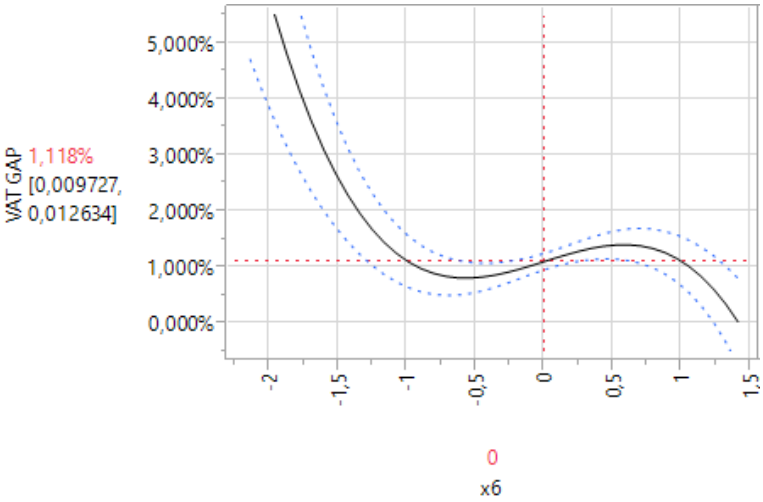

Figure 4. The influence of the input variable x_6 (SEDA) on the change in the value of the VAT Gap (re-sponse) in a standardized form
Source: Compiled by the authors (2025)

4. Discussion

Quantile Regression Analysis

However, the main questions remain: "What is the impact of individual global indexes and GDP values for countries with different levels of VAT gaps?"; "Is the effect of the selected regressors and their interactions (in nonlinear model) still the same, or it changes depending on the amount of the VAT Gap itself? To answer these main ques-tions and at the same time to clarify the understanding of the influence of global indices and the value of the gross domestic product on the amount of the tax gap, we applied quantile regression analysis. The current study deepens the empirical results in prior literature. We estimated these different responses and specified them by using the quantile regression analysis. The basic model from which we will base our analysis is a non-linear regression model (3).

The basic model from which we will base our analysis is a non-linear regression model (3):

$$\begin{aligned}\hat{y} = {} & 0.01118 + 0.00266 \cdot x_1 + 0.00443 \cdot x_4 - 0.00633 \cdot x_5 + 0.00773 \cdot x_6 - 0.00431 \cdot x_7 - \\ & -0.00490 \cdot x_9 - 0.00224 \cdot x_{10} - 0.00135 \cdot x_1^2 - 0.00869 \cdot x_1 \cdot x_3 + 0.00477 \cdot x_3 \cdot x_5 - \\ & -0.00291 \cdot x_3^2 - 0.00879 \cdot x_6 \cdot x_9 + 0.00388 \cdot x_9^2 + 0.00822 \cdot x_6 \cdot x_7 + 0.00422 \cdot x_1 \cdot x_7 + \\ & +0.00590 \cdot x_1 \cdot x_{10} + 0.00318 \cdot x_3 \cdot x_2 - 0.00297 \cdot x_7 \cdot x_9 - 0.00185 \cdot x_2^2 - 0.00777 \cdot x_6^3 + \\ & +0.00378 \cdot x_1 \cdot x_5 \cdot x_6 + 0.00883 \cdot x_3 \cdot x_6^2 - 0.00180 \cdot x_3^3 + 0.00131 \cdot x_1^2 \cdot x_9 - 0.00599 \cdot x_6^2 \cdot x_7 - \\ & -0.00300 \cdot x_3 \cdot x_5 \cdot x_7 + 0.00620 \cdot x_6 \cdot x_7 \cdot x_9 + 0.00266 \cdot x_5 \cdot x_7^2 - 0.00470 \cdot x_1 \cdot x_6 \cdot x_{10}\end{aligned}$$

For the purposes of the study, the following quantiles and the corresponding pre-dicted values of the amount of the VAT Gap were chosen: quantile 0.1 = 0.290%, quantile 0.2 = 0.543%, quantile 0.3 = 0.685%, quantile 0.4 = 0.759%, quantile 0.5 = 0.892%, quantile 0.6 = 1.062 %, quantile 0.7 = 1.321%, quantile 0.8 = 2.020%, quantile 0.9 = 2.597%. The main results of the quantile regression analysis for the selected values of the quantiles 0.1, 0.3, 0.5, 0.7 and 0.9 are shown in the summary Table 3 and the graphical representation of the change in the values of the regression coefficients for the respective quantiles in Figure 4.

Table 3. The results of quantile regression analysis for different quantiles in the nonlinear regression model of VAT Gap for monitored period 2012–2019.

Term	***q***				
	0.1	**0.3**	**0.5**	**0.7**	**0.9**
Intercept	0.00708* (0.00521; 0.00896)	0.00879** (0.00684; 0.01074)	0.01255** (0.01088; 0.01422)	0.01341** (0.01137; 0.01546)	0.01385** (0.01308; 0.01462)
x_1	0.00246** (0.00272; 0.00592)	0.00325** (0.00130; 0.00520)	0.00291** (0.00123; 0.00458)	0.00269* (0.00065; 0.00473)	0.00137** (0.00060; 0.00214)
x_4	0.004321** (0.00272; 0.00592)	0.00531** (0.00365; 0.00698)	0.00404** (0.00261; 0.00546)	0.00407** (0.00233; 0.00582)	0.00295** (0.00229; 0.00361)

x_5	-0.00456** (-0.00703; -0.00209)	-0.00679** (-0.00936; -0.00422)	-0.00483** (-0.00703; -0.00262)	-0.00622** (-0.00892; -0.00352)	-0.00687** (-0.00789; -0.00585)
x_6	0.01045** (0.00485; 0.01604)	0.00761* (0.00178; 0.01344)	0.00385 (-0.00114; 0.00885)	0.00441 (-0.00169; 0.01052)	0.00690** (0.00460; 0.00920)
x_7	-0.00382** (-0.00638; -0.00126)	-0.00524** (-0.00790; -0.00257)	-0.00506** (-0.00734; -0.00278)	-0.00454** (-0.00733; -0.00174)	-0.00272** (-0.00378; -0.00167)
x_9	-0.00547** (-0.00229; -0.00865)	-0.00389* (-0.00721; -0.00058)	-0.00290* (-0.00574; -0.00005)	-0.00288 (-0.00635; 0.00059)	-0.00527** (-0.00658; -0.00396)
x_{10}	-0.00155 (-0.00432; 0.00122)	-0.00267 (-0.00556; 0.00022)	-0.00253* (-0.00500; -0.00005)	-0.00202 (-0.00504; 0.00100)	-0.00294** (-0.00408; -0.00180)
$x_1 \cdot x_1$	-0.00113* (-0.00224; -0.00002)	-0.00114 (-0.00230; 0.00001)	-0.00173** (-0.00273; -0.00074)	-0.00131* (-0.00252; -0.00010)	-0.00173** (-0.00219; -0.00128)
$x_1 \cdot x_3$	-0.00805** (-0.01091; -0.00518)	-0.0095** (-0.01249; -0.00652)	-0.00821** (-0.01077; -0.00565)	-0.00712** (-0.01025; -0.00400)	-0.00776** (-0.00894; -0.00658)
$x_5 \cdot x_3$	0.00445** (0.00192; 0.00698)	0.00537** (0.00274; 0.00800)	0.00290* (0.00064; 0.00516)	0.00366* (0.00090; 0.00641)	0.00447** (0.00343; 0.00551)
$x_3 \cdot x_3$	-0.00229 (-0.00541; 0.00082)	-0.00419* (-0.00744; -0.00095)	-0.00352* (-0.00630; -0.00074)	-0.00162 (-0.00502; 0.00178)	-0.00075 (-0.00203; 0.00053)
$x_6 \cdot x_9$	-0.00712** (-0.01236; -0.00188)	-0.00737** (-0.01283; -0.00191)	-0.00713** (-0.01180; -0.00245)	-0.00769** (-0.01340; -0.00197)	-0.00739** (-0.00955; -0.00524)
$x_9 \cdot x_9$	0.00265 (-0.00048; 0.00577)	0.00361* (0.00036; 0.00686)	0.00328* (0.00049; 0.00606)	0.00332 (-0.00009; 0.00672)	0.00401** (0.00273; 0.00530)
$x_6 \cdot x_7$	0.00988** (0.00683; 0.01294)	0.00948** (0.00630; 0.01266)	0.00805** (0.00532; 0.01077)	0.00701** (0.00368; 0.01035)	0.00605** (0.00479; 0.00730)
$x_1 \cdot x_7$	0.00490** (0.00287; 0.00693)	0.00482** (0.00271; 0.00693)	0.00344** (0.00162; 0.00525)	0.00299** (0.00077; 0.00520)	0.00358** (0.00275; 0.00442)
$x_1 \cdot x_{10}$	0.00613** (0.0031; 0.00916)	0.00616** (0.00301; 0.00932)	0.00656** (0.00385; 0.00926)	0.00422* (0.00091; 0.00752)	0.00368** (0.00243; 0.00493)
$x_3 \cdot x_2$	-0.00023 (-0.00369; 0.00324)	0.00203 (-0.00158; 0.00564)	0.00482** (0.00173; 0.00792)	0.00188 (-0.00190; 0.00566)	0.00155* (0.00013; 0.00298)
$x_7 \cdot x_2$	-0.00266 (-0.00532; 0.00000)	-0.00292* (-0.00569; -0.00016)	-0.00209 (-0.00446; 0.00029)	-0.00281 (-0.00571; 0.00009)	-0.00313** (-0.00422; -0.00203)
$x_2 \cdot x_2$	-0.00114 (-0.0031; 0.00082)	-0.00179 (-0.00383; 0.00025)	-0.00338** (-0.00512; -0.00163)	-0.00091 (-0.00305; 0.00122)	-0.00027 (-0.00107; 0.00054)
$x_6 \cdot x_6 \cdot x_6$	-0.01299** (-0.0163; -0.00968)	-0.00809** (-0.01154; -0.00465)	-0.00578** (-0.00873; -0.00282)	-0.00540** (-0.00902; -0.00179)	-0.00371** (-0.00507; -0.00234)
$x_6 \cdot x_1 \cdot x_5$	0.00265* (0.00055; 0.00475)	0.00348** (0.00129; 0.00567)	0.00331** (0.00143; 0.00518)	0.00269* (0.00040; 0.00498)	0.00339** (0.00252; 0.00425)
$x_6 \cdot x_6 \cdot x_3$	0.01641** (0.01117; 0.02165)	0.01034** (0.00488; 0.01580)	0.00606* (0.00138; 0.01075)	0.00495 (-0.00077; 0.01067)	0.00301** (0.00085; 0.00516)
$x_3 \cdot x_3 \cdot x_3$	-0.00382** (-0.00590; -0.00174)	-0.00213 (-0.00430; 0.00003)	-0.00006 (-0.00192; 0.00180)	0.00004 (-0.00223; 0.00231)	-0.00059 (-0.00144; 0.00027)
$x_1 \cdot x_1 \cdot x_9$	0.00029 (-0.00089; 0.00146)	0.00083 (-0.00039; 0.00205)	0.00158** (0.00053; 0.00262)	0.00116 (-0.00012; 0.00244)	0.00133** (0.00085; 0.00181)

$x_6 \cdot x_6 \cdot x_7$	-0.00678** (-0.01046; -0.00309)	-0.00727** (-0.01111; -0.00344)	-0.00558** (-0.00886; -0.00229)	-0.00379 (-0.00781; 0.00023)	-0.00619** (-0.00771; -0.00468)
$x_5 \cdot x_3 \cdot x_7$	-0.00572** (-0.00898; -0.00246)	-0.00371* (-0.00710; -0.00031)	-0.00395** (-0.00686; -0.00104)	-0.00347 (-0.00702; 0.00009)	-0.00151* (-0.00285; -0.00017)
$x_6 \cdot x_9 \cdot x_7$	0.00857** (0.00560; 0.01155)	0.00714** (0.00405; 0.01024)	0.00605** (0.00340; 0.00870)	0.00403* (0.00078; 0.00727)	0.00596** (0.00473; 0.00718)
$x_5 \cdot x_7 \cdot x_7$	0.00195 (-0.00009; 0.00399)	0.00356** (0.00143; 0.00568)	0.00296** (0.00114; 0.00479)	0.00270** (0.00048; 0.00493)	0.00178** (0.00094; 0.00262)
$x_6 \cdot x_1 \cdot x_{10}$	-0.00497** (-0.00741; -0.00253)	-0.00492** (-0.00746; -0.00238)	-0.00494** (-0.00711; -0.00276)	-0.00360** (-0.00626; -0.00094)	-0.00221** (-0.00321; -0.00121)

Source: compiled and calculated by the authors using Statistica 13.5, Matlab2019b and JPM 11 (2025)

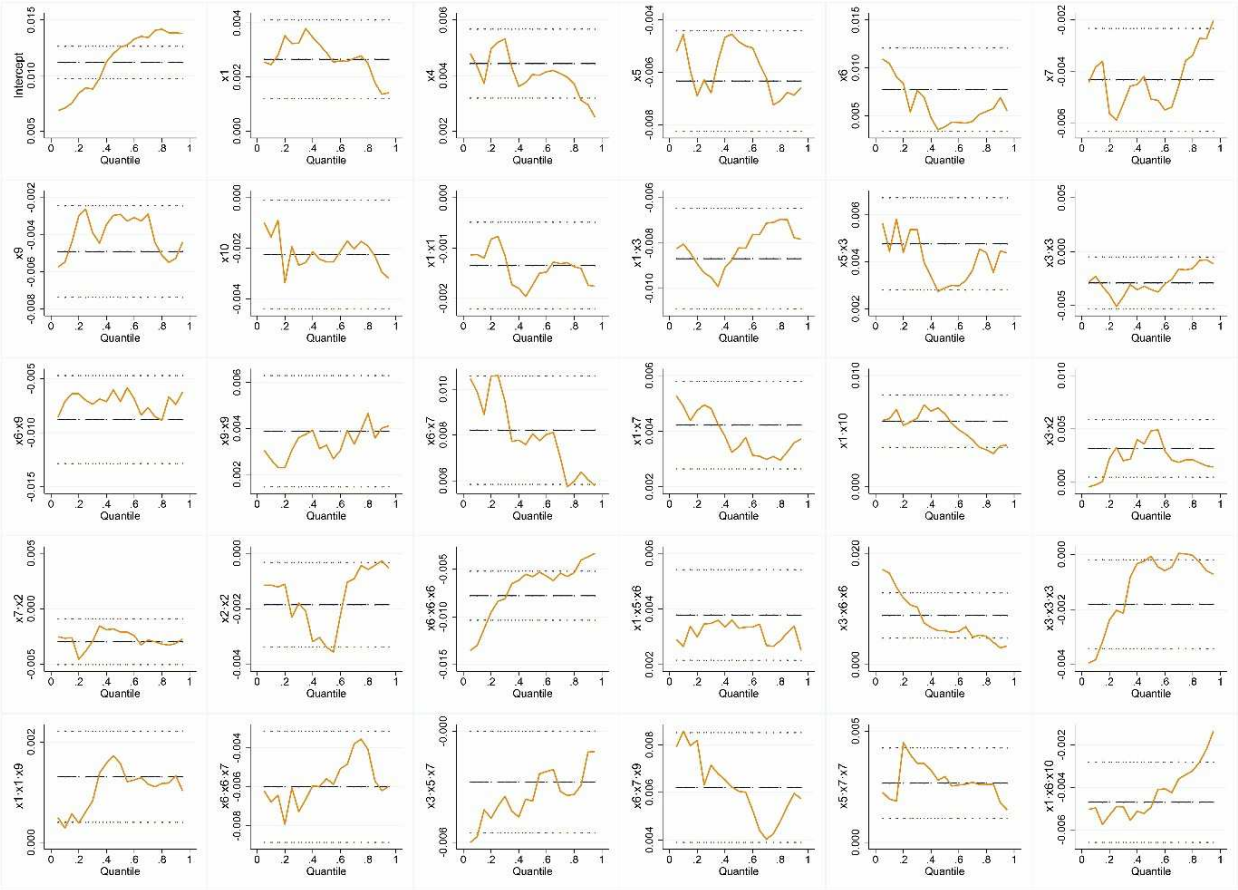

Figure 4. The changes in regression parameters' estimation in nonlinear model (4) at different level of used quantiles of the VAT gap amount (2012–2019)

Source: compiled and calculated by the authors using Statistica 13.5, Matlab 2019b and JPM 11 (2025)

The CPI index (x_3) within model (3) does not affect the VAT gap amount as an individual main effect, but always acts in interactions. The cross product of CPI ($x_3 \cdot x_3$) significantly affects the change of VAT gap value only in the interval from 0.543% (q = 0.2) to 0.892% (q =0.5) VAT Gap. The share of CPI cross product varies from 1.386% (q = 0.2) to 2.224% (q = 0.5). It is interesting that in countries with a high value of the VAT gap, i.e. in countries with a high level of corruption, the perception of corruption has no ef-fect on VAT gap change. The third power of the CPI affects the change in the VAT Gap amount only in countries where the amount of the tax gap is in the interval from 0.290% (q = 0.1) to 0.543% (q = 0.2). For countries where the amount of the tax gap is higher, the third power of the CPI index has no effect on its change. In both cases, increasing the value of the CPI index decreases the conditional value of the amount of the tax gap, which is a natural conclusion based on the nature of the CPI index.

The effect of GDP per capita (x_{10}) value is very interesting. This predictor appears in model (3) as a main effect and in interactions with the Basel AML index (x_1) and simultaneously in an interaction with Basel AML (x_1) and SEDA (x_6). Both interactions, i.e. $x_1 \cdot x_{10}$ and $x_6 \cdot x_1 \cdot x_{10}$) are significant within the entire interval of values of the VAT Gap amount at the chosen significance level $\alpha = 0.05$. Their share ranges from 3.813% (0.1) to 4.345 % (0.4) and a subsequent decrease to a value of 2.753% (q = 0.9). When the value of GDP per capita interacts with Basel AML and SEDA, its influence on the change in VAT Gap values ranges from 3.852% (q = 0.1) to 4.074% (q = 0.4) and again, as in the previous case, by a decrease to a value of 2.059% (q = 0.9). When analyze the value of GDP per capita (x_{10}) as the main effect, then the significant influence of this predictor is only for countries with VAT Gap at the level of 0.543% (0.2; 2.150%), 0.892% (0.5; 1.797%) and 2.597% (0.9; 2.403%). Apart from these values of the amount of VAT gap, the value of the gross domestic product per capita (x_{10}) does not have a significant influence on the change in the value of the amount of the tax gap.

Conclusion

This study focused on modeling the VAT Gap as a response variable influenced by ten global socioeconomic indicators across 24 EU countries. Unlike traditional approaches that favor multiple linear regression, this research employed nonlinear and quantile regression analyses to better capture complex relationships and structural variations.

The main findings confirm that the EFI (Index of Economic Freedom) is the most significant predictor influencing the VAT Gap, especially at lower levels (0.290%), where it explains 5.104% of the variance. Its effect weakens at higher levels, indicating a non-linear relationship. SEDA is also a key factor, with a 3.527% contribution at low VAT Gap values, but its significance is limited to lower intervals. Interestingly, SEDA regains importance when the VAT Gap exceeds 2.020%, contributing 2.134%. The GII (Global Innovation Index) shows increasing influence across the VAT Gap range, becoming the strongest predictor (6.303%) at higher VAT Gap levels.

The comparison of linear, nonlinear, and quantile regression methods illustrates that linear models often distort results in dynamic socioeconomic systems. Nonlinear regression captures interactions and changes more effectively, while quantile regression provides detailed insights into variability across different VAT Gap levels.

This study highlights the complexity of tax evasion and the limitations of standard modeling techniques. While it offers valuable insights, it also underlines the need for more comprehensive models incorporating additional variables. A deeper understanding of tax evasion dynamics is crucial for improving tax collection sustainability and protecting public finances within the EU.

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A Hybrid Model of Interpolative Boolean Algebra and Ordinal Sum of Conjunctive and Disjunctive Functions for Evaluation Semantically Connected Attributes

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Abstract

Research background: Evaluation is a challenging task when we have hierarchical attributes, vague attributes, not always precise values collected, correlated or logically connected attributes, and un-sharp borders of concepts like "perspective region" or "perspective company".
Purpose of the article: We propose aggregation by Interpolative Boolean Algebra (IBA) and ordinal sums of conjunctive and disjunctive (OSCD) functions to cover complex evaluation robustly. The practical value of the approach is demonstrated using an example of companies ranking on a simultaneously satisfied set of economic and environmental attributes. We should emphasize districts that strongly satisfy both categories, while using the same function to downplay those that satisfy both categories weakly.
Methods: Elementary attributes in the sets of economic and ecological attributes may be, to some extent, correlated or conditionally/logically connected. Based on this observation, we apply the suitable logical aggregation function within the IBA framework. The aggregation of compound economic and ecological attributes is formalized by OCSD functions. The result is in the unit interval, making it straightforward to rank or express intensities by color hues (e.g., map visualization). This enhances applicability and interpretability since it provides understandable feedback to a decision maker.
Findings & Value added: To the best of our knowledge, IBA-OSCD hybridization is applied in the context of hierarchical evaluation for the first time. Traditional roll-up queries in business intelligence reporting effectively summarize developments on hierarchical levels, but neglecting semantically complex features. On the other hand, IBA-OSCD is capable of modeling complex dependencies between attributes. Finally, this work outlines future research directions and real-world applications.

Keywords: Interpolative Boolean Algebra, Ordinal sums, Hierarchical aggregation, Uncertainty, Environmental attributes, Economical attributes, Aggregation functions

JEL classification: C02, Q59

1. Introduction

Evaluation is a challenging task, when we have hierarchical attributes, vague attributes, not always precise values, correlated or logically connected attributes, and un-sharp borders of concepts. An example is the evaluation (or classification) of "perspective companies", where the term *perspective* might not have clear boundaries. Models solving these tasks should cover the aforementioned features and should be directly related to observable properties of human reasoning (Dujmović, 2007). The benefit is that the logical models are transparent, understandable, and interpretable.

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For example, Yin et al. (2025) emphasize the need to pursue a dual approach that incorporates both ecological and economic aspects to ensure ecological and socioeconomic resilience in fisheries management to mitigate climate-driven losses by limiting profit. Attribute categories should be treated logically.

Human property or reasoning expects emphasising regions that strongly satisfy both categories, while downplaying regions exhibit weak performances in both categories and aggregate somewhere in the middle regions, which are good in one but weak in another category.

The benefit is when we use the same aggregation function category for such cases. The solution is a mixed aggregation function (Dubois and Prade, 2004). An option within this class of functions is a uni-norm function. However, due to their discontinuity in two borderline cases (one category is perfectly satisfied, while another is fully unsatisfied), we should either assign ideal value or full rejection (Munar et al., 2023). The gamma operator is also an option (Zimmermann and Zysno, 1980). But the strictness property is not able to evaluate when we want to assign the clear non-acceptance for entities which very weakly meet both criteria or the full acceptance for entities very significantly satisfying criteria. The option, which covers all the requirements in aggregating attributes, is an ordinal sum of conjunctive and disjunctive functions (OSCD) proposed in (Hudec et al., 2021) and improved in (Hudec et al., 2021).

When we look at elementary attributes like: share of energy used from renewable source, CO_2 production, allowances balance, and the like on the ecological category and attributes like profit, EBIDA, number of employees on the economic category, then attributes might be more or less correlated. When it is task to rank companies, relevant elementary conditions should be at least partially satisfied. This might be a task for conjunctive functions, but the question is which one is from the larger set of functions (Grabisch et al., 2009). Except for the borderline cases, conjunctive functions do not meet all the axioms of the Boolean algebra (Radojević, 2008). Next, we should also consider the correlation, the logical connection, or the partial influence between elementary attributes. The solution is Interpolative Boolean Algebra (IBA), which merges the logical aspect of Boolean algebra and the valued levels considering also dependencies, by selecting the most suitable conjunctive function (Radojević, 2000).

The aim of this work is to propose hierarchical aggregation by IBA and OSCD. This would enhance applicability and interpretability since it provides an understandable structure and feedback to a decision maker. In more detail, we perform data aggregation in two stages. First, we use IBA-based logical aggregation to combine all primary attributes within a single group. Subsequently, we applied a chosen OSCD operator to aggregate the group-level results into a single, globally representative value. This can be seen as the next step in exploring the synergy between these two complementary approaches. The proposed approach is validated using an example of ranking ten EU companies in the pulp and paper industry.

The structure of this paper is as follows. In the next section, a brief overview of methodology for the two aggregation methods, OSCD and IBA, is given. In Section 3, we explain the problem setup, describe the dataset, and evaluate entities. Finally, in the last two sections, we discuss the results, benefits, and limitations, and conclude the paper.

2. Methodology

In this section, we briefly present a theoretical background of OSCD and IBA. By both methods, the intensity of satisfaction of elementary conditions and categories is in the unit interval. Therefore, some data preparation, such as data normalization, is needed and is also explained.

2.1 Ordinal sums of conjunctive and disjunctive functions

In the framework of fuzzy sets theory, ordinal sums were considered to build new t-norms (conjunctive functions) or t-conorms (disjunctive functions) from the scaled versions of existing ones (Klement et al., 2000). On the other hand, mixed aggregation functions are adjustable to data in the sense of reinforcing (upward – disjunctive behaviour and downward – conjunctive behaviour) and averaging.

The ordinal sum of functions from not necessarily one class that considers satisfying two attributes (in our case, categories) is an aggregation function (De Baets and Mesiar, 2002):

$$A(x,y) = A_1(a\wedge x, a\wedge y) + A_2(a\vee x, a\vee y) + a \tag{1}$$

where x and y are intensities of satisfying categories, and $a \in [0,1]$ expresses the separation between upward and downward reinforcements. This function is shown in Fig. 1. Observe that

for $x, y \in [0, a]^2$ we get $A(x, y) = A_1(x, y)$, for $x, y \in [a, 1]^2$ we get $A(x, y) = A_2(x, y)$,
for $x, y \in [0, a] \times [a, 1] \vee x, y \in [a, 1] \times [0, a]$ we get $A(x, y) = x + y - a$

The key observation is that when A_1 is a conjunctive function (downward reinforcement) and A_2 is a disjunctive function (upward renforecmeent) (Durante and Sempi, 2005), then the remaining two sub areas are covered by the averaging function, i.e.,:

$$A(x, y) = x + y - a \in [\min(x, y), \max(x, y) \tag{2}$$

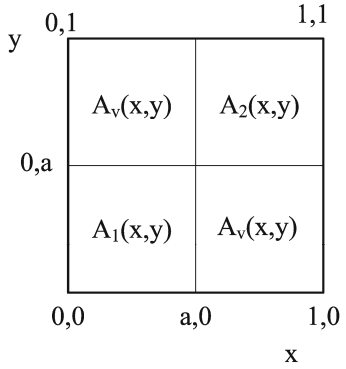

Figure 1. Graphical representation of ordinal sums of conjuctive and disjunctive functions
Source: own processing based on (Hudec et al., 2021)

For the aggregation function, we should keep the borderline cases, i.e., $A(0, 0) = 0$ and $A(1, 1) = 1$ (Klement et al., 2000). Therefore, for conjunctive and disjuctive functions, we should keep $A(a, a) = a$. The transformation from $[0, 1]^2$ to subsquare $[c, d]^2$ is realized by (Beliakov et al., 2007):

$$A_T(x, y) = c + (d - c)A\left(\frac{x-c}{d-c}, \frac{y-c}{d-c}\right) \tag{3}$$

Adjusting strict conjunctive function (e.g., product t-norm) by transformation (3) we get

$$A_1(x, y) = \frac{1}{a}xy \tag{4}$$

Analogously holds for the strict disjunctive function. Hence, for the probabilistic sum t-conorm, we get

$$A_2(x, y) = -1 + \frac{1}{a}x + \frac{1}{a}y - \frac{1}{a}xy \tag{5}$$

If we want to assign satisfaction 0 to entities which have very weak values of both categories, then the Lukasiewicz t-norm (as a representative of nilpotent functions) is suitable. It is adopted to A_1 as (Hudec et al., 2021):

$$A_1(x, y) = \max(0, x + y - a) \tag{6}$$

while its dual t-conorm (to assign full satisfaction) is:

$$A_2(x, y) = \min(0, x + y - a) \tag{7}$$

For the averaging part, we can keep the neutral arithmetic mean (2). In averaging behaviour, we can further manage inclination towards conjunctive, or disjunctive behaviour. Each quasi-arithmetic mean on [0, 1] is generated by an additive strictly monotone generator $g: [0,1] \rightarrow [-\infty, \infty]$, i.e., (Hudec et al., 2021)

$$A_v(x, y) = g^{-1}\big(g\big(A_1(x, a)\big) + g\big(A_2(a, y)\big) - g(a)\big) \tag{8}$$

In the case of careful or pessimistic evaluation (inclination towards conjunctive function), we might use the geometric mean ($g(t)$= - log(t)) in (8) as (Hudec et al, 2021):

$$A_v(x,y) = \frac{1}{a}xy \tag{9}$$

Observe that, although (3) and (7) have the same structure, they are in different sub squares (Figure 1) and therefore behave differently. Analogously, for optimistic evaluation (inclination towards the disjunctive function), we might use the quadratic mean ($g(t) = t^2$) in (8) as:

$$A_v(x,y) = \sqrt{x^2 + y^2 - a^2} \tag{10}$$

By this model, we are able to upwardly reinforce high values (or assign them value 1), downwardly reinforce low values (or even assign an them value 0), and assign average value for the other cases.

2.2 Interpolative Boolean algebra and Logical aggregation

Interpolative Boolean algebra is a real-valued realization of a Boolean algebra on the unit interval [0,1] (Radojevic, 2000). Despite other multi-valued logics, all the laws of Boolean algebra are preserved in IBA, including often problematic laws of excluded middle and contradiction (Radojevic, 2008). This is empowered by the existence of two levels of IBA, symbolic and value.

At the IBA symbolic level, the main focus is on the atomic elements of Boolean algebra and the structure of logical expressions, not on the primary (real) attributes in the expression. Of the n primary attributes of Boolean algebra, it is possible to form 2^n atomic elements, i.e., logical functions that, in their structure, contain only themselves and the trivial 0 constant (Radojevic, 2008). At the symbolic level of the IBA framework, logical functions are translated into the corresponding generalized Boolean polynomials (GBPs), according to IBA transformation rules (Radojevic, 2008):

$$(\gamma(b_1,\dots,b_n) \wedge \beta(b_1,\dots,b_n))^{\otimes} = \gamma^{\otimes}(b_1,\dots,b_n) \otimes \beta^{\otimes}(b_1,\dots,b_n) \tag{11}$$

$$(\gamma(b_1,\dots,b_n) \vee \beta(b_1,\dots,b_n))^{\otimes} =$$

$$\gamma^{\otimes}(b_1,\dots,b_n) + \beta^{\otimes}(b_1,\dots,b_n) - \gamma^{\otimes}(b_1,\dots,b_n) \otimes \beta^{\otimes}(b_1,\dots,b_n) \tag{12}$$

$$(\neg\gamma(b_1,\dots,b_n))^{\otimes} = 1 - \gamma^{\otimes}(b_1,\dots,b_n) \tag{13}$$

where $\gamma(b_1,\dots,b_n)$ and $\beta(b_1,\dots,b_n)$ are complex elements of Boolean algebra, and $b_i, i = 1,\dots,n$ are primary attributes. Additionally, the following transformation rules applies to primary attributes (Radojevic, 2008):

$$(b_i \wedge b_j)^{\otimes} = \begin{cases} b_i \otimes b_j, & i \neq j \\ b_i, & i = j \end{cases} \tag{14}$$

$$(b_i \vee b_j)^{\otimes} = b_i + b_j - b_i \otimes b_j \tag{15}$$

$$(\neg b_i)^{\otimes} = 1 - b_i \tag{16}$$

where b_i, $i = 1,\dots, n$ are primary attributes.

The IBA transformation rule given in (14) is particularly important, since it ensures idempotency on the one hand and allows satisfying the laws of the excluded middle and contradiction on the other.

GBPs consist of Boolean algebra elements representing variables, and the standard operators of addition, subtraction, and generalized product (GP) according to the following rules (Radojevic, 2008). Further, a generalized product (GP) can be any function that is a subclass of the t-norm satisfying the non-negativity condition and ranges from the Lukasiewicz t-norm to the minimum t-norm, i.e. in the following interval (Radojevic, 2008):

$$\max(a + b - 1, 0) \leq a \otimes b \leq \min(a, b) \tag{17}$$

The choice of operator for the GP does not affect the change of the algebra, but depending on the nature of the variables in the GBP, there are characteristic cases for choosing the appropriate operator.

After all transformations are completed and the minimal form of the GBP is achieved, the IBA introduces values only at the value level, ensuring that all the laws established at the symbolic level are preserved. Consequently, in certain situations, this approach yields better results than classical fuzzy logic. Moreover, the preservation of all the laws of Boolean algebra has led to the development and application

of logical aggregation (LA) (Mandic & Delibasic, 2014, Rakicevic et al., 2016, Milosevic et al., 2024, Radosavcevic et al., 2024).

LA represents a fully transparent method defined through normalization of primary attribute values on a unit interval [0,1] and aggregation of normalized primary attribute values into a single representative value via a logical function, using GBP, or via pseudo-logical functions, using a generalized pseudo-Boolean polynomial (GPBP). The formal definition of pseudo-logical aggregation according to (Radojevic, 2008) is:

Def. 1. A logical aggregation operator LA:$[0,1]^n \rightarrow [0,1]$ in general case is a pseudo-logical function, i.e. a linear convex combination of generalized Boolean polynomials

$$\underset{i=1}{\overset{n}{LA}}(x_i) = \sum_{j=1}^{n} w_j \cdot \varphi_j^{\otimes}(b_1, \ldots, b_n)$$

where $\sum_{j=1}^{n} w_j = 1, w_j \geq 0, j = 1, \ldots, n$ and $\varphi_j^{\otimes}(b_1, \ldots, b_n)$ are GBPs.

One of the main advantages of LA over classical aggregations is the possibility of modelling logical relationships between attributes (Poledica et al., 2015). The use of negation in logical aggregation unlocks the full potential of LA based on IBA. When negation is applied in LA, this approach surpasses conventional multi-valued and fuzzy methods, as the aggregation remains within the Boolean framework. Also, the use of weights in pseudo-logical functions enables very broad modeling possibilities, including generalized Boolean-consistent logical aggregation as well as many conventional approaches, such as the arithmetic mean, minimum, maximum, Choquet integral, etc.

2.3 Elementary attributes and their satisfaction degrees

In many valued logic, the condition can be satisfied (value 1), non-satisfied (value 0), and partially satisfied (values between 0 and 1). For instance, for the ecological attribute *percentage of green energy* we can express the requirement *high percentage of green energy* by a fuzzy set such as (Figure 2)

$$\mu_{HGP(x)=min\left(1,\max\left(0,\frac{x-a}{b-a}\right)\right)}$$

where *a* explains that below this value definitely is not high and *b* shows that above this value percentage is clearly high. These values can be set by domain expert or extracted from data (Alonso et al, 2021).

Other elementary conditions can be created in a similar manner by adjusting to the nature of each attribute. For example, preferred low values of attribute should be expressed by decreasing function. When the best values are somewhere inside the domain, we apply trapezoidal fuzzy sets. In this way, each elementary condition gets a value from the unit interval. When values from the whole domain should get degrees between 0 and 1, we apply strict function mapping the left border to 0 and the right border to 1, or the opposite. When the ideal value is inside domain, then the uncertain part of intervals spreads to domain edges.

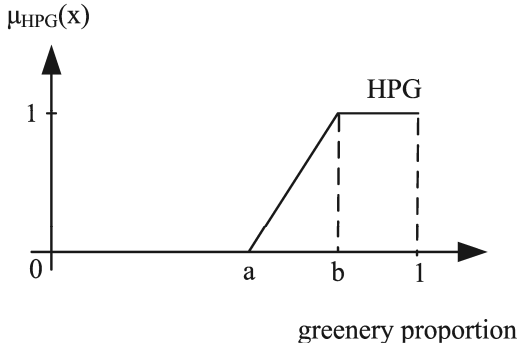

Figure 2. Fuzzy set high greenery proportion
Source: own processing

Data and experiments

This section is devoted to experiments in the evaluation companies in paper industry. Firstly, the data are described, followed by the evaluation.

2.4 Data

On the one hand, the pulp and paper industry is a significant pollutant; on the other hand, notable improvements have recently been recorded. Therefore, when assessing companies in this industry, it is essential to analyze both the economic and ecological aspects of their business.

In this study, we utilize data for year 2023. Ecological and ecnomic indicators are shown in Table 1. Each category contains five elementary attributes, which are transformed to the production per one tone as companies are of different sizes. In this research article, companies names are anomymised.

Table 1. Ecological and economic indicators for companies in pulp and paper industry

comp.	CO_2 prod. [tt/t]	Allowance allocation [pc/t]	ESG sustainal. risk score	ESG SAP score	Share of renew. energy	Net profit [EUR/t]	ROCE [%]	EBITDA [EUR/t]	Empl. [num./t]	Person expenses [EUR/t]
C1	0.7512	0.1053	15.6	54	80.3	766.3151	17.8	539.8813	0.0073	418.5893
C2	0.4989	-0.2120	15.3	57	63.3	-17.7311	5.4	32.0524	0.0044	382.3216
C3	0.6460	0.3731	17.4	45	87.0	563.3526	9	840.4159	0.0036	228.9982
C4	0.2019	0.0475	11.1	64	79.0	68.1408	26.1	250.4513	0.0060	248.6462
C5	0.3116	0.1882	17.9	52	73.0	235.6920	16.2	327.2633	0.0050	354.0062
C6	0.1742	0.1232	23.3	47	34.0	-4.0478	-7.8	33.7486	0.0011	82.6239
C7	0.1583	0.1464	19.7	49	72.0	234.2608	8.5	290.9544	0.0029	202.8692
C8	0.1324	0.0669	23.4	42	27.8	208.8091	8.5	676.0921	0.0089	742.1968
C9	0.0584	-0.0030	13.8	74	6.6	79.2433	12	165.0621	0.0020	21.0062
C10	0.4258	-0.0011	10.7	53	60.0	243.4829	16	453.9033	0.0166	793.8303

Source: Internal report of companies published on websites of these companies (for 2023) and selected databases[†]

2.5 Aggregation of ecological and economic attributes using LA based on IBA

LA is highly dependent on expert knowledge. Therefore, we consulted with both a financial expert and an ecological expert to define credible data aggregation models. These models were then translated into logical or pseudo-logical aggregation functions and processed within the IBA framework. All attributes have been normalized using standard min-max normalization into the unit interval.

In the case of economic attributes, the following model has been proposed by a financial expert: ROCE (Return on Capital Employed) and EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) are considered the most important indicators. If both are high, the company should be considered successful. However, if ROCE is not high, it is important that net profit (netProf) is high and the number of employees (empl) or personnel expenses (expens) is low.

This demand can be formulated as the following logical aggregation function:

$$ECONOMIC = (ROCE \wedge EBITDA) \vee \big(\neg ROCE \wedge netProf \wedge (\neg empl \vee \neg expens)\big)$$

Next, this logical expression corresponds to the following GBP:

$$ECONOMIC = ROCE \otimes EBITDA + netProf - netProf \otimes ROCE - netProf \otimes empl \otimes expens + netProf \otimes ROCE \otimes empl \otimes expens$$

Finally, the correlation in the dataset is taken into account. There is a strong positive correlation between Net Profit and EBITDA on one hand, and between the Number of Employees and Personnel Expenses on the other. Therefore, the minimum will be used as the Generalized Product (GP) for these pairs of attributes, while the standard product will be applied in other cases. Thus, the final aggregation model is as follows:

[†] www.carbonmarketdata.com, https://www.spglobal.com/, https://www.sustainalytics.com/esg-ratings

$$ECONOMIC = ROCE \cdot EBITDA + netProf - netProf \cdot ROCE - netProf \cdot \min(empl, expens) + netProf \cdot ROCE \cdot \min(empl, expens) \quad (18)$$

In the case of ecological attributes, an expert in the field proposed the following verbal model for aggregation: There are two key partial demands that should be considered. The first, and slightly more important, is that the company should have a low ESG Risk Score (esgScore) or a high S&P ESG ranking (esgRank). Additionally, the company should use a high Share of energy from renewable sources (share). If this is not the case, then the company should have a high balance between emission allowances (allow) and low CO_2 emissions (CO2).

This verbal model can be easily translated into the following pseudo-logical aggregation function:

$$ECOLOGICAL = w_1 \cdot (\neg esgScore \vee esgRank) + w_2 \cdot \big(share \vee (\neg share \wedge \neg CO2 \wedge allow)\big)$$

Since the first partial demand is slightly more important than the second one, we have assign weights $w_1 = 0.6$ and $w_2 = 0.4$. According to the IBA transformation rules, this expression is mapped in the following GBP:

$$ECOLOGICAL = 0.6 \cdot (1 - esgScore + esgScore \otimes esgRank) + 0.4 \cdot (share + allow - allow \otimes CO2 - allow \otimes share + share \otimes allow \otimes CO2)$$

At the IBA symbolic level, we analyzed the correlations within the data and found that all correlation coefficients are below 0.7. Therefore, the standard product is applied as a GP.

$$ECOLOGICAL = 0.6 \cdot (1 - esgScore + esgScore \cdot esgRank) + 0.4 \cdot (share + allow - allow \cdot CO2 - allow \cdot share + share \cdot allow \cdot CO2 \quad (19)$$

However, it should be noted that there is some positive correlation between CO_2 emissions and the share of renewable energy used, and that the ESG Risk Score and the S&P ESG ranking are negatively correlated. Including these relationships in the modelling process will be a subject of future work.

2.6 Aggregating compound economic and ecological categories

These categories are orthogonal. Hence, we apply ordinal sums. In Section 2.1, several functions for each sub-quadrant are introduced. In our work, when both categories are significantly satisfied, we apply upward reinforcement, and moreover, if both categories are very significantly met, we are not further interested in small nuances, so we assign ideal value. It is realised by the Lukasiewicz t-conorm (7). The same logical reasoning is applied for cases where both categories are weakly satisfied. This requirement is handled by the Lukasiewicz t-norm (6). Regarding the remaining two cases (economic category significantly met, while ecological category weakly, or opposite), we have three options (i) optimistic inclination from arithmetic mean to disjunction (10), (ii) pesimistic inclination between arithmetic mean and conjunction (9), and (iii) neutral evaluation or arithmetic mean. In this case, the evaluation without inclination (2) is applied.

Results are shown in Table 2. Company C3 has very high values of both categories, implying ideal value, while company C1 is upwardly reinforced, but has not achieved an ideal value. The opposite holds for C6 and C8, while C4 and C5 are evaluated using the neutral averaging function. In Table 2 we see companies that exhibit high values in both categories (bold), companies that weakly satisfy both categories (italic), and comapines that are good in one but weak in another category (bold-italic).

Discussion

Our approach can be applied to any problem where we exhibit two or more independent or orthogonal compound categories like economic, social, and governmental aspects (González-Pozo, et al., 2025; Luo and Farag, 2024). It is generally suitable when we should upwardly reinforce entities significantly meet all categories, downplay those weakly satisfying categories, and the other evaluate by averaging function. The examples are edge detection (Munar et al, 2023); plagiarism intensity detection (Bartoszuk and Gagolewski, 2021); or supporting explainable AI (de Santana et al, 2023).

This approach not only ranks companies, but also supports evaluation of individual companies. This means that any company can use this model independently on its own data. If the company is good in

economic aspect, but bad in ecological aspect, then a new investment in ecological innovation is highly recommended. In opposite results, investing in economic optimization is beneficial. It should be noted that directed innovation can mitigate or exacerbate climate change, as is reported, for instance, in agriculture (Moscona and Sastry, 2023).

Table 2. Aggregation of ecological and economic categories by OSCD

company	ECOLOGICAL category (20)	ECONOMIC Category (19)	aggregatiom by OSCD applying (2), (6) and (7)
C1	**0.8220**	**0.621643**	**0.9436**
C2	***0.7666***	***0***	***0.2666***
C3	**0.7131**	**0.809552**	**1.0000**
C4	***0.9683***	***0.270174***	***0.7385***
C5	***0.7267***	***0.329148***	***0.5559***
C6	*0.3598*	*0.017452*	*0.0000*
C7	***0.6323***	***0.300936***	***0.4332***
C8	*0.2309*	*0.457394*	*0.1883*
C9	***0.7429***	***0.147548***	***0.3904***
C10	***0.8884***	***0.366378***	***0.7548***

Source: own processing

Benefits are in handling observable properties of human reasoning by computational intelligence, i.e., the model is explainable and interpretable. The proposed functions are logic aggregations and, therefore, are explained linguistically.

In aggregation of elementary conditions by IBA dependencies between elementary attributes should be computed, and expert inputs are advisable for selecting weights and functions. The same holds for OSCD, where an expert should explain recommendations (linguistically) to select the right functions. The requirement of expert input might be considered as a limitation when experts are not available. In that case, we need past evaluation records to recognise the most sustainable categories of functions. In this way, we should recognize inclinations, logical dependencies, and correlation, so a large data set is not required for learning.

In a business intelligence drill-down reporting, Table 2 presents the aggregated level, while focussing on ecological or economic category, the domain expert is able to explore function and elementary conditions.

Concluding messages

In this research, the synergy of two logic-based aggregation methods is proposed to evaluate two orthogonal categories of attributes: economic and ecological. Aggregating elementary and compound conditions should consider their statistical correlation and logical connections. In this regard, we have demonstrated that IBA and OSCD are complementing approaches.

We applied it on the evaluation of companies in the paper and pulp industry by ecological and economic attributes. Each company knows how far and why it is from the ideal value or the area of ideal value. Despite the benefits, there are limitations which should be explored in future research.

Flexibility is a good feature when covering intensities of inclinations and dependences. However, a domain expert should explain requirements (in a structured way or linguistically). When an expert is not available, we should recognize logical relations, dependencies, and incantation from the past evaluation. In this field, we do not expect the existence of larger sets for learning. Thus, we should adapt out method to recognize the behaviour from a smaller data set.

The future application can also embrace elementary attributes in the governmental category to cover ESG evaluation. IBA and OSCD are flexible and adaptable to data and also in formalizing user inputs.

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Efficiency of Slovak Hospitals: Data Envelopment Analysis

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Abstract

Research background: The state of the overall economy determines the ability of decision-making units to achieve the required profitability. The decision-making unit is a symbiosis of a broad economic environment that generates the conditions for its existence. However, the entity itself determines and creates this environment. Data Envelopment Analysis (DEA) is a method that aims to measure the efficiency of decision-making units. We can also include hospitals in decision-making units.
Purpose of the article: The paper aims to analyze the efficiency of hospitals in the Slovak Republic using the DEA method. The research sample consists of 31 small and medium-sized hospitals according to SK NACE 86-Healthcare and SK NACE 861-Hospital activities. The efficiency of selected hospitals in the Slovak Republic was analyzed using data from 2019 (before the COVID-19 pandemic) and 2023 (after the COVID-19 pandemic).
Methods: The analysis used input- and output-oriented DEA models with constant and variable returns to scale. Personal costs to Sales Ratio and Number of Employees/Number of Beds were used as input variables. Patient satisfaction and Quality were selected as output variables.
Findings & Value added: Among small and medium-sized hospitals, the most effective are Ľubovnianska Hospital, Army General L. Svodoba Hospital Svidník, and Hospital in Žiar nad Hronom. A deeper understanding of hospitals' financial health and the ability to promptly address issues can improve their sustainability and competitiveness. The findings offer practical insights that inform future healthcare economics and management studies.

Keywords: Decision-making unit, DEA, Hospitals, Efficiency, Healthcare

JEL classification: G39, C67

1. Introduction

The healthcare sector is labor- and wage-intensive and can be described as a medium-sized sector in terms of the number of employees. The increasing dynamics and complexity of the marketing environment surrounding any organization, including healthcare facilities, intensifying competition, and many other factors and influences increase the requirements for a management concept that will effectively support the management of a healthcare facility (Morway, 2014).

Healthcare management is understood at the micro level as the management of healthcare organizations and at the macro level as the solution to crucial healthcare problem areas. According to Foltan (2010), management should mainly focus on increasing healthcare performance, the economic interpretation of individual healthcare concepts, creating an equilibrium between healthcare supply and demand, efficient financing, and quantifying healthcare output.

The DEA model represents a non-parametric method of measuring the relative technical efficiency of decision-making units, which belongs to the group of mathematical methods based on linear programming procedures. In this sense, a decision-making unit is a unit that creates some outputs to produce that consume specific inputs. These units can be, for example, banks, companies, hospitals, selected economic sectors, etc. We can also understand them as homogeneous units performing the same or similar activity (Kocisova, 2012).

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One of the earliest applications of efficiency measurement techniques was undertaken by Nunamaker (1983), who used the DEA to estimate the technical efficiency of 16 hospitals in Wisconsin, USA. Soon after, Sherman (1984) and Borden (1988) also employed the DEA methodology to compute the technical efficiency scores of hospitals in the USA.

Zaim et al. (2008) evaluated the efficiency of twelve hospitals in Turkey using Data Envelopment Analysis (DEA). Asandului et al. (2014) used DEA to assess the health system efficiency in 30 European countries in 2010. The data came from the Eurostat database. They calculated constant returns to scale (CRS) and variable returns to scale (VRS) DEA models with three outputs (life expectancy at birth, HALE - health-adjusted life expectancy, and infant mortality rate) and three inputs (number of doctors, number of hospital beds, and public health expenditures as a percentage of GDP). Cetin & Bahce (2016) applied DEA to assess the health system efficiency of 34 OECD member countries in 2011. The number of doctors, beds, and health expenditure per capita were used as inputs, and life expectancy at birth and infant mortality rate were used as outputs. Soares et al. (2017) examined and compared the efficiency of 21 public hospitals in Brazil using Data Envelopment Analysis (DEA). Luasa et al. (2018) used DEA to investigate the efficiency of 39 public and 73 private nursing homes in Ireland and found that the number of medical staff was the most critical input. Ahmed et al. (2019) applied an output-oriented DEA to estimate the technical efficiency of 46 Asian health systems. They used health expenditure per capita as an input and healthy life expectancy at birth (HALE) and infant mortality rate as outputs. Chen et al. (2019) analyzed the impact of the 2005–2012 recession on the performance of Pennsylvania hospitals using DEA. Lin et al. (2022) used DEA to assess the efficiency of 19 medical centers in Taiwan. The study selected five inputs, including total hospital beds, the total number of physicians, the total number of equipment, net fixed assets, and the rate of emergency transfer inpatient stays over 48 h. The output items were surplus or deficit of appropriation, length of hospital stay, total relative value units of outpatient service, total relative value units of inpatient service, and income from self-paid services. The empirical study by Wu (2023) utilized data envelopment analysis (DEA) to evaluate the efficiency of medical service capacity and identify potential improvement strategies for counties and cities in Taiwan from 2015 to 2020.

The study by Omir et al. (2024) aimed to evaluate the efficiency of the Republic of Kazakhstan's healthcare sector over the period 2014-2021 using the non-parametric method of data envelope analysis. Input variables were the number of medical facilities, number of beds, number of beds for sick children, number of doctors, and number of secondary medical staff. Output variables were child mortality rate, maternal mortality rate, and mortality rate of the population from infectious and parasitic diseases. Dlouhy & Havlik (2024) used multiple-criteria decision analysis (MCDA) and data envelopment analysis (DEA) to evaluate the efficiency of the health systems of 28 developed countries. The models included four inputs (health expenditure as a relative share of GDP, the number of physicians, nurses, and hospital beds) and three outputs (life expectancy at birth, healthy life expectancy, and infant mortality rate). The sample covers 27 OECD countries and Russia. The study by Pimentel & Mora-Monge (2024) benchmarked the efficiency of 58 public hospitals across Mexico between 2015 and 2018 and identified the most critical inputs affecting their efficiency.

2. Methods

The paper aims to analyze the efficiency of hospitals in the Slovak Republic using the DEA method. When calculating the efficiency of Slovak hospitals, two-stage DEA was used in variants: input-oriented DEA with constant returns to scale, output-oriented DEA with constant returns to scale, input-oriented DEA with variable returns to scale, and output-oriented DEA with variable returns to scale. Personal costs to Sales Ratio (PC/S) and Number of Employees/Number of Beds (E/B) were input variables. Patient satisfaction (PS) and Quality (Q) were selected as output variables. The inputs were financial and non-financial indicators obtained from the Register of Financial Statements of the Slovak Republic, the Institute for Economic and Social Reforms, and the Ministry of Health of the Slovak Republic.

The research sample consists of 31 small and medium-sized hospitals according to SK NACE 86-Healthcare and SK NACE 861-Hospital activities (Table 1). The efficiency of selected hospitals in the Slovak Republic was analyzed using data from 2019 (before the COVID-19 pandemic) and 2023 (after the COVID-19 pandemic).

Table 1. Research sample

Hospital	Code
AGEL Hospital Košice-Šaca	KS
Ľubovnianska Hospital	SL
Hospital Poprad	PP
Hospital Topoľčany	TO
Alexander Winter Hospital, Piešťany	PT
Dolnooravská Hospital with Polyclinic MUDr. L. Nádaši Jégé, Dolný Kubín	DK
Hospital with Polyclinic Spišská Nová Ves	SN
Hornooravská Hospital with Polyclinic Trstená	TS
AGEL Hospital Levoča	LE
Kysucká Hospital with Polyclinic Čadca	CA
AGEL Hospital Levice	LV
AGEL Hospital Komárno	KN
Faculty Hospital AGEL Skalica	SI
Štefan Kukura Hospital with Polyclinic Michalovce	MI
A. Leňa Hospital Humenné	HE
Hospital with Polyclinic Dunajská Streda	DS
AGEL Hospital Zvolen	ZV
General Hospital with Polyclinic Lučenec	LC
Liptovská Hospital with Polyclinic MUDr. Ivan Stodola Liptovský Mikuláš	LM
Hospital with Polyclinic Brezno	BR
Army general L. Svoboda Hospital Svidník	SK
Hospital with Polyclinic Prievidza with seat in Bojniciach	PD
Hospital Snina	SV
Vranovská Hospital	VT
Hospital with Polyclinic Myjava	MY
Hospital in Žiar nad Hronom	ZH
Hospital with Polyclinic St. Barbora Rožňava	RV
Hospital with Polyclinic St. Jakub, Bardejov	BJ
Hospital with Polyclinic St. Lukáš Galanta	GA
Hospital with Polyclinic Trebišov	TV
Hospital with Polyclinic Považská Bystrica	PB

Source: own processing

Stata 15.1 software was used to calculate the efficiency of hospitals.

DEA (Data Envelopment Analysis) is a frequently used method in the multicriteria evaluation of units in the healthcare sector. Efficiency and performance evaluation is an essential part of managerial management and decision-making. When we evaluate the efficiency or performance of a healthcare facility, we assess how this unit transforms inputs into outputs. This efficiency cannot be evaluated absolutely but relative to other units (Dlouhy et al., 2018).

The efficiency of transforming inputs into outputs is determined by solving the efficiency of a given production unit. We usually try to maximize outputs, i.e., at the same level of inputs, a higher value of outputs leads to higher efficiency. We try to minimize inputs, i.e., a lower value of inputs at the exact value of outputs leads to higher efficiency (Kocisova, 2012). The primary starting point of the DEA method is the reduction of a larger number of inputs and outputs. The relationship between output and input determines the degree of efficiency. Maximizing the output-to-input ratio gives us the relative efficiency of the decision-making unit. Each decision-making unit is compared with all other units, considering their inputs and outputs. This is a type of benchmarking (Dlouhy et al., 2018).

In efficiency analysis, there is a theoretical set of possible options (production possibility set), which comprises possible combinations of inputs and outputs. The theoretical efficiency frontier determines the production options. Decision-making units that lie on the production possibilities frontier are efficient. Units below the production possibilities frontier are inefficient, and their inefficiency can be measured as the distance from the frontier (Monelos et al., 2014).

Input-oriented models minimize inputs with unchanged output values, and vice versa; output-oriented models maximize outputs with unchanged input values. The criterion for possible classification of models is the nature of returns to scale. In this sense, we distinguish DEA models into models with constant returns to scale (CRS), CCR DEA models, and models with variable returns to scale (VRS), such as BCC

DEA models. Jablonsky & Dlouhy (2004) and Horvathova & Mokrisova (2019) provide a detailed analysis of DEA models.

3. Results

We analyzed 31 small and medium-sized hospitals between 2019 (before the Covid-19 pandemic) and 2023 (after the Covid-19 pandemic). First, the constant returns to scale algorithm and the input-oriented model were used on data from 2019. The results of this procedure are presented in Table 2. Due to the extensiveness of the outputs, we do not include reference data in the table. According to the mentioned algorithm, the most efficient hospitals according to the selected input and output variables are the Ľubovnianska Hospital, the Vranovská Hospital, and the Hospital with Polyclinic Trebišov. Using constant returns to scale and the output-oriented model (CRS OUT), we get the same outputs for Rank and Theta. We also note some negligible differences for slacks for the output variable Satisfaction. For this reason, we do not even present the corresponding table.

Table 2. Input-oriented DEA model with constant returns to scale (2019)

2019	Rank	Theta	Slacks			
			PC/S	E/B	PS	Q
KS	16	0.729		0.173		1.609
SL	1	1		0		0
PP	23	0.655			0.634	
TO	12	0.769			22.611	
PT	4	1		0.271	43.295	
DK	17	0.710			7.305	
SN	8	0.899			5.027	
TS	15	0.738			2.75e-06	1.478
LE	20	0.676			3.73e-06	
CA	29	0.515			1.25e-06	0.0126
LV	25	0.640			40.942	
KN	18	0.698			9.444	
SI	19	0.686			11.626	
MI	11	0.822				
HE	9	0.851			11.013	
DS	10	0.846	0.0308			
ZV	30	0.456			0.562	
LC	14	0.743			9.105	
LM	21	0.671			13.982	
BR	27	0.613		0.378	22.554	0
SK	5	0.998	0.029		3.29e-06	
PD	28	0.569			1.13e-06	8.613
SV	7	0.906			2.07e-06	11.814
VT	1	1			0	
MY	22	0.660				
RV	6	0.975	0.0674		8.21e-07	
BJ	13	0.749		0.246	10.509	
GA	24	0.659	0.0087		11.642	
TV	1	1				
PB	26	0.621			5.517	

Source: own processing

The exact sequence of algorithms was also used to process data for 2023. The Hospital in Žiar nad Hronom was added to the analyzed data, which was evaluated as efficient. The Ľubovnianska hospital retained its position in the group of effective hospitals, to which the Army General L. Svodoba Hospital Svidník was added (Table 3). As in 2019, we do not present the calculation results for CRS OUT 2023, as only minimal differences were noted in the case of Slacks - Satisfaction.

Table 3. Input-oriented DEA model with constant returns to scale (2023)

2023	Rank	Theta	Slacks			
			PC/S	E/B	PS	Q
KS	13	0.911		0.368	2.59e-06	11.0649
SL	1	1				
PP	26	0.736			7.371	
TO	8	0.978			12.283	
PT	5	1		0.159	27.491	
DK	12	0.917			1.567	
SN	18	0.836			4.728	
TS	17	0.862				4.164
LE	6	0.987			13.636	
CA	20	0.832			15.697	
LV	21	0.803			17.391	
KN	28	0.716			7.57e-07	
SI	9	0.966			3.345	
MI	10	0.930				2.456
HE	11	0.924			3.807	
DS	19	0.851				
ZV	31	0.596		0.500	9.00	
LC	14	0.889			3.264	
LM	25	0.757				9.06
BR	22	0.792		0.612	12.449	
SK	1	1				
PD	23	0.782				
SV	7	0.980				8.543
VT	16	0.887				
MY	4	1				8.147
ZH	1	1			0	
RV	24	0.762			2.777	
BJ	27	0.724		0.343	0.721	
GA	30	0.639			11.249	
TV	15	0.889	0.0408			2.661
PB	29	0.695				11.886

Source: own processing

Suppose we use variable returns to scale and input-oriented DEA for 2019. In that case, another effective hospital will be added to the Ľubovnianská Hospital, the Vranovská Hospital, the Hospital with Polyclinic Trebišov - the Army General L. Svodoba Hospital Svidník. The overall results are shown in Table 4.

Table 4. Input-oriented DEA model with variable returns to scale (2019)

2019	Rank	Theta	Slacks			
			PC/S	E/B	PS	Q
KS	25	0.779		0.185	5.592	5.916
SL	1	1		0		
PP	19	0.852			20.426	14.971
TO	16	0.893			36.495	3.768
PT	6	1		0.271	43.295	
DK	26	0.770			16.845	0.927
SN	14	0.916			7.603	
TS	24	0.794			5.095	5.186
LE	21	0.843			17.029	8.316
CA	20	0.844			29.239	21.632
LV	18	0.865			62.915	11.234
KN	15	0.900			27.075	8.334
SI	17	0.866			30.031	8.353

MI	10	0.980			13.628	4.713
HE	12	0.925			20.901	
DS	9	0.992	0.0407		11.954	3.603
ZV	29	0.750			33.475	21.972
LC	8	1			30.825	16.375
LM	27	0.759			24.945	5.343
BR	23	0.795		0.490	40.524	13.472
SK	1	1				
PD	30	0.695			11.424	16.438
SV	13	0.921				13.423
VT	1	1			0	
MY	22	0.822			14.705	8.920
RV	5	1	0.0710		14.705	8.920
BJ	7	1		0.328	30.361	15.117
GA	11	0.937	0.0228		35.854	8.218
TV	1	1				0
PB	28	0.753			22.486	3.598

Source: own processing

The group of efficient hospitals in the case of variable returns to scale and input orientation (VRS IN) was expanded by the AGEL Hospital Košice-Šaca in 2023 (Table 5). Therefore, four hospitals are efficient – AGEL Hospital Košice-Šaca, Ľubovnianska Hospital, Army General L. Svodoba Hospital Svidník, and Hospital in Žiar nad Hronom.

Table 5. Input-oriented DEA model with variable returns to scale (2023)

2023	Rank	Theta	Slacks			
			PC/S	E/B	PS	Q
KS	1	1	0			0
SL	1	1				
PP	28	0.788			12.935	2.277
TO	10	1	0.0755		14.934	
PT	12	1		0.159	27.492	
DK	15	0.969	0.111		7.351	
SN	24	0.883			8.202	
TS	25	0.866	0.0310			4.256
LE	9	1			14.394	
CA	26	0.853			17.309	
LV	23	0.884			25.075	2.064
KN	21	0.896			14.823	7.393
SI	14	0.969	0.0093		3.660	
MI	6	1			3.682	5.286
HE	18	0.946			5.272	
DS	17	0.959			7.617	3.482
ZV	27	0.837		0.702	29.136	13.741
LC	11	1			12.420	3.021
LM	30	0.786			2.354	10.997
BR	20	0.904		0.699	21.490	4.544
SK	1	1				
PD	29	0.788	0.00326			
SV	7	1	0.110			9.108
VT	19	0.905			2.037	
MY	5	1	0.510			7.940
ZH	1	1			0	
RV	16	0.960			21.940	
BJ	13	1	0.473		20.047	14.672
GA	22	0.892			33.942	4.092

TV	8	1			2.330	10.688
PB	31	0.784			5.723	16.539

Source: own processing

The composition of efficient hospitals does not change even after using variable returns in the output orientation in 2019 (Ľubovnianska Hospital, Army General L. Svoboda Hospital Svidník, Vranovská Hospital, Hospital with Polyclinic Trebišov). The results are presented in Table 6.

Table 6. Output-oriented DEA model with variable returns to scale (2019)

2019	Rank	Theta	Slacks			
			PC/S	E/B	PS	Q
KS	9	0.919	0.120	0.651	1.75e-06	1.609
SL	1	1		0	0	0
PP	18	0.746	0.0603	0.182	0.925	0
TO	16	0.776	0.023		23.384	
PT	6	1		0.271	43.296	0
DK	14	0.791	0.171	0.0867	11.821	
SN	8	0.922	0.080		7.797	
TS	15	0.781	0.155	0.0223		4.368
LE	23	0.690	0.0806		1.201	
CA	30	0.530	0.0670		0	1.379
LV	27	0.655	0.0227		42.655	
KN	20	0.703	0.0129		9.863	
SI	21	0.702	0.0554		13.429	
MI	12	0.823			0	
HE	11	0.851			11.0132	
DS	10	0.856	0.0319		1.156	
ZV	29	0.552	0.103	0.181	2.045	1.32e-07
LC	19	0.743			9.105	
LM	13	0.805	0.145	0.252	16.119	
BR	22	0.701	0.0474	0.603	23.03	1.67e-06
SK	1	1	0		0	
PD	28	0.614	0.198		0	12.626
SV	7	0.935	0.0490		1.97e-06	14.617
VT	1	1	0		0	
MY	24	0.669	0.0677		7.78e-07	0.371
RV	5	1	0.0710		2.569	
BJ	17	0.749		0.246	10.510	0
GA	25	0.665	0.010		13.204	
TV	1	1			0	0
PB	26	0.663	0.155		10.392	

Source: own processing

If we use variable returns to scale and the output orientation of DEA (VRS OUT) for 2023, the number of efficient hospitals will be expanded to include the Hospital Snina and the Hospital with Polyclinic Myjava. Therefore, the following hospitals are efficient: AGEL Hospital Košice-Šaca, Ľubovnianska Hospital, Army General L. Svoboda Hospital Svidník, Hospital Snina, Hospital with Polyclinic Myjava and Hospital in Žiar nad Hronom (Table 7).

Table 7. Output-oriented DEA model with variable returns to scale (2023)

2023	Rank	Theta	Slacks			
			PC/S	E/B	PS	Q
KS	1	1	0	0		0
SL	1	1		0	0	0
PP	23	0.845	0.0941	0.256	8.101	0
TO	8	1	0.0936		11.777	

PT	10	1		0.159	27.492	0
DK	11	0.896	0.139	0.00431	8.954	0
SN	18	0.883	0.531		9.052	0
TS	13	0.950	0.136	2.03e-07		3.389
LE	9	1			14.110	
CA	20	0.870	0.0779		21.486	0
LV	25	0.806	0.0241		15.822	
KN	29	0.716			3.4e-06	
SI	12	0.981	0.0416		3.756	
MI	7	1			3.682	5.286
HE	14	0.937			15.602	0
DS	22	0.851			1.256	0
ZV	30	0.656	0.0318	0.673	9.494	0
LC	16	0.893			3.386	
LM	19	0.875	0.106	4.33e-07		5.380
BR	24	0.833	0.0188	0.716	13.186	0
SK	1	1			0	0
PD	21	0.862	0.232		8.790	0
SV	1	1	0			0
VT	15	0.904	0.0251		8.87	
MY	1	1	0			0
ZH	1	1			0	0
RV	26	0.763			11.789	0
BJ	28	0.724		0.342	0.721	0
GA	31	0.653			19.480	0
TV	17	0.889	0.0408			2.661
PB	27	0.724	0.0544			8.007

Source: own processing

4. Discussion

According to the comparison of the performance of the European healthcare systems EHCI (Euro Health Consumer Index), the Slovak Republic took 17th place among 37 countries quantified using 48 criteria (722 points out of 1,000).

The share of expenditure on health decreased negatively from 7.3% of GDP in 2009 to 6.8% of GDP in 2016 and 6.5% in 2023. This development contrasts with the development of expenditures in developed OECD countries, where with the growth of GDP, the percentage of spending on healthcare also increases. In 2020-2021, the share of expenditure on GDP was 7.1%, which is a consequence of the economic impact of the COVID-19 pandemic.

The paper evaluated 31 small and medium-sized hospitals. Using the DEA method, we used input- and output-oriented DEA models with constant and variable returns to scale to analyze the efficiency of hospitals in the Slovak Republic.

A detailed mapping of the capital structure and hospital equipment is essential to increasing hospital efficiency. Stefko et al. (2018) used DEA to evaluate the efficiency of healthcare facilities at the regional level of Slovakia from 2008 to 2015.

Among the small and medium-sized hospitals, the most efficient hospitals included Ľubovnianska Hospital, Army General L. Svoboda Hospital Svidník, and Hospital in Žiar nad Hronom. For comparison, according to the Institute for Economic and Social Reforms (2024), before and during the pandemic (2018-2021), AGEL Hospital Košice-Šaca ranked 1st place in small and medium-sized hospitals. In the post-covid period in 2023, in the overall ranking, AGEL Hospital Košice–Šaca took the 1st place in the ranking of the best hospitals, Ľubovnianska Hospital took the second place, and Hospital Poprad took the 3rd place.

Conclusion

Due to the impact of globalization and worldwide problems, it is necessary to monitor the economic environment. Each decision-making unit should analyze its financial and economic situation and predict its future development. The paper aimed to examine the efficiency of hospitals in the Slovak Republic

using the DEA method. The research sample consisted of 31 small and medium-sized hospitals according to SK NACE 86 - Healthcare and SK NACE 861 - Hospital activities. For the analysis, we used both input- and output-oriented DEA models with constant and variable returns to scale. The efficiency of selected hospitals in the Slovak Republic was analyzed using data from 2019 (before the COVID-19 pandemic) and 2023 (after the COVID-19 pandemic).

Among the small and medium-sized hospitals, the most efficient hospitals included Ľubovnianska Hospital, Army General L. Svoboda Hospital Svidník, and Hospital in Žiar nad Hronom.

The study has a limitation: We only considered four variables. Future research could explore whether including additional variables improves the accuracy of the DEA model.

Patient satisfaction, quality, professional experience, expertise, transparency, economy, efficiency, effective management of financial resources, and above all, humanity are essential criteria that are the primary measure of evaluation of all medical facilities.

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Preventive Diagnostics of Financial Statements Data Empirical Analysis

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Abstract

Research background: Economic data are a crucial component of quantitative tools widely applied in analytical and comparative studies. It is evident that only accurate data are suitable for such analyses. Nevertheless, numerous studies indicate that economic data are frequently manipulated, which limits their reliability and prevents their proper numerical application. As Nobel Prize laureate in economics (2009) Prof. Paul A. Samuelson observed, *"Economics is not an exact science—it is a blend of art and elements of science."* Similar critical perspectives on the quality and usability of data in quantitative research have been expressed by many leading economists. This paper seeks to build on these insights by providing an empirical analysis of data quality issues.
Purpose of the article: The primary aim of this paper is to identify instances of incorrect accounting data and to demonstrate the potential of empirical analysis in developing more effective tools for preventive data quality control.
Methods: For this purpose, we apply a range of analytical techniques, including descriptive statistics, correlation and regression analysis, logistic regression, classification methods, discriminant and cluster analysis, econometric modeling, and specialized software-based evaluation tools. The most effective approaches are presented in detail.
Findings & Value added: The empirical analysis demonstrates the potential of non-parametric techniques for verifying the quality of economic data in corporate financial statements prior to their statistical processing. These methods not only help detect incorrect data but also uncover improper accounting practices and their negative implications for quantitative analyses and modeling. The findings also highlight the role of data diagnostics in preventing financial fraud.

Keywords: Economic data, Accounting data collection, Data processing, Statistical data quality, Economic data quality, Data manipulation

JEL classification: C81, M41

1. Introduction

Quantitative tools are an integral part of both economic science and managerial practice. They are widely applied in empirical analysis and in evaluating the economic performance of business entities, both individually and in comparison, with technologically and marketing-wise similar companies. These tools also serve as instruments for the rationalization and optimization of production and marketing strategies. However, practical experience confirms that *"the fundamental prerequisite for the effective application of analytical and modeling tools in managerial decision-making is the quality of data"* (Randieri, 2024). In this sense, it is essential to place stronger emphasis on data quality and to recognize it as a key factor in fostering economic growth (Ker & Lesher, 2021).

This paper concentrates on economic data generated, presented, and archived within enterprise accounting systems. Such data, typically accessible through annual financial statements, constitute a fundamental information source not only for managerial decision-making at the firm level but also for

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broader applications, including economic analyses, tax and levy assessments, and financial coordination of relationships with business partners.

To fulfill these functions, the data must be both reliable and applicable in managerial practice. Unlike statistical data, the qualitative attributes of accounting and economic data are not formally defined, which makes quality control algorithmically complex. This complexity is further increased by the fact that data quality is interpreted differently across user perspectives and contextual frameworks.

The only broadly accepted attribute of economic data quality is its **multidimensional character** (Serra, 2024). Accordingly, data quality is typically understood as a composite of characteristics such as value accuracy, user credibility, contextual relevance, formal and substantive consistency, and comparability with relevant datasets (Azeroual, Saake & Abuosba, 2018). Data meeting these criteria are considered *correct*, while those failing to do so are labeled *incorrect* (Pieńkowski & Skýpalová, 2024).

Verifying these attributes within large datasets—particularly identifying contaminated or distorted data—requires algorithmic and software support. One of the most effective approaches is the application of data analysis methods, which have become not only a prevailing trend but also a cornerstone of modern business strategy. Firms that adopt advanced data analytics are better positioned to respond to market dynamics and to design optimal growth strategies (Adebayo et al., 2024). However, such applications presuppose the availability of correct accounting data. Empirical evidence indicates a high incidence of accounting data that are inconsistently processed, erroneous, or deliberately manipulated. Leaving such data in the analytical set may distort derived economic parameters and misrepresent key indicators of business performance (Alabdullah, 2016).

These distortions can lead to the failure of major international corporations (Khan, 2011) and to misinformation about a company's market position (Alabdullah, 2016). Even more serious are the consequences for econometric modeling, where contaminated input parameters compromise the accuracy of subsequent analyses. The dissemination of incorrect information undermines both transparency and trustworthiness in the market environment. The persistent presence of manipulated data in analytical applications is also confirmed by crime statistics in Slovakia (Staričková, 2019; Generálna prokuratúra SR, 2024).

Ensuring the quality of economic data therefore requires rigorous control of financial statements and the elimination of incorrect data prior to any numerical processing. In practice, this implies that accounting data should undergo preventive **pre-processing quality checks**.

The purpose of this paper is to present selected methods of data analysis for verifying the correctness of accounting data and identifying the potential sources of inaccuracy. A wide range of analytical tools may serve this purpose, including descriptive statistics, correlation and regression analysis, logistic regression, classification techniques, discriminant and cluster analysis, econometric models, specialized software tools, and other evaluation and comparison methods. Illustrative applications of these approaches are presented in the subsequent sections of the paper.

1.1 Literature Review

Discussions on the quality of economic data, particularly accounting data, emphasize that such data should not be treated as statistical data by default. Rather, they are a byproduct of production and marketing activities at the enterprise level. Their collection cannot be repeated, nor can their accuracy be independently verified (Spiegler, 2024). Consequently, all actors involved in data collection bear responsibility for safeguarding the informational value and integrity of these records (Purtova & Van Maanen, 2024). Accounting data also constitutes the primary input for a wide spectrum of economic, econometric, and financial indicators (Lubis, 2023).

Research and empirical evidence suggest that economic data often fail to meet the necessary quality standards, which complicates—or even precludes—further numerical processing. One of the earliest strong warnings came from Prof. Morgenstern (1993), who emphasized the adverse consequences of inaccurate economic data. He illustrated the risks of widespread econometric processing without adequate accuracy checks and noted that, *"unlike in the natural and technical sciences, economic data do not include accompanying information on their accuracy or data collection methods."* This absence of metadata fundamentally limits their practical applicability. Morgenstern thus expressed doubts about *"the overall quality of economic data, particularly their usability in econometric applications"* (Grilliches, 1984; Bagus, 2011).

In recent decades, concerns over numerical reliability have been overshadowed by the problem of deliberate manipulation, commonly referred to as *creative accounting* (Murineanu, 2024). As a result,

academic, professional, and user communities increasingly focus on protecting data environments by identifying and eliminating incorrect values in the pre-processing phase. Manipulated data within databases may also conceal corporate corruption (Al-Shanti et al., 2024; Fisman, 2024). Numerous studies report intentional distortions of economic data (Al-Asfour, 2024; Murphy, 2024). Some of these arise from random errors or inappropriate accounting practices. While the former may constitute criminal offenses, the latter are often tolerated under the label of "creative accounting." Detecting both types of compromise is difficult, requiring reliance on indirect indicators and testing procedures (Donelson et al., 2021). Given the multi-criteria nature of data quality, more detailed verification is necessary when comparing accounting values across similar firms (Alazzam, 2022).

A noteworthy methodological approach to this challenge is **Comparative Corporate Analysis (CCA)**, which employs multi-criteria processing and comparison of extensive enterprise-level information to identify similarities or differences across firms. The method assumes that companies with comparable resources, outputs, production characteristics, labor structures, and strategies should achieve similar economic outcomes, reflected in their accounting data (Vipond, 2025; Bharadiya, 2024). For such analyses to be valid, accounting data must be reliable so that indicators derived from them are suitable for econometric and related modeling. Pre-processing analysis of economic data is therefore indispensable and should be incorporated into any project involving numerical processing of accounting records (Fan, 2021).

The concept of economic data quality itself is not formally defined. Due to the administrative character of accounting data, the correctness of reported values cannot be statistically verified (Bertomeu, 2023). Accounting records lack defined statistical distributions and are thus inherently **non-parametric**, which complicates quality assessment. The literature repeatedly stresses the need for control procedures (Mucko & Adamczyk, 2023). In practice, the principal criterion for evaluating economic data quality is demonstrated compliance with established administrative rules and the proximity of reported values to those of comparable products and services. However, the flexibility of accounting rules allows for a broad scope of result manipulation.

A particularly sensitive issue is the treatment of **outlier values**. While such deviations may signal technological or marketing innovations, they can equally reflect data manipulation (Shehadeh et al., 2022). In such cases, additional theoretically or empirically justified assessment procedures are required (Aragao & Lins, 2024).

Against this backdrop, the objective of this paper is to demonstrate the potential of non-parametric techniques for verifying the quality of economic data contained in corporate financial statements before statistical processing. These methods not only assist in identifying incorrect data but also expose improper accounting practices that distort subsequent quantitative analyses and modeling, many of which may be associated with fraudulent activities.

1.2 Topical relevance of the issue

The effective use of data has become a key component of both national and corporate development strategies. Large, information-rich datasets enable governments and enterprises alike to make operational and strategic decisions that not only stimulate economic growth but also foster innovation across industries (Wencn, 2024).

In the literature, data are often described as a "hidden tool" of business decision-making and a "hidden source" of market success. Data resources also accelerate technical, organizational, and managerial processes, thereby playing a decisive role in generating new value at both the enterprise and societal levels (Bernardoa et al., 2024).

Operational and strategic management requires the coordination of internal and externally oriented activities, encompassing performance-related tasks as well as material, service, and intellectual outputs. Such coordination is impossible without the continuous availability of accurate information, both structurally and temporally. For this reason, enterprise management must systematically monitor production inputs and evaluate their efficiency (Gegoire et al., 2024). Reliable data on ongoing economic and marketing processes are also indispensable for comparing the performance of firms operating in technologically and market-wise comparable environments (Vipond, 2024). Yet, our empirical analyses of primary data reveal a high proportion of incompletely or inconsistently processed accounting records, which reduces market transparency and constrains the scope of comparative analyses at the enterprise level.

These findings raise serious concerns about the methodology and practice of accounting data processing and verification. It is well documented that *creative accounting* exploits gaps in accounting

standards (Palanský & Schultz, 2024) and can be used to manipulate the informational portrayal of a company's competitiveness and market performance. In practice, this often involves artificially inflating profitability or distorting publicly visible indicators (Mileusni, 2024).

Various forms of creative accounting occur across multiple stages of the accounting process. Common techniques include:

- overstating revenues,
- reducing depreciation,
- deferring payments,
- concealing liabilities on both revenue and expenditure sides,
- misusing inventory adjustments,
- manipulating reported outcomes of corporate philanthropy.

Given the potential presence of such manipulated data, enterprise information systems should incorporate mechanisms for **preventive, pre-processing control** of economic data before they are entered into databases—and especially before they are subjected to statistical analysis. Statistical evidence confirms that the misuse and manipulation of accounting records frequently lead to criminal offenses with significant financial consequences for society (Mokrá et al., 2023). Monitoring relevant data is therefore essential to minimize risks of corruption or misuse in economic crime. This is confirmed by statistics from Slovakia (Table 1), which report on economic crimes including tax evasion, embezzlement, currency violations, corruption, and fraud.

Table 1. Development of economic crime in Slovakia, 2006–2025

Economic crime in Slovakia over 2006-2025												
	Economic criminality				Tax evasion				Embezzlement of funds			
	Detected	Clarified	%	Estimated loss 1000 euro	Detected	Clarified	%	Estimated loss 1000 euro	Detected	Clarified	%	Estimated loss 1000 euro
2006	19 167	9 616	50	303 986	1 689	807	48	41 198	1 486	841	57	24 241
2007	17 895	8 237	46	713 671	1 974	1 008	51	2 004 950	1 435	752	552	827 081
2008	16 974	7 513	44	278 791	1 845	929	50	67 201	1 421	758	53	28 764
2009	19 518	8 739	45	350 554	2 702	1 344	50	148 175	1 524	904	59	30 292
2010	16 781	7 338	44	550 841	2 229	1 185	53	156 823	1 423	903	63	28 538
2011	18 145	8 137	45	438 933	3 573	1 927	54	138 661	1 378	863	63	21 502
2012	16 681	7 272	44	583 768	3 679	2 385	65	160 969	1 101	670	61	28 277
2013	19 218	7 995	42	438 816	6 053	3 057	51	142 280	1 023	641	63	17 852
2014	17 450	8 060	46	355 595	5 739	3 440	60	139 220	851	531	62	18 053
2015	15 661	7 375	47	313 247	4 911	3 145	64	93 834	785	498	63	36 996
2016	14 895	6 994	47	303 166	5 585	3 721	67	133 801	706	426	60	14 410
2017	14 460	7 108	49	1 425 195	5 734	4 082	71	111 714	622	422	68	15 474
2018	13 515	6 784	50	284 000	5 392	3 851	71	122 797	560	385	69	8 404
2019	13 326	6 757	51	420 322	5 713	4 085	72	220 602	486	341	70	8 829
2020	11 212	5 171	46	235 405	4 130	2 783	67	69 246	382	235	62	9 857
2021	11 844	4 872	41	565 232	4 275	2 656	62	197 405	372	200	54	15 096
2022	12 767	4 923	39	379 527	5 176	2 950	57	119 535	312	190	61	8 209
2023	12 951	4 726	36	363 592	4 806	2 824	59	122 534	307	156	51	8 340
2024	9 544	3 681	39	823 249	2 911	2 114	73	563 695	289	156	54	10 536
2025*	740	253	34	14 262	236	151	64	4 974	29	10	34	141

Economic crime in Slovakia over 2006-2025												
	Currency protection				Corruption				Fraud			
	Detected	Clarified	%	Estimated loss 1000 euro	Detected	Clarified	%	Estimated loss 1000 euro	Detected	Clarified	%	Estimated loss 1000 euro
2006		92	14,	108 893	255	180	71		3 576	1 360	38	3 315 864
2007		84	13,	897	211	119	56		3 762	1 438	38	556
2008		63	9,0	2 399	260	174	67		3 795	1 529	40	2 616 955
2009		86	4,0	64	231	143	63		3 867	1 678	43	97 731
2010		45	2,0	62	148	82	55		3 755	1 637	44	282 147
2011		43	2,0	4 045	199	133	63		3 810	1 561	41	91 531
2012		28	1,0	2 584	139	82	59		3 354	1 239	37	256 126
2013		32	1,0	85	124	54	44		3 469	1 300	37	182 250
2014		31	2,0	51	134	51	38		3 008	1 110	37	102 915
2015		40	3,0	230	131	66	50		2 700	1 036	38	62 594
2016		33	2,0	70	106	60	57		2 312	874	38	74 314
2017		49	3,0	55	168	97	58		2 264	837	37	62 351
2018		45	4,0	167	151	79	52		2 157	843	39	69 346
2019		33	3,0	78	136	75	55		1 890	667	35	57 380
2020		46	5,0	3 733	131	80	61		1 665	568	34	58 542
2021		15	2	41	186	126	68		1 911	535	28	110 983
2022		9	1,0	35	138	80	58		2 122	572	27	96 115
2023		35	3,0	202	82	51	62		2193	560	26	96 463
2024	1 411	23	2,0	112	49	32	65		1 449	341	24	44 756
2025*	80	2	3,0	2	4				120	18	15	5 576

Source: Ministry of the Interior of the Slovak Republic; authors' processing

The statistics confirm that economic crime represents a major source of financial losses for society. Minimizing these losses is a long-term societal objective. Yet, this task is difficult, as identifying the primary sources and perpetrators of economic crime through accounting data manipulation is highly complex. Offenders often employ sophisticated methods that exploit legal loopholes and vague formulations within accounting standards. Moreover, the consequences of such criminal activity are often revealed only after considerable delay, which complicates and slows down the collection of evidence necessary for detection and prosecution.

The proposed pre-processing methodology seeks to facilitate the early identification of incorrect accounting values, thereby helping to prevent or block problematic operations at their initial stage. Practical experience shows that many such cases stem from careless, unqualified, or deliberate manipulation of data. Detecting such failures therefore requires detailed analysis of accounting procedures and long-term monitoring of cooperating entities and their accounting practices.

In the following section, attention is directed to preventive (pre-processing) analysis of accounting data, employing firm size classification, economic categorization, and other suitable tools of data analysis.

2. Methods and Data

The preceding discussion highlighted the complexity of verifying the quality and reliability of economic data. This paper focuses specifically on **accounting data**, with the objective of distinguishing between *correct* and *incorrect* values. Unlike statistical data, accounting data are not parametrically defined and cannot be experimentally reproduced (Leeson, 2020). Their interim and annual values are strongly influenced by changing market conditions for specific goods and services. Correct values are those that reflect market-generated prices for comparable goods and services—such as the unit price of wheat, coffee, or various technical products. Moderate deviations may reflect legitimate marketing strategies, whereas extreme divergences from market or contractual prices may indicate data manipulation (Wang, 2025).

Such distorted data are regarded as economically incorrect. Their detection is particularly challenging in cases involving products not subject to direct market competition. In such situations, only detailed comparisons of production and cost structures across comparable firms allow for a meaningful assessment of economic correctness. Importantly, comparisons must be limited to products and services that are both technologically and commercially similar. Within the European Union, price comparisons are further complicated by subsidy policies (Hockner et al., 2020), which distort market prices, for example, in agricultural products such as milk and meat.

Nevertheless, the scope of data correctness extends beyond pricing indicators. It also includes production volume, product quality, and cost efficiency, all of which are derived from accounting records. Reliable economic data is indispensable for both operational and strategic business management. The effort to eliminate or minimize incorrect accounting data and to prevent their use in subsequent analyses has thus become a central concern in both economic theory and econometric practice.

In this paper, **we address the issue of accounting data quality** at the enterprise level. For empirical analysis, we apply classification and comparative tools designed to identify not only economically incorrect values but also inappropriate accounting practices.

The prerequisite for meaningful comparative analysis is the prior classification of enterprises according to appropriate indicators. In our analysis, we therefore apply two principal criteria:

- **Size-wise classification of enterprises** – based on the values of selected accounting items.
- **Classification of enterprises according to EU methodology** – based on economic activities and products.

2.1 Size-wise classification of enterprises

Classifying business entities by size allows for a more detailed analysis of their performance. When applied across multiple years, such classification also enables tracking of business growth, decline, or dissolution, as well as structural changes in the distribution of firm size categories.

Within the European Union, size classification is typically based on a dual criterion: **total assets** and **annual turnover** (see Table 2).

The classification of enterprises by their core financial parameters facilitates the identification of groups of size-wise comparable firms. It can reasonably be expected that their efficiency levels and other economic indicators will be closer in value, which in turn enables meaningful mutual comparison. Given the absence of a precise measure of the accuracy of economic data, this alternative approach to verifying quality is especially valuable. For this reason, size indicators must be systematically monitored and taken into account in the processing of accounting data.

Table 2. Breakdown of enterprises by size

Size category	Total assets (EUR)	Sales category	Annual sales (EUR)
a1	less than 350,000	**o1**	less than 700,000
a2	350,000 – 4,000,000	**o2**	700,000 – 8,000,000
a3	over 4,000,000	**o3**	over 8,000,000
nn*	not specified	**nn**	not specified

Source: Eurostat, authors' processing (2025)

*Note: The symbolic code **a1-o1** refers to enterprises with assets below €350,000 and annual sales below €700,000. The symbol **nn** indicates missing data on assets or annual sales.*

2.2 Firms' classification according to the EU methodology

The size of an enterprise—whether measured by assets, number of employees, annual investment, or other indicators—constitutes one of its core attributes. However, economic data are expected to capture more than the financial value of material or service outputs. For analytical and policy purposes, there is strong demand for monitoring the *modes and technologies* through which economic products or services are generated. To address these needs, economic statistics combine two perspectives:

1. the outcomes of economic activities undertaken by enterprises, and
2. the nature of products of the activities themselves.

Accordingly, results are presented through two complementary classification systems: **the classification of economic activities** and **the classification of products by activity**.

The collection and processing of economic data are carried out within these frameworks. To ensure comparability across different systems, consistent coordination of methodological procedures is required. EU statistical programs are integrated into the global statistical system, which means that the EU's methodology for data collection and processing—**NACE**—must align with internationally recognized standards.

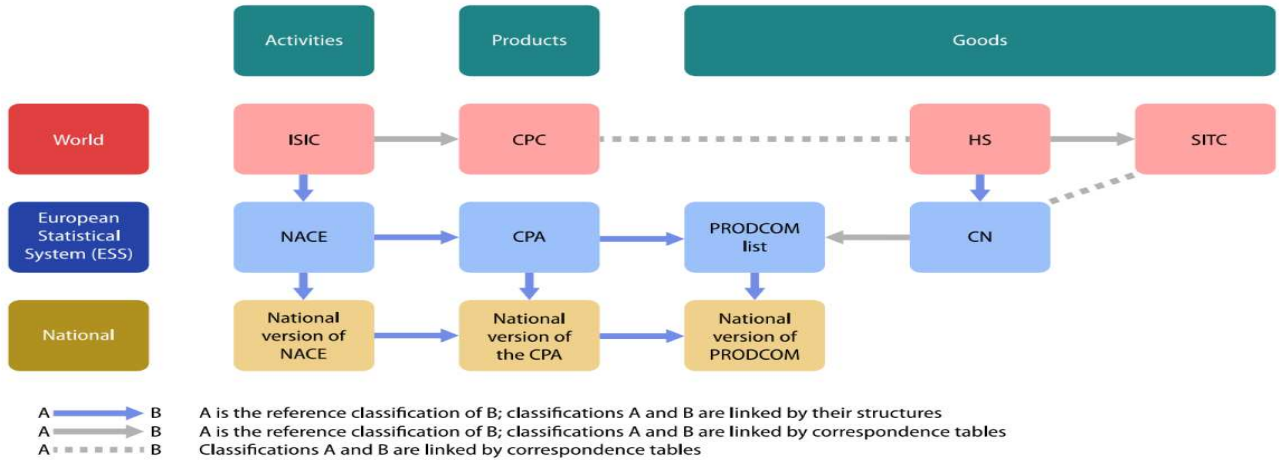

Figure 1. International systems of statistical classification
Source: https://ec.europa.eu/eurostat/statistics-explained/images/thumb/0/06/International_system_of_classifications. PNG/750px-International_system_of_classifications.PNG

2.2.1 Classification of economic activities (NACE)

The NACE system classifies economically active enterprises and accounting units in the European Union according to the nature of their activities. It was derived from the **International Standard Industrial Classification (ISIC)**, which is maintained under the methodological supervision of the United Nations.

NACE is structured as a four-level, four-digit system that provides the framework for sorting, collecting, processing, and presenting statistical data in economic, social, environmental, and agricultural domains:

- **First level**: 22 sections identified by alphabetical codes (A–V).
- **Second level**: 87 divisions identified by two-digit numerical codes (01–99).
- **Third level**: 287 groups identified by three-digit numerical codes (01.1–99.0).
- **Fourth level**: 651 classes identified by four-digit numerical codes (01.11–99.00).

The system also contains "reserved gaps," which allow for the future introduction of new divisions without requiring a complete restructuring. These were intentionally included in areas of expected technological expansion.

2.2.2 Classification of Products by Activities (CPA)

The CPA system classifies products—both goods and services—within the European Union. It is the EU equivalent of the internationally applied **Central Product Classification (CPC)**, ensuring consistency and comparability of statistics across EU member states and internationally.

Product classifications group together items with shared characteristics and provide the basis for generating statistics on production, consumption, trade, and transport. CPA product categories are explicitly linked to NACE activities: each CPA product—whether tangible or intangible, good or service—is assigned to a corresponding NACE activity. This linkage ensures a parallel structure between CPA and NACE at all levels.

Like NACE, the CPA follows a hierarchical structure but extends further into greater detail:

- **First level**: 22 sections (alphabetical code).
- **Second level**: 87 divisions (two-digit numerical code).
- **Third level**: 284 groups (three-digit numerical code).
- **Fourth level**: 644 classes (four-digit numerical code).
- **Fifth level**: 1,432 categories (five-digit numerical code).
- **Sixth level**: 3,359 subcategories (six-digit numerical code).

Thus, while the first four levels of CPA closely mirror NACE, the fifth and sixth levels provide additional granularity, particularly for rapidly evolving sectors such as digital technologies and AI-based services.

For the purposes of this paper, and given space limitations, the empirical analyses are illustrated using datasets processed and archived under the EU **NACE methodology**.

2.3 Data analysis – analytical tools for checking data correctness

The empirical analysis presented in this paper focuses on three core accounting variables: **assets, sales, and profits**, as reported in the annual financial statements of individual enterprises. By analyzing and comparing these variables across firms of different sizes and different SK NACE classifications, we aim to highlight not only differences in absolute values but also anomalies in the underlying accounting data that generate such outcomes.

Our interest lies particularly in those primary accounting values whose **economic interpretation appears questionable or inconsistent**. To confirm or reject preliminary assessments of data quality, we employ non-standard procedures, specifically applying correlation and regression analysis. Illustrative applications of these techniques are also presented graphically to demonstrate their diagnostic potential.

The primary objective of the empirical analysis is to identify accounting data that are **value-wise inconsistent or economically unacceptable** within their respective classification groups. Potential sources of such inconsistencies include:

- **incorrect size classification** of enterprises,
- **incorrect statistical classification** of enterprises,
- **erroneous processing** of primary accounting data, or
- **intentional manipulation** of data.

Each case identified according to these criteria is assigned to a group of enterprises whose accounting items require further verification of their reliability. To illustrate and clarify these procedures, we provide supporting graphical presentations. Interpreting these graphs assumes at least basic familiarity with descriptive statistics, graphical data representation, and the interpretation of statistical relationships.

3. Empirical data analysis - results

To assess the correctness of economic data, this study draws on accounting records available through the **FINSTAT platform** (www.finstat.sk). In total, more than **60,000 annual financial statements** from companies across the Slovak economy were examined. The analysis revealed a relatively high share of **low-quality or inconsistently processed data**. If such data are not identified and eliminated during pre-processing, they can contaminate larger datasets and significantly distort the results of subsequent quantitative analyses and modeling applications. For this reason, suspect data were flagged and forwarded for additional verification.

For illustration, we focus on accounting data for the years **2023–2024**, covering four selected industries with a total of **9796 companies**. The choice of industries was guided both by the number of firms and by the diversity of NACE classifications.

Sample composition by industry (NACE classification):

- **C24 – Production of base metals:** 262 companies
- **C25 – Manufacture of metal products:** 5,303 companies
- **C29 – Manufacture of motor vehicles:** 448 companies
- **I56 – Catering and beverage services:** 3,783 companies

3.1 Data analysis – Size breakdown of companies

For meaningful processing of economic data at the corporate level, it is essential to account for the **size of the enterprises** from which the data originate. Various indicators can be used for size classification, but in line with EU methodology, the firms in our sample were divided into **nine size groups** based on the reported values of **assets** and **annual sales** in their financial statements (Table 3).

For example, enterprises with assets of up to **€350,000** and annual sales of up to **€700,000** fall into the **a1-o1** group. This group alone includes **6,442 companies**, representing **65.76%** of the total sample. This demonstrates the **dominant role of small and medium-sized enterprises (SMEs)** in the Slovak economy. By contrast, only **3.23%** of companies belong to the largest category, exceeding 4 million in assets and €8 million in sales.

Table 3. Breakdown of enterprises in the sample by size

Assets\Sales	**o1**	**o2**	**o3**	**nn**	**∑a**
a1 (< €350k)	6442	199	0	0	6641
a2 (€350k–4m)	625	880	17	0	1522
a3 (> €4m)	16	109	316	0	441
nn* (missing)	390	19	0	783	1192
∑o	7473	1207	333	783	9796

Source: Fin Stat; authors' processing (2025)

The size classification enables more accurate evaluation of firms' economic performance within comparable groups. It also provides insights into broader structural changes in the economy. For example, a decline in the number of enterprises in the a1-o1 group may signal the disappearance of micro-firms, whereas increases in a2-o1, a1-o2, or a2-o2 groups may indicate firm growth and upward mobility across size categories.

3.2 Correlation and regression approach

In this section, we illustrate the application of **correlation and regression techniques** for verifying the relationships between key accounting variables: **assets, sales, and profits**. To support the analysis, both tabular and graphical representations are employed.

Table 4 provides examples of selected accounting data (SK NACE 24, 25, 29, and 56), while **Table 5** summarizes descriptive indicators, including minimum and maximum values for assets, sales, and profit across the chosen industries.

The main task is to assess the quality of the entire dataset of 9,796 companies, with particular attention to identifying economically incorrect values. Neither individual data entries nor simple descriptive statistics such as minimum and maximum values are sufficient to achieve this. For instance, the occurrence of **negative profit values** (as shown in Table 5) requires deeper investigation to determine whether they result from legitimate economic conditions or from errors and manipulation.

As discussed in the introduction, there is no direct measure of accuracy for economic values. Therefore, **indirect tools such as correlation and regression analysis must be applied**. These methods are illustrated using partial samples (Table 4) from the four SK NACE sections: C24 – Production of base metals (262 firms), C25 – Manufacture of metal products (5,303 firms), C29 – Manufacture of motor vehicles (448 firms), and I56 – Catering and beverage services (3,783 firms).

Table 4. Illustration of selected accounting data SK NACE 24-25-29-56

IČO	SK NACE	Assets	Sales	Profit
36199222	24100	2 589 475 000	2 684 573 000	-99 608 000
36389030	24100	92 157 810	95 001 567	-7 956 516
36579751	24100	3 627 079	19 534 176	155 935
35930837	24100	11 284 754	12 620 401	-1 256 639
31646697	24100	3 995 867	11 558 567	-60 657
53059280	24100	5 507 943	6 917 661	53 128
50901311	24100	143 529	4 791 095	81 242
50854691	24100	1 201 638	4 514 997	54 412
48259691	24100	1 608 853	2 602 993	-421 304
52163334	24100	539 161	1 943 352	402
51337053	24100	553 691	1 921 662	6 671
50982109	24100	1 319 534	1 808 497	-16 557
46121391	24100	2 038 218	1 710 843	4 217
51419297	24100	861 776	1 556 582	5 066
53591313	24100	2 705 172	1 495 665	600 218
31562141	24200	346 065 125	276 693 807	-30 828 976

Source: Fin Stat; authors' processing (2025)

Table 5. The selected descriptive indicators

SK NACE		Assets	Sales	Profit
24	Minimum	143 529	1 418 941	**-99 608 000**
	Maximum	2 589 475 000	2 684 573 000	12 933 000
SK NACE		**Assets**	**Sales**	**Profit**
25	Minimum	12 031	1 145 764	**-9 555 918**
	Maximum	346 065 125	338 838 000	12 933 000
SK NACE		**Profit**	**Sales**	**Profit**
29	Minimum	0	100 580	**-48 434 643**
	Maximum	3 838 581 000	12 520 644 000	682 581 000
SK NACE		**Assets**	**Sales**	**Profit**
56	Minimum	12 031	1 145 764	**-99 608 000**
	Maximum	346 065 125	338 838 000	12 933 000

Source: Fin Stat; authors' processing (2025)

By adding the NACE classification code as an additional variable, we can compare results across industries. For example, the dataset presented in Table 4 shows firm-level identifiers (IČO), NACE code, and the associated values of assets, sales, and profit. However, even with this structured format, no clear conclusions about correctness can be drawn. Similarly, the variance estimates in Table 5 provide only limited insights. For this reason, **graphical methods** are applied. **Figure 2** illustrates two different types of relationships:

- a relatively strong regression-type relation between **assets** and **sales**, and
- a relatively weak relation between these variables and **profit**.

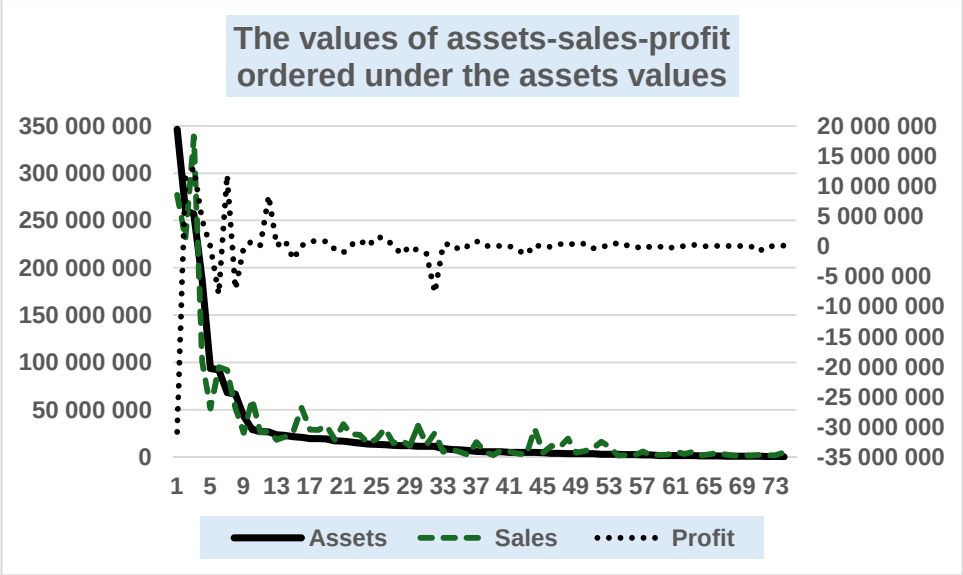

Figure 2. The values of assets – sales-profit ordered under the assets values
Source: Fin Stat; authors' processing (2025)

While the graphs do not provide definitive answers, such findings serve as valuable signals for deeper economic analysis.

Figure 3 presents the distribution of assets and sales across 282 selected companies, revealing a relatively high level of consistency. This is consistent with expectations and confirms the usefulness of regression coefficients as complementary, though not decisive, indicators of data quality.

It is important to note, however, that the dataset includes enterprises of very different sizes. This heterogeneity can significantly distort descriptive measures. Therefore, in addition to structural (NACE-based) classification, it is also appropriate to disaggregate data according to **firm size criteria**.

Figure 4 highlights a special case: a slightly **negative relationship** between assets and profit. From an economic perspective, this is questionable and warrants re-examination. For example, the company marked as **point B** should undergo recalculation and verification of its reported data. In practice, the above situation can arise if the accounting unit records depreciation of assets and sales have significantly decreased for the given accounting period. In this case, it is necessary to review the correctness of the depreciation calculation and the reason for the decrease in sales.

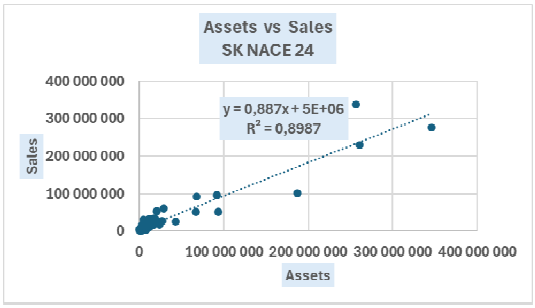

Figure 3. Assets vs Sales SK NACE24
Source: Fin Stat; authors' processing (2025)

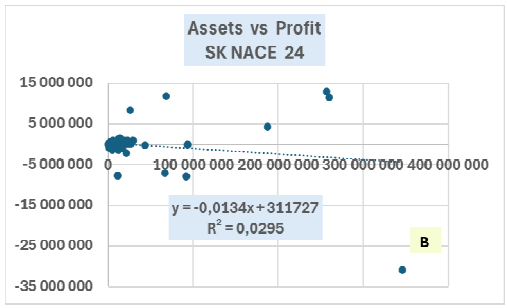

Figure 4. Assets vs Profit SK NACE24
Source: Fin Stat; authors' processing (2025)

Similar considerations apply to **Figures 5 and 6**, which highlight firms with extremely high values for certain variables (e.g., **Point C**). Such cases may indicate low marketing efficiency across the dataset or, alternatively, possible data manipulation. These outliers therefore require careful verification of primary accounting records.

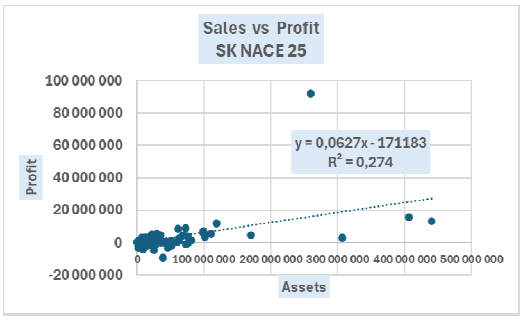

Figure 5. Sales vs Profit SK NACE25
Source: Fin Stat; authors' processing (2025)

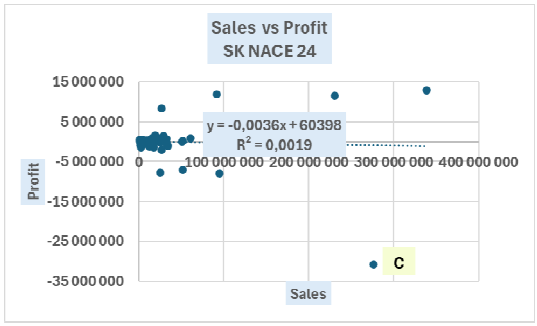

Figure 6. Sales vs Profit SK NACE 24
Source: Fin Stat; authors' processing (2025)

However, the above graphical situation presents also strong economic message on low efficiency of marketing activities across the whole set of companies studied. Referring to theoretical section, the clarification of this situation requires also qualified checking of primary data. Possible data manipulation should be considered.

Given the central role of assets, sales, and profit as pillars of corporate accounting, their reliability must be checked using both descriptive characteristics and correlation/regression diagnostics within the **pre-processing quality control framework**.

4. Discussion

Empirical analysis underscores the **complexity of verifying the quality of economic data**. This complexity arises not only from the large volume of accounting records to be processed but also from their heterogeneous character and the methodological challenges of distinguishing between correct and incorrect values.

A fundamental prerequisite for the effective use of quantitative analytical tools is the **accuracy of data input**. The consequences of relying on incorrect or manipulated records are especially severe in econometric modeling, where flawed parameters may generate systematically biased results. Such distortions can mislead managerial decision-making, misrepresent a firm's competitive position, and in extreme cases, contribute to corporate failure.

It is important to stress that low-quality or misleading data do not always stem from intentional manipulation. Frequently, they may result from **inadequate accounting procedures**, **insufficient professional qualifications of staff**, or **loopholes in accounting standards**. Regardless of origin, however, the presence of incorrect data undermines the credibility of analyses and diminishes transparency of the relevant market environment.

The findings confirm that **conventional descriptive statistics and simple data checks are insufficient** for ensuring data correctness. More sophisticated approaches—such as correlation and regression analysis, classification methods, and comparative techniques—are necessary to uncover economically inconsistent or questionable values. While indirect, these tools provide valuable evidence for preventive data diagnostics.

Furthermore, the results highlight the importance of **structural factors** such as company size and industry classification. Size-wise breakdowns enable the identification of clusters of comparable enterprises, while NACE-based classification facilitates benchmarking within sectors. When used in combination, these approaches substantially enhance the reliability and robustness of data quality verification.

Conclusion

The quality of economic data is a **fundamental prerequisite** for their effective application in empirical analysis, econometric modeling, and managerial decision-making. Incorrect or manipulated data not only distorts analytical outcomes but also diminishes transparency and undermines trust in the market environment. For this reason, **preventive diagnostics and pre-processing quality control** must be regarded as essential components of modern data management.

The empirical analysis conducted in this study confirms that **conventional descriptive statistics alone are insufficient** for verifying the correctness of accounting data. Instead, more advanced

approaches—such as correlation and regression analysis, classification methods, and comparative techniques—are required to detect economically inconsistent or suspicious values.

The results also emphasize the importance of **structural perspectives**, particularly enterprise size classification and industry-based sorting (NACE). These classifications enable benchmarking within comparable groups of firms and enhance the robustness of preventive diagnostics.

From a practical standpoint, integrating **systematic pre-processing checks** into enterprise accounting systems would significantly improve the reliability of economic data. Such measures would not only strengthen the credibility of subsequent analyses but also support better-informed managerial decisions and foster greater transparency in the business environment.

Future research should focus on **refining preventive diagnostic methodologies** and testing their effectiveness across diverse datasets, industries, and national contexts. Particular attention should be given to **detecting deliberate data manipulation** and to embedding diagnostic tools into **digital and automated accounting platforms**, thereby advancing the integrity of economic information in practice

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Organizational Management in Educational Systems: Leadership in the 21st Century using an Integration of Psychological Flexibility, AI-Assisted Assessment and Innovative Thinking

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Abstract

Research Background: Today's educational institutions face unprecedented challenges requiring fundamental shifts in leadership approaches and organizational management in increasingly complex digital environments. Traditional management paradigms are proving inadequate to address diverse challenges including technological innovation, demographic change, and shifting societal expectations.
Purpose of the Article: This study develops a comprehensive theoretical framework integrating principles of psychological flexibility, artificial intelligence capabilities, and innovative organizational management strategies to address critical gaps in educational leadership theory and practice. The research examines how educational leaders can effectively manage digital transformation while preserving human-centered educational values and stakeholder relationships.
Methods: A systematic theoretical synthesis and intensive case study analysis of organizational transformation at the "Hatikva" school in Barcelona was employed. The theoretical development process synthesizes established knowledge from psychological flexibility theory, organizational learning framework, and educational technology research. The Barcelona case study provides empirical validation through analysis of comprehensive organizational change over three years.
Findings and Added Value: Research indicates that psychological flexibility serves as a foundational meta-skill enabling educational leaders to maintain effectiveness while implementing technological innovations, managing relationships with diverse stakeholders, and upholding educational mission during extensive organizational change. Analysis shows successful integration of artificial intelligence requires human-centered design approaches prioritizing pedagogical values while strategically leveraging technological capabilities. The Advanced Integrative Model encompasses five interrelated dimensions of educational leadership transformation demonstrating measurable improvements in financial sustainability, organizational culture, stakeholder engagement, and pedagogical effectiveness.

Keywords: Educational leadership, Psychological flexibility, Digital transformation, Organizational learning, Theoretical framework development

JEL classification: J24; J21

1. Introduction

Educational institutions around the world are at a critical inflection point where traditional management paradigms are proving increasingly inadequate to address the diverse challenges of today's educational landscape (Darling-Hammond, 2017; OECD, 2019). The convergence of technological innovation, demographic change, and shifting societal expectations has created complex dynamics across all education sectors, requiring enhanced leadership skills to address evolving challenges while maintaining educational effectiveness and institutional sustainability (UNESCO, 2020). This transformation extends beyond simple adoption of new technologies or administrative procedures, involving fundamental reconceptualization of what effective educational leadership entails in an era characterized by rapid change, uncertainty, and unprecedented complexity.

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Contemporary educational leaders must simultaneously manage technological integration without compromising human-centered educational values (Holmes et al., 2019; Selwyn, 2016), coordinate increasingly diverse stakeholder communities with different cultural and educational expectations, develop organizational resilience that can adapt to rapid technological and social change, and ensure equitable access to quality education while optimizing resource allocation through innovative management approaches. These demands require what scholars refer to as digital educational leadership—an integration of technological competence with psychological adaptability and ethical commitment to educational mission and values (Avolio et al., 2014).

The concept of digital pedagogical leadership has emerged as institutions recognize that successful technology integration requires more than technical proficiency. Recent theoretical developments suggest that effective implementation of artificial intelligence in educational management requires leaders who are proficient not only in technology and data science, but also in ethics, change management, and psychological adaptability (Chen et al., 2020; Cheng et al., 2019). This evolution represents a fundamental paradigm shift from viewing technology as an external tool to be adopted toward understanding technology as an integral part of pedagogical leadership that must be harmoniously integrated with human capabilities and pedagogical goals.

In the context of digital transformation and organizational complexity, psychological flexibility has emerged as a fundamental meta-competence enabling educational leaders to maintain effectiveness in the face of uncertainty, resistance, and rapid change. Psychological flexibility, defined within acceptance and commitment therapy as the ability to consciously experience the present moment while maintaining unbiased awareness and acting by chosen values, provides theoretical basis for understanding how leaders can successfully integrate technological innovations with human-centered approaches to education (Hayes et al., 2006; Kashdan & Rottenberg, 2010).

Despite increasing recognition of the importance of both technological integration and psychological adaptability in educational leadership, significant gaps remain in understanding how these elements can be systematically combined to create effective frameworks for contemporary educational leadership. Most research focuses on either technological implementation or leadership development without accounting for complex interactions between human psychological processes, technological capabilities, and organizational dynamics in educational contexts (Antonakis & Day, 2018).

2. Methods

2.1 Research Design

This research employed a theoretical development approach integrating existing knowledge with empirical case studies to provide a novel framework for understanding transformation of educational leadership in digital contexts (Torraco, 2005; Whittemore & Knafl, 2005). The research design was grounded in principles of grounded theory development, adhering to rigorous analytical standards through systematic integration of multiple knowledge sources and empirical validation through detailed case analyses of organizations.

The methodological approach recognized that complex organizational phenomena require theoretical frameworks that can bridge gaps between abstract conceptual understanding and practical implementation realities. The research framework built upon established theoretical foundations in psychological flexibility (Hayes et al., 2006), organizational learning (Senge, 1990), and educational technology (Holmes et al., 2019), extending these areas through novel synthesis and empirical application.

2.2 Theoretical Synthesis and Integration Framework

The process of theoretical synthesis drew on several established research traditions to develop integrated understanding of change in educational leadership that transcends traditional disciplinary boundaries. The synthesis included psychological flexibility theory as developed within acceptance and commitment therapy (Hayes et al., 2006), organizational learning theory evolved from systems thinking and change management research (Senge, 1990), and educational technology research addressing applications of artificial intelligence in institutional management contexts (Chen et al., 2020).

This multi-theoretical approach allowed identification of converging insights while highlighting areas where different theoretical traditions offer complementary rather than competing perspectives. The integration framework employed systematic comparison across different theoretical fields to identify underlying principles operating consistently in various contexts and at multiple analytical levels.

2.3 Case Study Method: Analysis of Organizational Transformation

The empirical component involved intensive case study analysis of organizational change in an educational institution in Barcelona over three years, concretely illustrating theoretical principles while gaining insights that support and refine framework development. Purposive case selection was made based on theoretical relevance rather than statistical representativeness, identifying one organization undergoing comprehensive transformation under conditions illuminating key theoretical relationships of interest.

The institution faced several converging challenges including financial crisis, cultural dysfunction, demographic change, and infrastructure decay, creating natural experimental conditions for examining leadership effectiveness under extreme pressure. The case study methodology incorporated multiple sources of evidence to ensure comprehensive understanding of transformational processes and outcomes while maintaining analytical rigor through systematic data triangulation.

Documentary evidence included financial records, organizational charts, policy documents, and demographic data providing objective verification of transformation claims and specific mechanisms through which transformation occurred. Observational data included systematic documentation of leadership practices, decision-making processes, stakeholder interactions, and implementation strategies illustrating practical application of theoretical principles.

2.4 Framework Integration and Model Development

In developing the framework, constant comparative methodology was applied to identify patterns, relationships, and theoretical insights in literature synthesis and case studies, while remaining open to new insights that cannot be anticipated based on existing theoretical frameworks. This analytical approach enabled systematic identification of theoretical themes while remaining flexible enough to accommodate new insights extending or challenging current understanding.

The development process involved iterative cycles alternating between theoretical analysis and empirical investigation, ensuring resulting frameworks were grounded in both scientific rigor and practical relevance. In developing the model, focus was on identifying fundamental relationships and mechanisms, rather than descriptive categorization, to understand how different components of educational change interact to bring about sustainable organizational change.

3. Results

3.1 Synthesis of Psychological Flexibility in Pedagogical Leadership

Analysis revealed that psychological flexibility functions as a fundamental metacognitive skill enabling educational leaders to maintain effectiveness in the face of uncertainty, resistance, and rapid organizational change. Psychological flexibility, conceptualized within acceptance and commitment therapy as the ability to experience present-moment awareness while acting by chosen values, emerges as particularly relevant to educational contexts where leaders must balance competing demands while maintaining educational mission and stakeholder relationships (Hayes et al., 2006; Kashdan & Rottenberg, 2010).

Theoretical synthesis suggested that components of psychological flexibility work synergistically to improve leadership effectiveness across multiple dimensions relevant to educational change (Bond & Bunce, 2003). Acceptance skills enable leaders to acknowledge difficult organizational realities without becoming reactive or defensive, facilitating more objective assessment of challenges and opportunities. Cognitive distraction skills support maintenance of broad perspective in crises, allowing consideration of different viewpoints and creative problem solving rather than being overwhelmed by immediate pressures or catastrophic thinking patterns.

Mindfulness components prove particularly important in educational leadership contexts characterized by rapid decision-making amidst competing stakeholder demands and resource constraints. Present-moment awareness allows leaders to perceive subtle organizational dynamics, respond thoughtfully rather than reactively to concerns, and focus on immediate priorities without losing sight of long-term vision. Research shows significant correlations between mindfulness and effective decision-making ($r = 0.40$, $p < 0.001$) and positive feedback ($r = 0.41$, $p < 0.001$), highlighting its practical importance in leadership contexts (Bond et al., 2013).

3.2 Applications of Artificial Intelligence in Education Management

Study of artificial intelligence applications in educational management shows growing evidence of technologies that enhance rather than replace human skills and judgment, with implementation success

critically dependent on human-centered design principles and comprehensive change management approaches (Chen et al., 2020; Cheng et al., 2019). Analysis revealed that effective AI applications in education primarily focus on supporting human decision-making and reducing administrative burdens, rather than automating complex decisions requiring cultural sensitivity, ethical considerations, or relationship management.

Predictive analytics applications hold significant potential for enhancing educational management by identifying students needing additional support early and enabling targeted intervention strategies based on comprehensive data analysis (Rahiman & Kodikal, 2024). These systems analyze multiple indicators including academic performance, attendance patterns, and engagement metrics to create profiles serving as basis for funding decisions. However, effectiveness depends on integration with human judgment and ethical oversight to ensure automated recommendations complement rather than replace professional judgment about individual student needs.

Communication technologies such as intelligent chatbots and virtual assistants hold promise for improving stakeholder engagement while reducing routine administrative overhead. These systems can provide consistent information, handle standard requests, and route complex questions to appropriate personnel (Dogan et al., 2023). Successful implementation requires careful attention to maintaining opportunities for personal interaction and relationship building, which are fundamental to educational effectiveness and stakeholder satisfaction.

3.3 Barcelona Transformation: Empirical Analysis and Insights

The Barcelona case provides concrete example of integrated leadership approaches combining psychological flexibility principles with systematic technological implementation and extensive stakeholder engagement under conditions of extreme organizational stress. The transformation occurred against backdrop of several converging crises including severe financial deficits, dysfunctional organizational culture, demographic tensions, and infrastructure decay, creating natural experimental conditions for examining leadership effectiveness.

The leadership approach demonstrated practical application of psychological flexibility through consistent behavior showing acceptance of challenging realities without defensive reactions, cognitive distraction maintaining perspective during conflicts with stakeholders, mindfulness enabling adaptive responses to rapidly changing circumstances, values-based decision making preserving educational mission during change processes, and committed action sustaining implementation efforts despite resistance and uncertainty. These capabilities proved essential for maintaining stakeholder trust and organizational coherence during comprehensive transformation (Fuchs et al., 2023).

Technological implementations specifically focused on enhancing rather than replacing human capabilities through customer relationship management systems improving financial oversight while enabling strategic resource allocation, digital communication platforms expanding capacity for engagement while maintaining personal relationships, and data management tools improving transparency of decision making while maintaining accountability to educational values. These implementations were successful because they were guided by clear pedagogical principles and implemented with approaches emphasizing human relationships and pedagogical quality (Campion et al., 2020).

Measurable improvements were achieved through transformation including moving from financial deficit to surplus, evolving from tribal leadership to professional management structures, successfully integrating diverse community groups while maintaining institutional identity, and establishing sustainable systems supporting continuous learning and adaptation.

3.4 Integration of Patterns and Theoretical Insights

Integration of theoretical analysis with empirical findings revealed robust patterns supporting comprehensive framework for educational leadership transformation considering psychological, technological, organizational, and governance dimensions simultaneously. Convergence between theoretical predictions and practical implementation results provided strong support for psychological flexibility as fundamental capability enabling effective leadership during technological and organizational change (Hayes et al., 2006; Judge & Piccolo, 2004).

Analysis showed that successful technology integration requires leadership approaches emphasizing educational values and stakeholder relationships while strategically leveraging technological opportunities rather than letting technological considerations drive decision-making. This pattern underscores

fundamental importance of human-centered design principles positioning technology as tool to enhance educational mission rather than end in itself necessitating organizational adaptation (Selwyn, 2016).

The relationship between immediate technological benefits and long-term organizational learning capacity emerged as crucial factor determining sustainability of transformation efforts. Early implementation phases typically focus on crisis management and operational improvements; however, lasting change necessitates systematic development of organizational learning capabilities including professional development, collaborative structures, and continuous improvement mechanisms based on stakeholder feedback and performance evaluation (Hargreaves & Fullan, 2012).

4. Discussion

4.1 Theoretical Contributions and Scientific Significance

This research contributes to several theoretical advances that broaden understanding of educational leadership while bridging gaps between established knowledge areas typically studied in isolation. The integration of psychological flexibility theory with educational leadership and technological implementation represents novel synthesis overcoming limitations of current frameworks that treat individual psychological processes, technological capabilities, and organizational dynamics as separate analytical domains requiring independent theoretical approaches (Antonakis & Day, 2018; Hayes et al., 2006).

Evidence that psychological flexibility functions as meta-competence enabling leadership effectiveness in various challenging contexts extends acceptance and commitment therapy theory to organizational and leadership domains, with implications extending beyond education. This theoretical extension provides empirical basis for understanding how specific psychological skills enhance leadership effectiveness, offering practical guidance for leadership development programs aiming to prepare professionals for today's organizational challenges characterized by uncertainty, complexity, and rapid change (Fuchs et al., 2023).

The Advanced Integrative Model represents original theoretical framework combining human-centered leadership principles with strategic technological implementation and systematic approaches to organizational development. This framework addresses fragmentation in existing scholarship by demonstrating how psychological, technological, organizational, and governance dimensions interact synergistically to enable sustainable transformation while preserving institutional values and stakeholder relationships defining effectiveness in education (Judge & Piccolo, 2004).

4.2 Practical Implications for Educational Leadership

Important implications for educational leadership preparation and professional development emerge from findings, addressing shortcomings of current approaches to preparing leaders for digital transformation while maintaining educational mission and stakeholder relationships. The demonstrated importance of psychological flexibility as foundational leadership skill suggests that traditional preparation programs focusing primarily on technical management skills may not be sufficient to develop leaders capable of meeting today's organizational challenges (Hargreaves & Fullan, 2012).

Educational leadership preparation should integrate development of psychological flexibility alongside technical competencies to equip future leaders with adaptive psychological skills enabling effective decision-making under pressure while maintaining values-based approaches to organizational change (Fuchs et al., 2024). This integration requires practical training in mindfulness techniques enhancing present-moment awareness, decision-making exercises developing engaged action skills, values clarification processes connecting personal and professional values to educational mission, and cognitive defusion practices maintaining psychological flexibility when complex implementation challenges arise.

The framework provides guidance for institutional change management through systematic approaches addressing technology infrastructure, organizational culture, and stakeholder engagement simultaneously, rather than treating these areas as separate implementation domains. Educational institutions should develop comprehensive transformation strategies leveraging technological capabilities while emphasizing human relationships and pedagogical values to ensure efficiencies enhance rather than detract from pedagogical effectiveness and stakeholder satisfaction (Senge, 1990).

4.3 Recommendations for Policy and Practice

The review advocates for comprehensive policy approaches addressing technology implementation within broader frameworks emphasizing educational values, stakeholder engagement, and democratic

accountability, rather than fragmented approaches that may lead to implementation gaps or unintended consequences. Education policymakers should develop integrated frameworks balancing promotion of innovation, ethical responsibility, and stakeholder protection while being flexible enough to accommodate institutional diversity and technological development (UNESCO, 2020).

Policy frameworks should emphasize skill building and knowledge sharing rather than focusing solely on technology acquisition or regulatory compliance. This emphasis requires support for professional development in technological literacy and psychological flexibility, collaborative learning networks enabling knowledge sharing between institutions, and funding mechanisms prioritizing comprehensive transformational approaches over narrowly focused technological implementations which may achieve short-term efficiency gains but compromise long-term educational effectiveness.

Institutional governance should encompass transparent decision-making processes, systematic stakeholder engagement, and clear accountability mechanisms ensuring technological innovation supports educational mission while maintaining democratic participation and fostering community trust. These governance approaches necessitate ongoing effort to balance operational efficiency with educational values, ensuring technological capabilities complement rather than replace human judgment in decisions impacting educational opportunities and outcomes (Noddings, 2005).

Research suggests that successful transformation requires sustained commitment to comprehensive approaches addressing psychological, technological, organizational, and governance dimensions simultaneously. Educational institutions should avoid fragmented implementation strategies treating these dimensions as separate concerns, instead developing integrated approaches leveraging synergistic relationships among human capabilities, technological innovations, and organizational learning to achieve sustainable transformation while preserving educational values and stakeholder relationships defining institutional effectiveness and community trust.

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Digital Performance of Businesses in EU Countries - a Prerequisite for Success in an Era of Instability

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Abstract

Research background: The current business environment is increasingly characterized by rapid change, uncertainty and unpredictability. In this period of instability, it seems necessary for companies to reconsider traditional approaches to implementing various business activities.
Purpose of the article: The article focuses on determining the digital performance of the business environment of EU countries. The aim of the paper is to identify the efficiency of the digital transformation of the EU business environment and to compare its level in individual EU countries.
Methods: It analyzes the shift from static approaches to measuring digital performance towards dynamic ones. The input for the analysis was a selected set of digital transformation indicators of enterprises in EU countries. The importance of digital indicators and their values for assessing the digital performance of enterprises, as well as the performance evaluation itself, was carried out using the Data Envelopment Analysis method. The dynamic development of digital transformation indicators was analyzed using the Malmquist index.
Findings & Value added: Using the results of this index, it is possible to evaluate the change in efficiency in the use of individual digitalization elements, as well as the technological change that has occurred in the digital transformation over time. The results indicate that EU countries are improving the performance of the digital transformation of the business environment, which is favorable for its rapid adaptation to changing needs. The benefit is to determine Slovakia's position within the digitalization process and identify EU countries that can be an example of digital development.

Keywords: Data Envelopment analysis. Digital performance, efficiency, Malmquist index

JEL classification: O11; O33; C44

1. Introduction

Digitalization has become a key phenomenon of the present time and one of the most important priorities of the European Union in building a modern, efficient and sustainable economy. With the development of digital technologies, transformation comes to almost every area of life and economy, from public services, through education to the business environment. For EU countries, digitalization represents not only an opportunity to increase efficiency and productivity, but also a tool to strengthen the competitiveness of enterprises in a globalized and unstable environment. Digitalization is the most important engine of innovation, competitiveness and economic growth in the world (Kravchenko et al., 2019).

Digitalization has changed the world. The advent of the internet and social media, followed by technologies such as cloud computing and artificial intelligence (AI), has radically changed the way we interact, learn, and make decisions, disrupting many existing markets and creating new business models and opportunities (Kraus et al., 2019; Vadana et al., 2019). These changes are so significant that scholars are referring to digitalization as the fourth industrial revolution (Björkdahl, 2020).

Digitalization can be viewed from two perspectives. On the one hand, the subjects of the economic system are ready to adopt and spread the practice of using digital tools in the professional activities. Digitalization can be viewed from two perspectives. On the one hand, the subjects of the economic system are ready to adopt and spread the practice of using digital tools in the processes of professional activity.

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On the other hand, both the business sector and employees have some doubts about the appropriateness of a radical transformation of the business environment. These subjects feel the need for new models of organizing life due to global instability, which has a destructive impact on every sector of the economy and emphasizes the low effectiveness of traditional mechanisms and tools for ensuring business processes in the context of the post-pandemic crisis (Fedyk et al., 2022).

The European Union actively supports digitalization through various initiatives and programs. Various indicators are used to assess the level of digitalization, with the European Commission focusing on collecting data within the Digital Economy and Society database.

Reminder of the paper is structured as follows: “Literature review” section describes the theoretical foundations of digitalization and digital transformation and presents studies that have dealt with measuring the efficiency of implementing digitalization elements in companies and countries. The "Methods" section outlines the data and their sources, providing a comprehensive description of the Malmquist index applied for the measurement of the efficiency of digital transformation. In the "Results and discussion" section, the study presents its findings and analyses of the efficiency of implementing digitalization elements in EU businesses and provides more detailed discussion of the achieved results. Finally, the "Conclusion" section summarizes research conclusions, limitations, and its contribution to the scientific field and managerial practice.

2. Literature review

Digitalization is a new trend that encourages businesses to adapt and improve their digital capabilities in all areas, thereby ensuring their survival and development. It allows them to better manage uncertainties and respond promptly to current business needs. However, this process is not just about implementing technologies, but represents a fundamental transformation within the organizational strategy, business processes, knowledge and the entire socio-technical organizational system. Digital technologies have transformed both internal and external aspects of the organization and their interconnections, which can directly and indirectly affect the performance of the business (Alsufyani, 2022). Digitalization is more than just technology. It is a comprehensive transformation that affects all aspects of an organization and society. It enables companies to respond to rapidly changing market conditions, provides new business opportunities, improves access to information and supports innovation. Ultimately, digitalization leads to increased efficiency, productivity and competitiveness in the global market (Imgrund et al., 2018). Digitalization is also one of the key goals of the European Union (EU) countries. The term began to emerge in the mid-20th century (Shpak et al., 2020) and has gradually become one of the main trends shaping the current and future society and business environment (Parviainen et al., 2017). Digitalization and innovation have become key tools driving organizations forward in transforming their operations. Digitalization can be defined by two basic approaches. The first focuses on digitalization as the process of converting analog data into a digital format, also known as digital enablement (Gartner, 2023). The second approach sees digitalization as the integration and more intensive use of digital technologies by organizations, industries, and countries (Gorenšek, Kohont, 2019). A similar view is shared by Legner et al. (2017), who consider digitalization as a process involving sociotechnical phenomena and the widespread adoption of these technologies. Digital transformation is a complex and extensive process in which existing or even new business processes are digitally modified in order to effectively meet changing business and market requirements (Morháč, 2022). It follows that digital transformation requires a significant redesign of processes to become digital and a redesign of customer experiences to match the digital environment. Digital transformation is “a modern mainstream of social and economic development promising significant digital dividends for citizens and businesses worldwide” (Dobrolyubova, 2021). The implementation of a quality digital infrastructure is crucial for almost every sector of a modern and innovative economy and society (Stankovic et al., 2021).

Digitalization processes are taking place more or less in every industry. Digitalization in the European airport industry was studied by Kováčiková et al. (2021). These authors used digitalization indices to compare selected Slovak airports with digitalization leaders. Riasanow, Galic and Böhm (2017) studied digital transformation in the automotive industry. Barnewold and Lotermoser (2020) studied digitalization in the mining industry. Based on the results of their study, they concluded that the key technologies for the mining industry are automation, robotics, the internet of things, big data, real-time data, machine learning, artificial intelligence and 3D printing.

Bánhidi and Dobos (2023), measured the efficiency of digital transformation based on the five principal dimensions of the Digital Economy and Society Index (DESI) index. They ranked EU countries

using Data Envelopment Analysis (DEA) Without Explicit Inputs (WEI) or DEA-type Composite Indicators (DEA/CI). Results of their study revealed that the countries of Northern Europe, especially Denmark, Finland and Sweden, placed in the best group according almost all rankings, while Balkan countries like Romania, Bulgaria and Croatia placed in the bottom group. Similar conclusions were reached by Krejnus et al. (2023), who focused on the efficiency of digitalization in the field of e-Government, which according to this author may be one of the key elements of the state`s functioning in the future. According to the results of DEA in their study the Nordic countries are the most efficient in terms of e-Government efficiency. They were joined by Hungary, Poland, Italy, Malta, Greece and Portugal. Andronieceanu et al. (2023) confirmed the results of previous authors. Using Principal Component Analysis (PCA) and K-means clustering, they revealed that the most significant increase in digitalization and government efficiency in the EU is achieved by the countries of Northern Europe. Efficiency of the use of information and communication technologies (ICT) in EU businesses measured Krstic et al. (2023). They used the DEA window model for efficiency measurement and the bootstrap method for robustness analysis. The highest average technical efficiency of the use of ICT in businesses per window was recorded in Belgium and Denmark. Countries with the lowest average technical ICT efficiency per window included Bulgaria, Romania, Greece and Latvia.

Different results were achieved by Yalcin (2021) who also measured the efficiency of digitalization of EU countries. In his research he focused on finding the countries which transformed digitalization into their economic growth and employment rate. To measure efficiency, he used DEA methodology, while five dimensions of the DESI index were used as inputs and GDP growth rate and employment rate were used as outputs. Results of the study revealed that in countries like Denmark, Finland or Spain, DESI indicators are not used effectively in the values of GDP and employment rate. Therefore, Yalcin (2021) concluded that developing countries use digitalization more effectively in terms of economic growth and job creation than developed ones. Similar results were achieved by Inel (2019) who investigated digital transformation in businesses using DEA. As inputs to the DEA model were used digitalization indicators like Digital infrastructure, Supply and demand of digital skills and others, while as the outputs were used ICT start-ups and Digital Transformation. The results revealed that the United Kingdom, Italy and Denmark were ranked among the efficient countries, while Germany and the Netherlands, but also Denmark or Spain were considered not very efficient countries

3. Methods

To evaluate the efficiency of digitalization in EU countries, the Malmquist index based on the DEA method was applied. Suppose that each $DMU_j (j = 1,2, \dots, n)$ uses a vector of inputs $x_j^t = \left(x_{1j}^t, \dots, x_{mj}^t\right)$ to produce vector of outputs $y_j^t = \left(y_{1j}^t, \dots, y_{mj}^t\right)$ at each period of time $t, t = 1, \dots, T$. Efficiency of DMU_0 can change or the frontier can shift or both changes may occur in the same time. The Malmquist Productivity Index is than defined as follows (1) (Zhu, 2014):

$$MI_o = \frac{\theta_o^t(x_o^t, y_o^t)}{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})} \times \left[\frac{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})}{\theta_o^t(x_o^{t+1}, y_o^{t+1})} \frac{\theta_o^{t+1}(x_o^t, y_o^t)}{\theta_o^t(x_o^t, y_o^t)} \right]^{\frac{1}{2}} \quad (1)$$

where MI_0 measures the change in productivity between the periods t and $t+1$. $\theta_o^t(x_o^t, y_o^t)$ is calculated by comparing x_o^t to the EPF (Empirical Production Frontier) at time t with the use of input oriented CRS DEA model, while $x_o^t = (x_{1o}^t, \dots \dots \dots \dots x_{mo}^t)$ and $y_o^t = (y_{1o}^t, \dots \dots \dots \dots y_{so}^t)$ are the input and output vectors of DMU_0. Similarly $\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})$ is calculated by comparing x_o^{t+1} to the EPF at time t+1, $\theta_o^{t+1}(x_o^t, y_o^t)$ by comparing x_o^t to the EPF at time $t+1$; and $\theta_o^t(x_o^{t+1}, y_o^{t+1})$ is calculated by comparing x_o^{t+1} to the EPF at time t applying input-oriented CRS DEA model. The change in productivity is expressed by multiplying the change in technical efficiency (Change in Efficiency - ECH) and the technological change (Frontier Shift - FS).

ECH (2) is equivalent to the ratio of efficiency defined by Farrell in 1957 at time t and at time $t+1$ (technical efficiency change between periods t and $t+1$). Usually, this term expresses the improvement, deterioration or stability of technical efficiency.

$$ECH = \frac{\theta_o^t(x_o^t, y_o^t)}{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})} \quad (2)$$

The term (3) represents FS in the EPF between periods t and $t+1$. FS is the geometric mean of the shift in technology between two periods (Zhu, 2014). It indicates the shift in the production possibilities frontier due to implemented technological changes. $FS > 1$ means that there has been an increase in efficiency and EPS has shifted outwards. $FS = 1$ means that the production possibilities frontier has not changed. $FS < 1$ means that efficiency has deteriorated and the frontier has shifted inwards.

$$FS = \left[\frac{\theta_o^{t+1}(x_o^{t+1}, y_o^{t+1})}{\theta_o^{t}(x_o^{t+1}, y_o^{t+1})} \frac{\theta_o^{t+1}(x_o^{t}, y_o^{t})}{\theta_o^{t}(x_o^{t}, y_o^{t})} \right]^{\frac{1}{2}} \quad (3)$$

The following inputs were selected for the analysis of the level of digital transformation: Share of fixed broadband subscriptions (FBS), Internet access (IA), Use of computers and the internet by employees (CIE), Cloud computing services (CCS), Use of AI in businesses (AI), Internet purchases (IP), Internet use – interaction with public authorities (IPA). The results achieved in the implementation of individual digitalization elements are presented in Table 1.

Table 1. Indicators measuring digital performance of companies (in %)

Indicator	**FBS**	**FBS**	**IA**	**IA**	**CIE**	**CIE**	**CCS**	**CCS**	**AI**	**AI**	**IP**	**IP**	**IPA**	**IPA**
Year	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
Belgium	96.9	96.9	93.04	93.57	69.13	71.29	52.2	53.69	12.8	13.81	62.6	64.97	83.27	84.78
Bulgaria	91.9	93.6	78.97	79.83	40.19	39.69	15.82	17.5	2.97	3.62	23.92	26.94	26.38	29.72
Czechia	90.2	91.1	89.68	89.91	51.97	54.14	45.17	47.15	3.78	5.9	66.35	69.07	71.12	78.81
Croatia	67.4	71.5	80.65	82.46	56.67	56.91	42.42	45.08	7.7	7.89	44.4	49.93	56.98	74.62
Cyprus	86.9	92.5	89.22	91.19	55.46	55.06	50.89	52.93	3.47	4.67	33.67	50.57	66.12	89.74
Denmark	97.3	98	96.44	97.47	79.65	78.85	66.18	69.48	15.96	15.17	77.85	79.78	96.98	97.68
Estonia	84.2	84.4	90.13	92.29	55.42	56.71	57.9	58.57	4.22	5.19	59.11	62.04	85.83	88.74
Finland	71	78	94.82	95.45	86.46	85.02	76.51	78.29	15.6	15.1	63.47	64.39	94.78	95.49
France	74	82.1	89.87	92.17	64.3	63.23	28.12	26.76	5.24	5.88	63.48	65.78	82.64	85.17
Greece	60.07	63.8	81.89	84.23	46.53	47.46	22.14	23.59	2.91	3.98	45.8	48.3	67.64	68.69
Netherlands	98.7	98.7	94.4	98.92	77.01	78.04	62.94	61.19	13.29	13.37	79.48	84.2	92.5	94.78
Ireland	90.7	91.6	91.63	93.17	64.04	67.89	61.22	63.1	7.98	8.01	74.45	80.49	80.83	85.56
Lithuania	86.7	86.9	86.8	87.59	62.17	64.27	35.94	38.39	4.54	4.86	46.25	48.32	71.82	73.49
Latvia	62.6	63.6	90.26	91.5	55.37	61.11	32.11	35.76	3.92	4.53	42.17	46.28	70.98	73.18
Luxembourg	95.1	95.4	95.23	96.87	56.59	59.53	35.49	37.04	13.72	14.45	70.33	70.27	88.9	89.4
Hungary	91.9	95.1	88.13	90.63	56.82	58.81	38.41	44.94	2.89	3.68	60.75	58.98	72.68	75.63
Malta	100	100	91.03	91.51	56.47	59.87	62.78	66.74	12.9	13.17	58.95	59.67	76.41	81.34
Germany	91	92.9	89.88	90.98	61.57	64.36	43.6	47	10.98	11.55	66.23	67.52	51.24	58.07
Poland	73.8	81.5	85.71	85.32	53.53	55.26	43.55	55.67	2.98	3.67	50.91	49.87	55.38	58.54
Portugal	94.9	95.7	83.25	84.18	48.15	48.86	35.77	37.5	7.2	7.86	43.95	48.94	68.72	69.63
Austria	85.8	87.5	90.46	91.99	66.12	65.13	43.43	46.48	9.93	10.79	56.82	62.41	73.88	75.6
Romania	94.5	95.7	84.05	88.05	40.85	41.84	16.4	18.4	1.42	1.51	27.09	31.72	20.93	22.56
Slovakia	80.2	84.7	86.06	87.67	52.17	53.17	35.7	34.42	6.2	7.04	65.18	65.84	71.69	73.58
Slovenia	87.2	89	87.73	89.41	61.8	61.13	41.93	40.21	11.98	11.37	50.16	53.18	71.14	73.09
Spain	91.2	95.7	92.94	94.48	59.81	60.08	31.78	30.04	8.86	9.18	55.26	55.85	79.68	79.75
Sweden	86.8	89	95.75	96.87	83.04	86.83	74.28	71.62	10.12	10.37	75.9	80.16	93.07	94.58
Italy	82.8	87.1	82.94	85.45	55.75	54.59	60.92	61.39	5.92	5.05	37.28	39.19	60.11	65.69

Source: Eurostat (2025)

If we compare the results achieved in 2022 and 2023, it can be stated that there has been a shift in almost all analyzed digital performance indicators. FBS achieved the best improvement in France by 8.1% and in Poland by 7.7%. Slovakia achieved an improvement in this indicator by 4.5% during these two analyzed years. In terms of IA, the best improvement occurred in the Netherlands. CIE was applied to a greater extent in Latvia. Slovakia improved its position in this indicator by 1%. During the analyzed years,

CCS strengthened the most in Poland. Slovakia achieved an average coverage of 35% in this indicator, which can be considered insufficient compared to, for example, Finland and Denmark, which are among the leaders in this area. The application of AI is one of the least developed areas of digital transformation. The leaders in this area are the Netherlands, Belgium, Finland and Luxembourg. A significant shift in this area was recorded by the Czech Republic and Greece. In the case of Slovakia, there was an increase in AI applications by 0.84%. In the case of IP, Slovakia is one of the countries in which this indicator achieves higher coverage, which is approximately at the level of Belgium, Luxembourg, Germany and some other countries. Regarding the application of IPA, Cyprus and Croatia have made the most progress. Slovakia is also achieving improvement, but not at such a significant level as the already mentioned countries

Based on the initial analysis of input data, it can be concluded that the digital transformation process is progressing, which can be confirmed by analyzing the development of selected digital transformation indicators. As the outputs in Malmquist index model were used indicators expressing the performance of the economy – HDP per capita and employment rate.

4. Results and discussion

The results of Malmquist Index (MI) are a suitable data source for analyzing the change in digital transformation efficiency over time. They show not only how a specific European Union country performed in 2023, but also how it improved or deteriorated compared to the previous period. The values of technical efficiency indicate whether the country has approached the efficiency frontier, or how the technical efficiency has changed. The values of Frontier shift indicate how a specific country has approached or moved away from the efficiency frontier over time (Table 2).

Table 2. Results of Malmquist index

No.	DMU	Input CRS Malmquist Index	Technical efficiency	Frontier shift
1	Belgium	1.12984	1.12000	1.00879
2	Bulgaria	1.06487	1.00000	1.06487
3	Czechia	1.01768	1.00000	1.02400
4	Croatia	1.02490	1.01602	1.00874
5	Cyprus	1.15904	1.02056	1.13569
6	Denmark	1.01254	1.00352	1.00899
7	Estonia	1.01961	1.00476	1.01477
8	Finland	1.06959	1.03819	1.03024
9	France	1.04402	1.00000	1.04402
10	Greece	1.03971	1.00000	1.03971
11	Netherlands	1.05320	1.04353	1.00927
12	Ireland	1.07411	1.00000	1.07411
13	Lithuania	1.01461	1.00627	1.00829
14	Latvia	1.04210	1.00000	1.04210
15	Luxembourg	1.04522	1.00000	1.04522
16	Hungary	1.06198	1.01520	1.04609
17	Malta	1.10108	1.09058	1.00962
18	Germany	1.03731	1.00000	1.03731
19	Poland	1.05742	1.00000	1.05742
20	Portugal	1.09999	1.09065	1.00857
21	Austria	1.02067	1.01021	1.01036
22	Romania	1.08120	1.00000	1.08120
23	Slovakia	1.01178	1.00000	1.01178
24	Slovenia	1.02349	1.01501	1.00835
25	Spain	1.01547	1.00000	1.01547
26	Sweden	1.02924	1.02003	1.00902
27	Italy	1.12284	1.00000	1.12284

Source: authors (2025)

Slovakia achieved an MI value 1.01178 between the two periods, thus increasing its digital transformation performance by approximately 1.178% between the two years. This is a positive signal, because either the efficiency of using digital transformation elements has improved, or the frontier of

established technologies has shifted. In technical efficiency, the Slovak Republic reached a value 1, meaning that there has been no change and the country has maintained its efficiency in using already established digitalization elements, but at the same time it has not improved it. In other words, the country was equally distant from countries with a higher level of digital transformation in both years. The value of the frontier shift for Slovakia was 1.01178, which means that although it did not change its efficiency against this frontier, the frontier shifted, meaning the country benefited from technological progress or innovation.

Based on the DEA model, the target values of digitalization indicators for Slovakia were calculated (Figure 1). We can see that the DEA model calculated the target value of the indicator "Share of fixed broadband subscriptions" 85.99%, while Slovakia, according to statistics, reached actual value 84.70%, and therefore is approaching the goal of becoming an efficient country. When we focus on "Cloud computing services", the target value of this indicator for Slovakia in 2023 is 35.66%. The country should reach this value to become fully efficient, but the actual value of the country is 34.42%. Based on the above, it can be concluded that only minimal improvement is needed for Slovakia to be efficient in implementing "Cloud computing services" in 2023. Regarding "Internet purchases" and "Internet use – interaction with public authorities", we can see that Slovakia has the largest reserves for these two indicators, and it still lacks approximately 3-5% of the target.

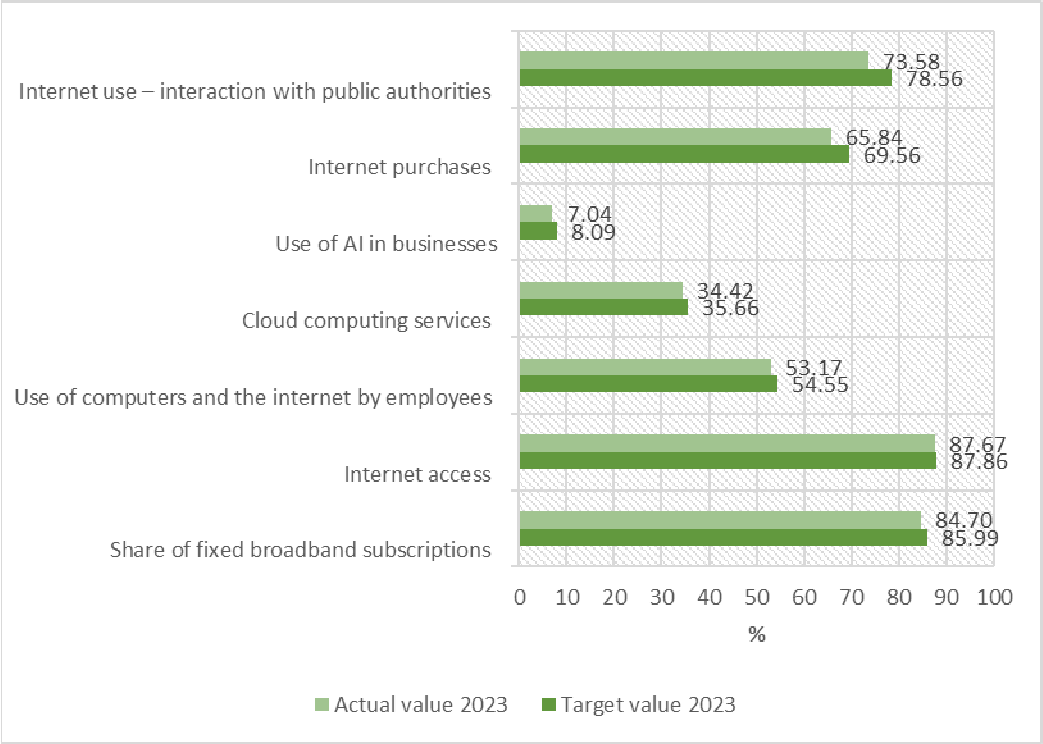

Figure 1. Actual and target values of digitalization indicators for Slovakia
Source: authors (2025)

The actual and target values increased slightly in 2023 compared to the previous year, which may indicate that Slovakia is improving in the efficiency of implementing digitalization elements every year.

Conclusion

MI results pointed to the fact that all EU countries achieved MI above 1, which indicates that the digital transformation process is taking place in accordance with the established EU strategy. Similarly, the values of technical efficiency and the shift of the efficiency frontier reach values above 1 in all EU countries. The results indicate that the digital transformation process is taking place successfully and efficiently in all EU countries. Within the framework of the given analysis, it can be stated that the limitation was the data that was the basis for the analysis. The data that evaluate the process of digital transformation are incomplete, and within individual countries there is a lack of data on individual elements of digital transformation in individual years. The contribution of the paper to the academic and scientific field is the possibility of applying the MI index when assessing the digital transformation of the business environment of EU countries. The contribution of the paper to managerial practice is the finding

that Slovakia does not lag behind other EU countries in the implementation of individual elements of digitalization from the perspective of the MI index, technical efficiency and technological change. This finding could also be communicated within the Slovak business environment.

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Digital Native Markets: A Fluid Reality Framework for Business Strategy in Virtual-Physical Consumer Ecosystems

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Abstract

Research background: The emergence of digital native consumers fundamentally transforms market dynamics, requiring new frameworks for understanding consumer behavior across virtual and physical touchpoints. Traditional binary approaches that treat digital and physical channels as separate market segments fail to capture how digital natives naturally integrate virtual and physical experiences into coherent purchasing narratives.
Purpose of the article: This study introduces Fluid Reality Theory as a strategic framework for businesses operating in integrated virtual-physical consumer ecosystems. The research aims to identify core market capabilities that define next-generation consumer behavior and provide evidence-based guidelines for fluid reality business strategies.
Methods: Through interdisciplinary analysis of consumer psychology, market dynamics, and digital transformation patterns, this research employs theoretical framework development grounded in environmental adaptation principles. The study integrates insights from virtual reality marketing research, omnichannel customer experience literature, and digital native consumer behavior studies to establish theoretical foundations.
Findings & Value added: The framework identifies three core market capabilities: spectrum thinking, imaginative integration, and connection understanding that define digital native consumer behavior. Key findings reveal that virtual consumer experiences activate similar decision-making patterns as physical experiences, support brand loyalty through avatar-mediated identity formation, and enhance market reach through global community participation. Virtual environments function as sophisticated innovation laboratories, while omnichannel integration proves more valuable than channel separation. This research demonstrates significant business opportunities for companies that understand virtual-physical integration rather than treating digital and physical channels as competing segments. The framework provides practical applications for product development, marketing strategy, organizational design, and technology investment that supports competitive advantage within fluid reality commerce, offering both theoretical advancement and actionable business insights for 21st-century market dynamics.

Keywords: Fluid Reality Theory, Digital native consumers, Virtual-physical integration, Omnichannel strategy, Consumer behavior, Digital transformation

JEL classification: A10, A12, A14

1. Introduction

Contemporary consumer markets are experiencing unprecedented convergence of virtual and physical touchpoints, fundamentally transforming business environments and competitive dynamics. Digital native consumers, defined as those who have never known a world without the internet and smartphones (McKinsey, 2024), naturally navigate sophisticated virtual marketplaces, construct brand relationships through avatar-mediated experiences, and engage in complex purchasing decisions within integrated digital ecosystems. This digital transformation represents more than technological adoption—it constitutes a fundamental shift in consumer behavior requiring new strategic frameworks.

The emergence of Generation Z as a dominant consumer force has intensified this transformation. Born between 1997 and 2012, Generation Z accounts for 15% of the UK population and represents the first generation of true digital natives (Mintel, 2025). Their spending power is projected to reach $12

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trillion by 2030, making understanding their behavior essential for business success (NIQ, 2024). Research demonstrates that 98% of Gen Z use social media, with many turning to platforms like TikTok to research products before purchasing, fundamentally altering traditional marketing approaches (Chang & Chang, 2023).

Current business approaches to virtual consumer engagement are dominated by binary thinking that treats digital and physical channels as separate market segments, often creating fragmented customer experiences that fail to capture emerging market opportunities. This binary approach ignores how digital native consumers naturally integrate virtual and physical experiences into coherent purchasing and brand engagement narratives. The omnichannel customer experience has emerged as a critical response to this challenge, with research showing that integrated experiences encompassing promotion, product, price, and transaction information significantly enhance customer engagement (Gao et al., 2021).

Virtual and augmented reality technologies are revolutionizing customer experiences by creating immersive environments that blur the distinction between physical and digital interactions (Orús et al., 2019). Studies reveal that virtual experiences can be characterized as "vivid, involving, active, and affective psychological states that consumers encounter when interacting with 3D products in computer-mediated environments" (Rauschnabel et al., 2022). These technologies enable businesses to create unprecedented opportunities for customer engagement, product visualization, and brand interaction.

The COVID-19 pandemic has accelerated the adoption of virtual shopping experiences, with retailers prioritizing the implementation of advanced interactive technologies including AR and VR as key post-pandemic business strategies (Kim & Baek, 2023). This acceleration has revealed both the potential and limitations of current approaches to virtual-physical integration, highlighting the need for comprehensive theoretical frameworks that guide strategic decision-making.

This study introduces Fluid Reality Theory as a strategic framework for understanding consumer behavior and business opportunities across integrated virtual-physical market ecosystems. The theory posits that consumer reality exists as a flowing continuum rather than discrete channels, with virtual and physical experiences functioning as interconnected components of unified customer journeys. This approach addresses the critical gap in existing literature that predominantly treats digital and physical channels as competing rather than complementary market environments.

The research contributes to existing literature by bridging virtual reality marketing research with omnichannel customer experience theory, providing a unified framework for understanding how digital native consumers navigate integrated virtual-physical ecosystems. By examining the intersection of technological capability, consumer psychology, and business strategy, this study offers both theoretical advancement and practical guidance for organizations seeking to optimize their engagement with digital native markets.

2. Methods

2.1 Research Approach

This study employs theoretical framework development methodology, integrating insights from multiple disciplinary perspectives to establish Fluid Reality Theory as a comprehensive business strategy framework. The research adopts an interdisciplinary approach, synthesizing knowledge from consumer psychology, digital marketing, virtual reality applications, and omnichannel customer experience research to develop a unified theoretical model.

The methodology builds upon established approaches in virtual reality marketing research, which emphasize the importance of multidisciplinary teams synergizing different scientific disciplines, including engineering, computer science, neuroscience, and marketing (Rauschnabel et al., 2022a). This interdisciplinary foundation enables the development of frameworks that account for both technological capabilities and consumer behavioral patterns.

2.2 Theoretical Foundation Development

The framework development process integrates three primary areas of existing research:

Virtual Reality and Consumer Experience Research: Drawing from studies that examine how virtual environments influence consumer behavior, including research on virtual experiences as psychological states (Li et al., 2003) and the impact of immersive technologies on customer engagement (Hilken et al., 2017).

Omnichannel Customer Experience Literature: Incorporating findings from research on integrated channel strategies, including studies that demonstrate the superior effectiveness of channel integration

over channel separation (Lemon & Verhoef, 2016) and frameworks for understanding customer journey management across touchpoints (Verhoef et al., 2015).

Digital Native Consumer Behavior Studies: Integrating research on Generation Z consumer characteristics, including their digital nativity, social consciousness, and demand for authentic brand experiences (Chang & Chang, 2023; NIQ, 2024).

2.3 Framework Construction Methodology

The Fluid Reality Theory (Fuchs, 2025) framework construction follows established principles for theoretical development in marketing research, emphasizing:

Environmental Adaptation Principles: Based on research demonstrating that consumer behavior adapts dynamically to market environments, including virtual spaces, through sophisticated psychological and social mechanisms (Belsky & Pluess, 2013).

Spectrum Thinking Paradigm: Moving beyond binary categorizations to recognize market value along continuums, enabling nuanced analysis of how virtual experiences contribute to customer lifetime value (Mudambi, 1997).

Quasi-Organic Systems Approach: Conceptualizing virtual marketplaces as systems exhibiting characteristics of living markets—responsiveness, adaptation, and emergent properties that serve as extensions of business capacity (Fuchs et al., 2024).

2.4 Literature Integration and Synthesis

The research methodology incorporates systematic analysis of current literature across relevant domains, with particular emphasis on:

- Studies examining the impact of virtual and augmented reality on customer experiences (Orús et al., 2019; Kim & Baek, 2023)
- Research on omnichannel strategy effectiveness and customer journey optimization (Gao et al., 2021; Rahman et al., 2025)
- Analysis of digital native consumer behavior and preferences (Chang & Chang, 2023; Mintel, 2025)
- Investigation of virtual environment applications in business contexts (Rauschnabel et al., 2022a, 2022b)

2.5 Framework Validation Approach

The theoretical framework validation draws upon established business cases and empirical evidence from existing research, including:

Technology Integration Studies: Examining how businesses successfully implement virtual and augmented reality technologies to enhance customer experiences and business outcomes.

Consumer Behavior Research: Analyzing documented patterns in digital native consumer preferences, decision-making processes, and engagement patterns across virtual and physical touchpoints.

Business Performance Analysis: Reviewing case studies and research findings that demonstrate the effectiveness of integrated virtual-physical business strategies compared to channel-separated approaches.

This methodology ensures that the Fluid Reality Theory framework is grounded in empirical evidence while providing practical guidance for business application, addressing the noted gap in existing literature regarding rigorous methodological frameworks for virtual-physical market integration (Rauschnabel et al., 2022a).

3. Results

3.1 Fluid Reality Theory Framework

The research yields a comprehensive framework identifying three core capabilities that define successful virtual-physical integration: spectrum thinking, imaginative integration, and connection understanding. These capabilities emerge as fundamental requirements for businesses seeking to engage effectively with digital native consumers who naturally operate across integrated virtual-physical ecosystems.

Core Market Capabilities Identified:

1. **Spectrum Thinking:** Consumer ability to perceive multiple possibilities and pathways rather than binary choices, creating opportunities for complex product customization and service offerings. This capability aligns with research showing that digital natives expect seamless transitions between channels and resist artificial boundaries between online and offline experiences (Rahman et al., 2025).

2. **Imaginative Integration:** Consumer capacity to synthesize experiences across touchpoints into coherent brand narratives, enabling powerful brand storytelling and loyalty programs. Studies demonstrate that virtual environments naturally support this integration through their inherent characteristics of multiple pathway architecture and dynamic complexity (Rauschnabel et al., 2022).

3. **Connection Understanding:** Consumer recognition of fundamental interconnection between self, others, and environment, supporting community-based marketing and social commerce strategies. Research reveals that 98% of Gen Z use social media platforms for product research, indicating the critical importance of understanding these connection patterns (Chang & Chang, 2023).

3.2 Virtual-Physical Integration Evidence

Empirical findings demonstrate that virtual and physical consumer experiences activate similar decision-making mechanisms, supporting the framework's assertion that market reality exists as a fluid continuum. Studies reveal that virtual shopping experiences trigger the same decision-making mechanisms governing responses to physical retail environments, challenging traditional distinctions between "online" and "offline" consumer experiences (Kim & Baek, 2023).

Key Integration Findings:

- **Neural Network Activation:** Research shows that virtual and physical purchasing experiences activate similar neural networks and trigger identical consumer decision-making mechanisms, providing biological evidence for fluid reality theory (Orús et al., 2019).
- **Brand Loyalty Development:** Virtual environments enable brand experimentation that provides psychologically safe contexts for exploring different consumption patterns, supporting healthy consumer identity development while building brand resilience and customer retention (Rauschnabel et al., 2022).
- **Market Expansion Capabilities:** Virtual communities provide unprecedented opportunities for global market expansion through authentic interaction with consumers from diverse backgrounds, reducing market entry barriers and enhancing cross-cultural commerce capabilities (Hilken et al., 2017).

3.3 Omnichannel Integration Superiority

Research findings consistently demonstrate that integration of virtual and physical customer experiences proves more valuable than channel separation. Studies examining omnichannel customer experience reveal that integrated efforts encompassing promotion, product, price, and transaction information significantly enhance both cognitive and affective customer experiences (Gao et al., 2021).

Integration Performance Metrics:

- **Customer Engagement:** Businesses implementing integrated virtual-physical strategies show enhanced customer engagement metrics compared to those maintaining separate channel approaches (Rahman et al., 2025).
- **Lifetime Value Enhancement:** Consumers who engage with well-designed virtual shopping environments demonstrate enhanced brand loyalty, strategic purchasing behavior, and collaborative consumption patterns that transfer to increased lifetime customer value (Lemon & Verhoef, 2016).
- **Market Responsiveness:** Virtual marketplaces functioning as "quasi-organic" systems exhibit superior responsiveness to market changes and consumer preferences compared to traditional segmented approaches (Fuchs et al., 2024).

3.4 Digital Native Consumer Behavior Patterns

The research reveals distinct behavioral patterns among digital native consumers that support the fluid reality framework. Generation Z consumers, representing the primary digital native demographic, demonstrate unique characteristics that require integrated business approaches rather than traditional channel-separated strategies.

Documented Behavioral Patterns:

- **Multi-Platform Integration:** Digital natives naturally navigate between virtual and physical touchpoints, expecting seamless experiences across all interaction points (Chang & Chang, 2023).
- **Social Commerce Preferences:** 69% of Gen Z consumers turn to platforms like TikTok for learning about products, indicating the critical importance of social integration in purchase decisions (Mintel, 2025).

- **Authenticity Demands:** Digital native consumers prioritize authenticity, sustainability, and social impact, making these factors essential considerations for any brand hoping to connect with them (NIQ, 2024).

3.5 Business Application Opportunities

The framework identifies specific business opportunities for companies that successfully implement fluid reality strategies. These opportunities span product development, marketing strategy, customer engagement, and operational efficiency.

Identified Opportunity Areas:

Product Development Innovation: Virtual environments function as sophisticated "innovation laboratories" providing unique affordances for product development that enable unlimited experimentation while providing meaningful customer feedback and social validation (Rauschnabel et al., 2022a).

Enhanced Customer Decision-Making: Virtual environments naturally support spectrum thinking through their inherent characteristics, enabling strategy-adaptation commerce that shows enhanced decision-making flexibility and improved ability to adjust preferences based on feedback (Kim & Baek, 2023).

Community Building Capabilities: Virtual reality provides powerful tools for community development through immersive brand experiences, with research showing significant improvements in brand loyalty and reduced customer acquisition costs following immersive experiences (Orús et al., 2019).

Global Market Access: Virtual communities enable collaborative consumption that develops both individual customer relationships and collective market intelligence, supporting enhanced understanding of brand ecosystems and improved capacity for co-creation (Hilken et al., 2017).

These results provide empirical support for the Fluid Reality Theory framework while demonstrating practical applications for businesses seeking to engage effectively with digital native consumers across integrated virtual-physical market ecosystems

4. Discussion

4.1 Theoretical Implications

The Fluid Reality Theory framework represents a significant theoretical advancement in understanding how digital native consumers navigate integrated virtual-physical market ecosystems. The framework challenges existing binary approaches to digital commerce by demonstrating that virtual and physical experiences function as interconnected components of unified customer journeys rather than competing channels.

The three core capabilities identified—spectrum thinking, imaginative integration, and connection understanding—provide a theoretical foundation that bridges consumer psychology research with business strategy development. This integration addresses a critical gap identified in existing literature, where virtual reality marketing research has been noted as fragmented due to its multidisciplinary nature (Rauschnabel et al., 2022a). By establishing these core capabilities as fundamental requirements for digital native engagement, the framework provides a unified theoretical lens for understanding complex consumer behaviors.

The empirical evidence supporting neural network activation similarities between virtual and physical experiences validates the framework's central premise that consumer reality exists as a fluid continuum. This biological foundation strengthens the theoretical argument against artificial channel separation and supports integrated business strategies that recognize the natural cognitive patterns of digital native consumers (Orús et al., 2019).

4.2 Digital Native Consumer Behavior Insights

The research findings reveal that digital native consumers represent a fundamentally different market segment requiring specialized engagement strategies. Generation Z's characteristics as true digital natives—having never known a world without the internet—create unique expectations and behaviors that traditional marketing approaches fail to address effectively (Chang & Chang, 2023).

The finding that 98% of Gen Z use social media platforms for product research, with 69% specifically turning to TikTok for product information, indicates a complete transformation in how consumers access and process purchasing information (Mintel, 2025). This behavior pattern supports the framework's emphasis on connection understanding as a core capability, demonstrating that digital natives naturally operate within interconnected information ecosystems that span multiple virtual touchpoints.

The preference for authenticity, sustainability, and social impact among digital native consumers aligns with the framework's emphasis on meaningful integration rather than superficial channel multiplication. Research showing that these consumers prioritize genuine brand values over marketing messaging suggests that fluid reality strategies must focus on authentic virtual-physical integration rather than simply expanding channel presence (NIQ, 2024).

4.3 Omnichannel Strategy Evolution

The research demonstrates that traditional omnichannel approaches, while representing progress from multichannel strategies, remain insufficient for engaging digital native consumers effectively. The superiority of integrated virtual-physical experiences over channel separation indicates that businesses must evolve beyond current omnichannel thinking toward fluid reality strategies.

The finding that integrated efforts encompassing promotion, product, price, and transaction information significantly enhance both cognitive and affective customer experiences provides evidence for the framework's spectrum thinking approach (Gao et al., 2021). This suggests that businesses should focus on creating seamless value continuums rather than optimizing individual channel performance metrics.

The enhanced customer engagement metrics observed in businesses implementing integrated virtual-physical strategies compared to those maintaining separate channel approaches validates the framework's core premise that integration creates superior business outcomes (Rahman et al., 2025). This evidence supports strategic investment in fluid reality capabilities rather than continued channel separation maintenance.

4.4 Virtual Reality Business Applications

The research reveals that virtual environments offer unique business advantages that extend beyond simple channel expansion. The identification of virtual spaces as "innovation laboratories" that enable unlimited experimentation while providing meaningful customer feedback represents a significant strategic opportunity for businesses seeking competitive advantage (Rauschnabel et al., 2022a).

The finding that virtual communities provide unprecedented opportunities for global market expansion through authentic interaction supports the framework's connection understanding capability. The documented reduction in market entry barriers and enhancement of cross-cultural commerce capabilities indicates that virtual environments can serve as strategic business development tools rather than merely additional sales channels (Hilken et al., 2017).

The evidence that virtual brand experiences lead to significant improvements in brand loyalty and reduced customer acquisition costs demonstrates measurable business value from fluid reality strategy implementation (Orús et al., 2019). This quantifiable benefit provides justification for strategic investment in virtual-physical integration capabilities.

4.5 Business Strategy Implications

The Fluid Reality Theory framework requires fundamental changes in how businesses approach market strategy, organizational structure, and performance measurement. The move from channel-based to spectrum thinking demands corresponding evolution in business systems, marketing practices, and investment frameworks.

Strategic Transformation Requirements:

Traditional assessment criteria focusing on quantitative "channel performance" metrics prove inadequate for capturing optimal virtual-physical integration opportunities. The framework suggests fluid reality commerce approaches that emphasize customer journey quality and developmental appropriateness rather than simple channel separation metrics.

Organizational Capability Development:

Businesses must develop new competencies in virtual environment design, avatar-mediated commerce, and cross-reality customer experience management. The research indicates that these capabilities cannot be developed through simple technology adoption but require comprehensive understanding of digital native consumer psychology and behavior patterns.

Investment Priority Shifts:

The evidence supporting virtual environments as innovation laboratories and community building platforms suggests that investment priorities should shift toward capabilities that enable creative experimentation and authentic relationship development rather than traditional channel multiplication.

4.6 Limitations and Future Research Directions

While the Fluid Reality Theory framework provides a comprehensive approach to understanding digital native markets, several limitations should be acknowledged. The rapid pace of technological change means that specific virtual platform capabilities may evolve quickly, requiring continuous framework refinement to maintain relevance.

Future Research Priorities:

- Longitudinal studies tracking the evolution of digital native consumer preferences as Generation Z transitions into higher earning power phases
- Investigation of cultural variations in virtual-physical integration preferences across different geographic markets
- Development of quantitative measurement frameworks for assessing spectrum thinking, imaginative integration, and connection understanding capabilities
- Analysis of optimal virtual environment design characteristics for different industry contexts and consumer segments

Emerging Research Questions:

The framework raises important questions about the long-term implications of fluid reality commerce for traditional retail infrastructure, supply chain management, and brand relationship development. Future research should investigate how businesses can optimize their virtual-physical integration while maintaining authentic brand values and sustainable business practices.

The research also suggests the need for investigation into the psychological and social implications of increasing virtual-physical integration, particularly regarding consumer identity development, social relationship formation, and community building in hybrid virtual-physical environments.

5. Conclusions

This research introduces Fluid Reality Theory as a strategic framework for understanding and engaging digital native consumers across integrated virtual-physical market ecosystems. The framework provides both theoretical advancement and practical guidance for businesses seeking to optimize their market strategies for 21st-century consumer behavior patterns.

5.1 Key Theoretical Contributions

The identification of three core market capabilities—spectrum thinking, imaginative integration, and connection understanding—establishes a foundation for understanding how digital native consumers naturally navigate virtual-physical market environments. This theoretical framework bridges existing gaps between virtual reality marketing research, omnichannel customer experience literature, and consumer behavior studies, providing a unified approach to complex market dynamics.

The empirical evidence demonstrating neural network activation similarities between virtual and physical consumer experiences validates the framework's central premise that market reality exists as a fluid continuum rather than discrete channels. This biological foundation strengthens theoretical arguments for integrated business strategies that align with natural consumer cognitive patterns.

5.2 Practical Business Applications

The framework enables specific strategic applications including enhanced product development through virtual innovation laboratories, improved customer engagement through spectrum thinking architecture, and expanded market reach through authentic virtual community development. These applications provide measurable business value through increased customer lifetime value, reduced acquisition costs, and enhanced brand loyalty.

The research demonstrates that businesses implementing integrated virtual-physical strategies achieve superior performance metrics compared to those maintaining channel separation approaches. This evidence supports strategic investment in fluid reality capabilities as essential for competitive advantage in digital native markets.

5.3 Strategic Transformation Guidance

The framework provides practical guidance for organizational transformation, including movement from channel-based to spectrum thinking approaches, development of new competencies in virtual

environment design, and evolution of performance measurement systems that capture virtual-physical integration effectiveness.

The research reveals that traditional omnichannel approaches, while representing progress from multichannel strategies, remain insufficient for engaging digital native consumers effectively. Fluid reality strategies that emphasize authentic integration rather than channel multiplication provide superior business outcomes and consumer satisfaction.

5.4 Market Evolution Implications

As Generation Z's spending power grows to an estimated $12 trillion by 2030, understanding and implementing fluid reality strategies becomes essential rather than optional for business success. The research provides evidence-based frameworks for navigating this market transformation while capitalizing on emerging opportunities.

The documented behavioral patterns of digital native consumers—including multi-platform integration expectations, social commerce preferences, and authenticity demands—require fundamental changes in business strategy, organizational design, and customer relationship management approaches.

5.5 Future Business Landscape

The framework anticipates continued convergence of virtual and physical market environments, with increasing sophisticated of virtual technology capabilities and growing consumer comfort with hybrid virtual-physical experiences. Businesses that develop fluid reality capabilities early will be positioned to lead in this evolving landscape.

The research suggests that virtual environments will become increasingly important as innovation laboratories, community development platforms, and global market access tools rather than simply additional sales channels. This evolution requires strategic thinking that moves beyond current technology limitations to envision comprehensive virtual-physical integration possibilities.

5.6 Final Recommendations

Organizations seeking to implement fluid reality strategies should prioritize development of the three core capabilities identified while investing in comprehensive virtual environment design competencies. Success requires understanding digital native consumer psychology and behavior patterns rather than simply adopting new technologies.

The transformation from channel-based to spectrum thinking requires corresponding evolution in organizational systems, marketing practices, and investment frameworks. As virtual environments become increasingly sophisticated and prevalent, understanding how to optimize their business potential becomes essential for supporting comprehensive growth and competitive advantage within the fluid reality of 21st-century commerce.

This research provides the theoretical foundation and practical guidance necessary for businesses to navigate successfully the fundamental market transformation driven by digital native consumers, offering both immediate strategic applications and long-term competitive advantage development opportunities.

Resources

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Thriving in the Midst of Uncertainty: Strategically Mitigating HR and Payroll Risks through Digital Transformation

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Abstract

Research background: In today's volatile global environment, businesses face unprecedented uncertainty – from evolving international regulations to changing cross-border relationships. HR and payroll services, once seen as operational, are now critical to managing compliance, continuity and stability. Traditional approaches often fall short when the legal, political and technological environment changes unpredictably.
Purpose of the article: This paper explores how strategic digital transformation – including secure data transmission, AI-driven analytics and e-signature technologies – enables companies to mitigate operational and legal risks. It shows how outsourcing HR and payroll to specialist providers combines technological innovation with compliance expertise to create a flexible and resilient business infrastructure.
Methods: The study draws on a questionnaire survey of 698 organisations in nine CEE countries, combined with secondary data analysis. Quantitative descriptive statistics, qualitative content analysis and comparative methods were applied, supported by ethical standards and GDPR compliance.
Findings & Value added: Results show that digitalisation of HR is advanced but uneven, facing obstacles such as legal uncertainty and digital exclusion. Outsourcing HR functions strengthens organisational resilience, while HR 5.0 emphasises human-centric approaches. The paper contributes by linking empirical findings with Smith's and Marx's theoretical perspectives, offering a framework for resilient HR systems in times of uncertainty.

Keywords: HR digitalization, HR 4.0 and HR 5.0, Human capital, Corporate culture, Central and Eastern Europe

JEL classification: M15, J24, O33, J81

1. Introduction

Over the last five years, European labour markets have undergone significant turbulence, which has had a profound impact on the functioning of organisations, the shape of work strategies and HR infrastructure. The confluence of the COVID-19 pandemic, the economic upheavals of 2020-2022 and the war in Ukraine have fundamentally transformed companies' approaches to managing risk and uncertainty in corporate decision-making across countries and sectors. Areas such as human resource management or payroll processing, previously seen as largely technical-administrative support functions, have now become a key element of the strategic management of organisations. Given the changing environment, stability, flexibility and technological readiness of the workforce are proving to be essential conditions for the resilience of companies.

However, in addition to the immediate crisis stimuli, it is necessary to reflect deeper structural changes that are transforming the nature of work. In a globalised and digitalising context, **business risks** are increasingly being **transferred to individuals, while collective protection for workers is weakening**. This trend, which can to some extent be interpreted through the prism of Marx's analysis of alienation and precarisation of labour, is currently manifested **in the growth of insecurity, job instability and the weakening of workers' bargaining power**. According to A. Smith's classic thesis,

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the current economic logic, in which short-term returns outweigh long-term sustainability, reinforces the role of the individual as a rational actor, but without adequate institutional support, this **rationality can easily become an instrument of forced adaptation rather than free choice** (Marx, 1978), (Smith, 2007).

This study is based on an extensive questionnaire survey conducted in cooperation with Elanor, an international HR and payroll company operating in Central and Eastern Europe. A total of 698 organisations from nine countries - Czech Republic, Slovakia, Poland, Hungary, Bulgaria, Romania, Serbia, Albania and Ukraine - completed the questionnaire. The results show that the digitalisation of HR processes is advanced in the region, but still faces obstacles such as uneven technical infrastructure, legal uncertainty or digital exclusion of some employees. These findings illustrate different levels of institutional support and approaches to technology investments.

The current economic uncertainty has implications not only for corporate strategies but also for broader societal processes. Respondents to the survey frequently mention the impact on living standards, particularly through the rising cost of basic necessities such as housing, healthcare and energy. This phenomenon - referred to as the **financialisation of everyday life - makes visible the limits of a purely market-based approach to basic services**. At the same time, from the perspective of human capital theories (Schultz, 1961), (Becker, 1976), it appears that investments in education and professional growth face new uncertainties about returns. Workers and firms are thus moving in an increasingly dynamic and less predictable environment where human capital is no longer a guarantee of stability or mobility.

In this context, **digital transformation** stands out **as a key tool for managing risk, increasing efficiency and promoting inclusion**. The paper shows how organisations - through technologies such as cloud-based HR solutions, e-signatures, AI analytics tools and outsourcing of payroll and HR services - can strengthen their resilience to economic fluctuations while better responding to changing employee needs. The results of the analysis not only offer insights into the current state of HR digitalization in CEE, but also a broader reflection on the roles that technology, politics and economic rationality play in shaping the current labour market (Titor, Opimpiev & Eriashvili, 2021).

2. Methods

2.1 Objective and approach

The aim of this paper is to present how companies in Central and Eastern Europe are responding to the growing uncertainty and changes in the labour market through the digitalisation of HR processes, payroll services and organisational adaptation. The research presented combines quantitative data from a questionnaire survey with contextualisation of selected trends within secondary sources. The interpretive framework draws on the concept of human capital, which remains central to understanding the strategic role of HR policy in an era of technological and structural change. (Kuzior, Mańka-Szulik & Krawczyk, 2021)

2.2 Questionnaire survey

The core of the primary research was a **questionnaire survey conducted in May 2025**, targeting HR and payroll professionals. The survey was conducted with the support of **Elanor**, **an international** payroll outsourcing & HR services **company** in eleven European countries, focused on technology solutions in payroll processing and HR.

The questionnaire was distributed electronically and consisted of several thematic blocks:

- Current level of digitalization of HR and payroll processes,
- Use of technologies typical for HR 4.0 and HR 5.0,
- The approach of organisations to risk management and adaptability in a changing environment,
- Experience in outsourcing HR functions,
- Barriers to innovation (legal, technological, human factors).
- The participants were mainly HR managers, CFOs, directors of smaller and medium-sized companies and compliance specialists. The responses obtained were processed anonymously and interpreted in the context of regional differences and sectors.

2.3 Secondary sources and analytical framework

In addition to data from the survey itself, a wide range of secondary data and literature sources were used to help place the findings in a wider context. These sources included:

a) Theoretical frameworks and development of HR technologies

An important background was recent literature distinguishing the different developmental phases of HRM - from HR 4.0 to HR 5.0, emphasizing the interconnection of technology with an emphasis on empathy, inclusion and employee mental health (Polívka & Dvořáková, 2021; Rachmad, 2021).

(b) Statistical and institutional resources

Data on digital readiness, employment, wage structures and technology adoption rates were drawn from:

- Eurostat, Czech Statistical Office (CSO), OECD and ILO.
- Expert reports by Deloitte, PwC, CIPD or World Economic Forum.
- Regulatory frameworks including the European Pillar of Social Rights, EU directives on platform work and minimum wages.
- This information allowed to capture regional inequalities, technological heterogeneity and different levels of institutional readiness within the CEE countries.

2.4 Analytical methods

The research uses a **mixed design** combining:

- Quantitative descriptive statistics (frequency analysis, contingency tables).
- Qualitative content analysis of open-ended questionnaire responses.
- A comparative approach to working with data across countries.

Through this approach, it was possible to identify patterns of behaviour, key barriers and areas for advanced adoption of digital tools.

2.5 Ethical foundations

- Respondents were informed in advance of the purpose of the survey and its anonymous nature.
- Data processing was carried out in accordance with GDPR requirements and ethical standards of social science research.
- The published outputs do not allow for the retrospective identification of individuals or specific companies.

3. Results of the questionnaire survey

Over the last five years, European labour markets have undergone significant turbulence, which has had a profound impact on the functioning of organisations, the shape of work strategies and HR infrastructure. The convergence of the COVID-19 pandemic, economic turbulence, and the war in Ukraine has thus indirectly contributed to the transformation of working conditions, the acceleration of HR process digitalization, and significant changes in human resource management, fundamentally impacting organizational adaptability and strategic direction in workforce-related areas.

3.1 Introduction to the results

The survey conducted in May 2025 provided an up-to-date view of the state of HR processes in the CEE region. It focused primarily on the degree of digitalization of the HR agenda, the level of technological readiness of companies and the experience with outsourcing HR and payroll functions. The organisations were companies operating in a wide range of industries - from logistics to IT to the university sector - across size categories and national markets. The results are presented along several dimensions that reflect the underlying sociodemographics of the sample and key thematic areas.

3.2 Structure of respondents

Table 1. Distribution of organisations by country

Country	Number of organisations	Share (%)
Czech Republic	471	67,5 %
Slovakia	32	4,6 %
Poland	23	3,3 %
Hungary	76	10,9 %
Serbia	25	3,6 %
Bulgaria	14	2,0 %
Romania	29	4,2 %
Kosovo	11	1,6 %
Albania	17	2,4 %
Total	**698**	**100 %**

Source: Authors' research, 2025

Table 1. The Czech Republic had the largest representation among the organisations, accounting for more than two-thirds of the sample. This largely reflects the strong regional anchoring of the research partner and also provides deeper insight into the specifics of the Czech labour market. Other countries are represented in smaller numbers, which will be further taken into account when interpreting the results.

Table 2. Size of organisations

Size category	Share (%)
Small (<50 employees)	6 %
Medium (51-250)	47 %
Large (251-1000)	29 %
Large+ (1001 or more)	18%
Total	**100%**

Source: Authors' research, 2025

Table 2. Medium-sized enterprises account for almost half of the sample, which is consistent with their strong position in the CEE economies. Interestingly, the proportion of large and very large organisations is also relatively high, allowing for comparisons of approaches to digitalisation in different organisational contexts.

Table 3. Branch activities of organisations

Scope	Share (%)
Logistics and transport	23 %
Universities	18 %
IT companies	18 %
Production and production	17 %
Construction	6 %
Other	18 %
Total	**100 %**

Source: Authors' research, 2025

Table 3. The sectoral composition corresponds to a wide range of organisations. Logistics and transport are strongly represented, but also knowledge-oriented sectors such as IT and academic institutions. The "Other" category includes, for example, public administration, services or retail.

Table 4. Respondents' job positions

Position of the respondent	Share (%)
CFO	29 %
HR Director	23 %
HR manager	22 %
HR Specialist	8 %
Payroll Specialist	8 %
Administrator	7 %
Total	**100 %**

Source: Authors' research, 2025

Table 4. Almost three-quarters of the responses came from middle and top management, which adds strategic depth to the survey's explanatory value. The high proportion of CFOs and HR directors indicates the growing importance of the HR agenda in corporate finance and strategic planning.

3.3 Key findings

3.3.1 Level of digitalization of HR processes

In the area of digitalization of HR processes, organizations are gradually adapting to new technologies and systems that bring about more efficient and faster processes. Of the companies surveyed, more than 60% (mostly larger) have already implemented HR 4.0 compliant systems, including automation, use of AI for talent management and predictive analytics. This trend indicates a growing interest in modern technologies that can significantly simplify the administrative and managerial tasks associated with HR management.

3.3.1.1 Adoption of technology

Core HR 4.0 technologies are becoming increasingly common in organisations across sectors. The most widespread technology is e-signatures, used by 71% of organisations. This is followed by cloud-based HR systems and secure data transfer protocols, which have been implemented in 47% of organisations. These technologies facilitate digital document signing and data management, which significantly increases the efficiency and security of operations. AI-based payroll and workforce analytics, on the other hand, are in the early stages of adoption, with only 12% of organizations having implemented these advanced tools.

3.3.1.2 Benefit for agility

The digitalization of HR processes not only makes administration more efficient, but also increases the agility of companies. Respondents noted a number of positive changes, including speeding up processes and the ability to handle many tasks remotely, which increases flexibility and makes it easier to implement changes. The rapid implementation of change is particularly important in the context of crises such as the COVID-19 pandemic, where the digitisation of HR processes has enabled rapid adaptation to new conditions. Another interesting trend is the increased control and resilience of organisations to crises through the use of digital tools and HR analytics. (Ciampi, Faraoni, Ballerini, & Meli, 2021)

3.3.1.3 HR 5.0 - Human-Centric Approach

The HR 5.0 concept, which is gradually being implemented in practice, emphasizes the integration of advanced technologies with a strong focus on employee well-being and the development of empathy. This approach seeks to create a work environment that is not only efficient but also focused on the needs of individual employees. HR 5.0 focuses on a holistic approach to employees, ensuring employee satisfaction and supporting their development.

3.3.1.4 Access to facilities

Support for access to corporate devices within HR processes varies by size and type of organisation. In 76% of companies, employees have access to corporate devices more than 80% of the time, indicating a high level of digitalisation and mobility. On the other hand, 12% of organisations allow access to between

60% - 80% of employees, and the remaining 12% of companies give access to less than 40% of employees.

3.3.1.5 Use of personal devices

When it comes to the use of personal mobile devices for the HR agenda, 59% of organisations support the use of these devices, indicating a growing emphasis on flexibility and mobility in the way we work. **In contrast, 41% of companies do not support this practice**, mainly due to security or technological reasons such as data protection requirements and VPN connectivity.

3.3.2 Challenges in the implementation of HR 4.0 and HR 5.0

The introduction of technology in the field of human resource management and the transition to modern HR 4.0 and HR 5.0 concepts is desirable for most organizations, but at the same time burdened with significant challenges. These challenges are not only technological, but also human, structural and systemic - as confirmed by the results of the questionnaire survey.

3.3.2.1 Impact of geopolitical and economic uncertainty

The geopolitical situation and economic upheavals - such as the COVID-19 pandemic, the 2021-2022 energy crisis and the war in Ukraine - have significantly slowed down the speed and scale of the implementation of digital tools in HR. These events have increased the level of caution in organisations, while frequent regulatory amendments have also brought a higher level of administrative burden and uncertainty, making long-term planning for digitalisation difficult.

3.3.2.2 Digital maturity and exclusion

The digital maturity of organisations remains predominantly at an intermediate level (70%), while only 12% declare an advanced level. This state of affairs is also linked to the persistence of digital exclusion (53% of organisations), which most often affects them:

- Working professions - there is a lack of motivation and support for digital learning.
- Older employees - barrier to learning and fear of technology.
- Support and service positions - low digital literacy and access to tools.

This negatively affects the possibility of widespread deployment of self-service HR portals, electronic agendas or hybrid working models.

3.3.2.3 Key barriers to transformation

Cost and lack of competence are the main blockers, especially for SMEs, which make up the majority of respondents. The survey revealed the following main barriers to digital transformation of HR processes.

Table 5. Key barriers to transformation

Barrier	Share (%)
Cost of technology	53 %
Lack of digital skills	47 %
Resistance to change	29 %
Legal uncertainty	24 %
Insufficient infrastructure	24 %
Other	6 %

Source: Authors' research, 2025

3.3.2.4 Risks in HR and payroll processes

Increasing digital dependency also increases the need to address the security and legal aspects of data, particularly in the areas of GDPR, employment law and access control. In terms of threats to HR and payroll systems, respondents most frequently perceive:

Table 6. Risks in HR and payroll processes

Risk	Share (%)
Cyber attacks / personal data leaks	53 %
Non-compliance with legal and regulatory provisions	41 %
Technological outages or system failures	29 %
Political/economic instability	18 %
Labour shortage / disruption	18 %
Other	12 %

Source: Authors' research, 2025

3.3.2.5 Electronic signatures - extensions and limits

Respondents report that their use is often limited to agendas such as the CSSA, the FÚ or health insurance companies. A significant barrier is legislative ambiguity and lack of binding standards. In this respect, it is therefore important to mention that the use of electronic signatures is still inconsistent.

Table 6. Risks in HR and payroll processes

Status of recognition of electronic signatures	Share (%)
Fully recognised and enforceable	35 %
Partially recognised and enforceable	35 %
Don't know/not sure	30 %

Source: Authors' research, 2025

3.3.2.6 Legislative changes and impacts

Up to 71% of organisations said they had faced the impact of legislative changes in recent months. The most frequent topics were:

- Amendment of the Labour Code (2023-2025), the so-called Flexinovela.
- Changes in the area of FTEs, leave records, benefits, lump-sum compensation.
- Digitalization of processes towards the Ministry of Labour and Social Affairs, the Social Security Agency and the Social Security Office.

The changes have led to a higher administrative burden, legal uncertainty and complicated adaptation in HR practice.

3.3.2.7 Learning from crises and mitigating risks

Interestingly, only 29% of organisations reported that they had learned concrete lessons from previous crises. Improvements reported include:

- Increased security.
- Accelerating the digitisation of HR agendas.
- Introduction of teleworking and increased flexibility.

Risk mitigation through digitisation included:

- Eliminating the need for physical mail.
- Ensuring access and minimizing data leakage.
- Investment in systems, training, automation of calculations.
- Better security and geo-location of data access.
- Clarity, transparency and centralisation of documentation.

3.3.2.8 Complexity in cross-border operations

Another significant challenge in the area of HR systems modernisation is the complexity of HR and payroll in cross-border employment and in managing employees working in multiple countries. The questionnaire survey revealed the following distribution of the complexity of these operations:

Table 7. Complexity in cross-border operations

Level of complexity	Share (%)
Medium	64 %
High	18 %
Low	18 %

Source: Authors' research, 2025

Respondents often cite problems related to different legislation and wage regulations between countries, especially between **EU and non-EU countries**, or when posting employees and employing foreigners on multiple jobs in several countries at the same time.
Specific comments from respondents include:

- Employing foreigners with more than one full-time job in more than one country, sending employees abroad.
- Labour Code, wage regulations, employment of foreigners.
- Extremely laborious, unnecessarily time-consuming and, above all, time-consuming with the risk of penalties for late payment in another country.

In some cases, organisations are addressing complexity through internal guidelines, while others indicated that they are not yet concerned or unable to assess the issue.

These challenges point to the need for harmonisation of employment law across the EU or the need for flexible HR systems capable of handling a multi-national agenda without unnecessary risk of errors and penalties.

3.3.3 Impact on employees and company culture (including theoretical framework)

Digitalization of HR processes brings not only technical streamlining of agendas, but also major impacts on employees and company culture. The results of the questionnaire survey showed that a significant part of the surveyed organisations have improved the efficiency and speed of decision-making in the HR agenda. The introduction of modern systems has made it possible to reduce the administrative burden and facilitate access to information, thereby increasing the transparency and responsiveness of HR departments.

From a theoretical point of view, this shift can be framed in the spirit of Adam Smith, who in his Wealth of Nations drew attention to the importance of the division of labour in increasing the productivity and efficiency of organisations. **In this respect, the digitisation of HR can be seen as a modern tool for the division of labour** - technology is taking over routine tasks, freeing up space for human capital to engage in strategic and creative activities. At the same time, Smith warned against "dulling the human spirit" if a worker performs too monotonous an activity. In this respect, modern HR approaches (particularly HR 5.0) represent a response to this concern - it is the emphasis on empathy, individuality and employee wellbeing that seeks to prevent the degradation of the work experience in a digital environment. (Smith, 2007), (Dahlbom, Järvenpää, Sajasalo & Siikanen, 2019)

A significant finding from the questionnaires is that 82% of companies **perceive the HR agenda strategically**, which means that it is seen as an important element of change management and human capital development. However, for the remaining organisations (18%) HR is still perceived more as a legislative or administrative necessity. In some cases, the agenda is not given the necessary weight by management, which may hinder its full use in the context of digital transformation and the development of organisational culture.

At the same time, it is important to look at the more critical perspective that Karl Marx brings, especially in the Economic-Philosophical Manuscripts or Capital. Marx drew attention to the process of alienation of labour, whereby the worker becomes a mere instrument of production and loses control over the results of his activity. Even modern HR technologies, if not implemented with the human dimension in mind, can lead to digital alienation - for example, when employees do not understand new tools, have no influence on their selection, or are systematically excluded because of low digital literacy. The results of the survey showed that certain groups (workers, older workers, support staff) face a real risk of digital exclusion, which can lead not only to frustration but also to a loss of work autonomy.

Respondents also pointed to the need to systematically develop inclusive approaches and increase the digital literacy of employees. This area is crucial for the effective use of HR 4.0 and HR 5.0 tools. Some

organisations mentioned that their employees, especially those in blue-collar, service or administrative professions, face barriers to using digital systems due to low digital competence or limited access to technology. (Park, Ahn, Hosanagar & Lee, 2021)

The surveys also showed that organisations are starting to invest more in inclusion strategies - typical tools include training, webinars, internal e-learning platforms, access to HR portals or IT support. These initiatives are key not only for engaging employees in new processes, but also for building a culture of openness, trust and technological confidence in the workplace.

3.3.4 Impact on employees and company culture (including theoretical framework)

The introduction of technology within HR 4.0 and the move towards HR 5.0 brings significant changes not only in the field of human resources management, but especially in the impact on the company culture and employees themselves. The digitisation of HR processes, automation and the increasing use of artificial intelligence play a key role in this process. A survey of 698 organisations showed that 76% of companies declared improvements in the efficiency and speed of decision-making in HR processes. This is reflected positively not only in operational performance but also in human capital management. (Yu & Jinajun, 2023)

In terms of the strategic perception of the HR agenda, there is a noticeable strengthening of its role:

- 82% of organisations reported that the HR agenda is viewed strategically,
- 18% consider it partly strategic or administrative.

At the same time, some respondents report that in their organisations the HR agenda is still perceived as a legislative necessity rather than as a strategic management partner. This discrepancy points to the uneven pace of transformation, which is conditioned not only by technological but also by cultural factors.

At the same time, however, more than 64% of respondents point to a lack of involvement of all employee groups in digital transformation. The need for a greater focus on digital literacy, inclusiveness and support for employees at risk of digital exclusion is therefore ever present. The main groups at risk include blue-collar occupations, older workers and employees in support or service roles.

Inclusion strategies noted in the research include:

- training and e-learning,
- internal information systems and HR portals,
- onboarding training and webinars,
- IT infrastructure support and access to digital devices.

4. Discussion

Theoretical framework: Smith versus Marx - two sides of the same coin?

In terms of theoretical anchoring, one can draw on the ideas of both Adam Smith and Karl Marx, although their approaches differ in many respects.

Adam Smith views the division of labour as a tool for productivity and efficiency growth, thereby implicitly advocating the digitisation and automation of processes as a natural development within economic rationality. According to him, specialization increases efficiency and enables economic growth - this logic can be applied in parallel to contemporary HR processes (Smith, 2007). In light of the digitalization of HR processes, Smith's theory takes on a new dimension: the division of labour is now heavily dependent on information, and digitalization brings tools that ensure its more accurate and faster distribution. For example, obtaining data on employee competencies enables more accurate task allocation and more effective team management - i.e. data-driven division of labour.

Karl Marx, on the other hand, warns of the risk of alienating the worker from his work, especially in situations where the worker becomes a mere tool of the production system. In the context of the digital transformation of HR, his concerns are still relevant - for example, in cases where employees are insufficiently integrated into technological change, or are replaced by automation without adequate support and opportunities for retraining (Marx, 1978). Moreover, digitalization can bring a new form of alienation - not only the loss of direct control over work, but also the loss of meaningful human contact and the weakening of interpersonal relationships in the workplace. Work can be reduced to a sequence of numbers, processes and algorithmically driven tasks.

Here, however, there is room for a positive role for the digitisation of HR processes. If grasped correctly, digitalisation can contribute to deepening the relationship between employee and employer. provides HR professionals with more comprehensive and up-to-date information about employees - their needs, performance, motivations or career aspirations. This can support a more individualised approach and strengthen the human dimension of the organisation, the very dimension that Marx called for.

Thus, the two approaches need not be seen as antithetical, but rather as **complementary perspectives**: the Smithian orientation towards efficiency and growth should be balanced by Marx's emphasis on humanity, justice and the dignity of labour. It is the concept of **HR 5.0**, which builds on a human-centric approach, that may represent a modern synthesis of these two traditional paradigms.

In this sense, digitalisation is not only a tool for optimisation, but also a means of looking after the quality of working life.

In the context of corporate culture, the implementation of HR 4.0 and HR 5.0 approaches becomes not only a technological challenge, but also **a test of the ability of organizations to combine efficiency with empathy and innovation with inclusion**. Successful implementation of these approaches then brings not only higher performance but also a more stable and sustainable work environment. In this framework, it is important to distinguish between the digitisation of the company as a whole and the digitisation of specific HR processes - it is these processes that we focus on in the following sections.

The results of the survey show that digitization of HR processes is on the rise in organizations in the CEE region, but its pace and scope varies significantly depending on digital maturity, company size, sector and geographic location. This diversity confirms that digital HR transformation is not a one-size-fits-all process, but a complex adaptation that must take into account the specificities of each organisation. (Mukamurera, Lacourse & Couturier, 2022)

4.1 Differences in digital readiness across countries and sectors

A significant finding is the persistent unevenness of digital readiness. While some organisations are already integrating advanced AI tools, others are still addressing basic infrastructure or staff skills gaps. Digital exclusion is most acute for blue-collar and support professions, but also for older workers who are more likely to face technological barriers.

This shows that digital transformation is not just a matter of investing in technology, but primarily a change in culture and attitudes towards human capital

4.2 HR as a strategic function vs. HR as an operational cost

The survey found that 82% of organisations see HR as a strategic partner. This is a positive shift that confirms the growing importance of human capital in the context of organisational agility and adaptability. Conversely, for the remaining 18% of companies, HR is still seen predominantly as an operational cost or legal necessity. The pace of digitalisation itself may influence this difference - strategic HR departments have a greater capacity to push for systemic change and leverage new technologies.

4.3 HR 5.0 as an opportunity to de-value employees

The comparison with the ideas of Adam Smith and Karl Marx is interesting. Smith saw the division of labour as the key to productivity growth - by analogy, the digitisation of HR can be seen as a tool to make human labour more efficient. Marx, on the other hand, pointed to the alienation of humans from their work due to over-mechanisation.

In this spirit, HR 5.0 can be seen as a response to the risk of digital alienation - it aims to create a work environment where technology supports, not replaces, the human dimension of work. Respondents in the research highlighted the importance of inclusive strategies, access to tools and training as a means of preventing digital marginalisation.

4.4 Risks of digital transformation

The transition to digital HR systems brings a number of benefits, but also new risks that organizations must actively manage. The most common threats include:

- Cyber attacks and personal data leaks (53% of respondents),
- Non-compliance with legislative provisions, in particular in the area of data protection,
- Inadequate security of systems that can lead to operational failures,
- Digital exclusion, which puts specific groups of employees at a disadvantage.

In the context of these challenges, it is imperative that digitisation is not just a technical upgrade, but a holistic transformation process that encompasses IT, law, education and human relations.

5. Recommendations for practice

The survey results show that successful digital transformation of HR agendas depends on a combination of technological, HR and organisational factors. Below are key recommendations for different types of organisations that can help overcome the identified barriers and maximise the benefits of HR 4.0 and HR 5.0.

5.1 For small and medium-sized enterprises (SMEs)

SMEs most often face barriers related to cost, lack of competence and low digital maturity.
Recommendation:

- Consider shared or modular HR systems - cloud-based solutions often allow for scaling as needed and easier implementation.
- Outsource HR agendas in less strategic areas (payroll, compliance), freeing up capacity for development and people-oriented activities.
- Support internal digital ambassadors - select employees with digital talent to help others learn new tools.
- Work together within professional associations or clusters - to share training costs and exchange good practice.

5.2 For large and multinational organisations

Large companies often face the complexity of cross-border operations, legal differences and the need to manage digital diversity within a heterogeneous workforce.
Recommendation:

- Implement a centralised HR system with localisation - a unified approach with the ability to adapt to local requirements reduces errors and costs.
- Create a role for a "Digital Inclusion Officer" - a person responsible for equal access to training, technology and support.
- Consider partnering with regional experts or HR BPO providers who are familiar with local legislation.
- Test cross-border agendas in pilot modes before deploying them across the entire organisation.

5.3 For companies with low digital maturity

Organisations at the beginning of their digital journey are often stuck on how to start and what to prioritise.
Recommendation:

- Start with simple tools with a high return (e.g., electronic signatures, digital attendance, payroll automation).
- Assess the digital competencies of your employees and create a training plan focused on the practical use of technology.
- Define a digital HR strategy that links the organization's goals to specific technology actions.

We understand digital maturity at work:

a. knowledge of the use of HW and SW,
b. common use of digital tools and,
c. equipped with the technical means for normal use.

5.4 For companies with high digital maturity

Rather, mature companies face issues of scaling, security and the ethical impact of technology.
Recommendation:

- Integrate HR analytics and AI tools into strategic management - e.g. to predict turnover or optimise recruitment.
- Strengthen cybersecurity standards in HR systems - especially in remote working and BYOD scenarios.

- Monitor the impact of automation on employees - assess whether new technologies are creating inequality or frustration.
- Build a culture of digital trust and ethics - transparent communication and the ability to give feedback on new tools.

5.5 What companies can demand from the legislation

Given the uncertainty and fragmentation of the legal framework, we recommend that companies proactively articulate their requirements to regulatory institutions.

Recommendation:

- Support the standardization of electronic signatures and documents - reduce barriers between institutions (CSSA, MLSA, health insurance companies).
- Seek legal harmonisation on cross-border issues - especially within the EU (e.g. uniform approaches to FTEs, holidays, posting).
- Advocate for more support for digital education in government programmes - targeted even for low-skilled professions.

Conclusion

The digitisation of HR processes represents a fundamental transformation in the way organisations manage their human resources. In a context of increasing uncertainty - geopolitical, economic and legislative - it is becoming clear that the ability to adapt through technology can have a decisive impact on the sustainability and competitiveness of companies.

The results of a survey of 698 organisations across Central and Eastern Europe showed that:

- The HR agenda is becoming a strategic tool for change management and human capital in 82% of organisations.
- Companies are already partially implementing HR 4.0 technologies, especially in the area of electronic signatures and cloud systems.
- Awareness of the benefits of HR 5.0, which combines technology with an emphasis on empathy, wellbeing and individuality, is spreading.
- However, significant barriers remain in the areas of digital maturity, security, legal certainty and inclusion - especially for SMEs.

At the same time, it has been shown that companies that invest in training, digital literacy support and secure infrastructure experience not only more efficient operations, but also higher levels of employee satisfaction and willingness to participate in change.

HR outsourcing, especially in the areas of payroll, compliance and administration, is profiled as a flexible solution that allows companies to focus on strategic people management while reducing the risks and costs associated with complex legislative and technical requirements.

Overall, the future of HR lies not only in the introduction of technology, but above all in finding a balance between efficiency and humanity. HR 5.0 presents an opportunity to synthesize these two approaches - linking Smith's vision of productivity with Karl Marx's socially critical view of the dignity of work and the right of every employee to meaningful participation in the organization.

The future success of organisations will depend on their ability to:

- use the technology effectively and safely,
- actively support and involve employees,
- while creating a company culture based on trust, openness and a human approach.

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Optimization of Tourist Routes Using Traveling Salesman Problem Algorithms

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Abstract

Research background: This paper investigates combinatorial optimization methods, specifically the Travelling Salesman Problem (TSP), for optimizing tourist routes within the city of Lodz. It explores how mathematical modeling and modern optimization tools can enhance personalized sightseeing experiences.
Purpose of the article: The primary objective is to design and implement a functional prototype of a tourist route planning system that identifies the shortest possible path between multiple landmarks using Google OR-Tools, an advanced open-source optimization library.
Methods: The study applies graph theory, UML modeling, and constraint programming to formulate and solve the route optimization problem. Accurate travel distances are obtained via Google's Distance Matrix API, and the system architecture is structured into three modules: user interface (map view), business logic, and database. Tourists interact with the application to select destinations and receive an optimized travel route.
Findings & Value added: The results confirm the feasibility of using constraint programming for small to moderately sized TSP instances in urban tourism. The prototype provides efficient route recommendations and demonstrates the potential for scaling with additional constraints such as time windows, public transport schedules, and environmental conditions. This work lays the groundwork for developing intelligent, user-centric tourism applications and contributes to the broader smart city travel planning field.

Keywords: Traveling Salesman Problem, Tourist Route Optimization, Application, System modelling, Tourist Attractions.

JEL classification: M3, O350, O350.

1. Introduction

Consider a scenario in which a traveling salesman departs from his home city, visits a collection of distinct cities exactly once, and subsequently returns to the point of origin. The goal is to find the least travel distance needed to finish such a tour. This optimization issue is the Travelling Salesman Problem (Pop, Cosma, Sabo, & Sitar, 2024; Ling, Zhang, & Chen, 2023), a fundamental combinatorial optimization challenge.

The "cities" in this paper are historical sites in Lodz. The issue, therefore, becomes finding the quickest path on a city map that lets visitors see all sites. From a graph-theoretical point of view, every landmark is a vertex, and every path between landmarks is an edge with a corresponding weight-distance. A Hamiltonian cycle (Bowtell, Morris, Pehova, & Staden, 2025; Min, Bai, & Gomes, 2023), the tour visits every vertex precisely once before returning to the starting point.

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Finding the right Hamilton cycle is a computationally intractable task (Bosnić & Šikić, 2023). Imagine a complete graph (Fig. 1 and Fig. 2) (a graph in which every vertex is connected to every other vertex) with 10 vertices.

To understand the computational complexity of the Travelling Salesman Problem (TSP), consider a complete graph with nnn vertices, where each vertex is directly connected to every other vertex. The number of distinct Hamiltonian cycles in such a graph is given by (Wałaszek, 2025):

$$L_H = (n-1)! \qquad (1)$$

since the salesman can start from a fixed vertex (to avoid counting symmetrical cycles) and then choose the remaining n−1 cities in any order (Wałaszek, 2025).

For example, in a complete graph with 10 vertices:

$$L_H = 9! = 362{,}880 \qquad (2)$$

This factorial growth places the problem in the class of exponential time complexity, O(n!). For each Hamiltonian cycle identified, the total length (sum of edge weights) must be calculated, and the optimal solution corresponds to the cycle with the minimum total weight.

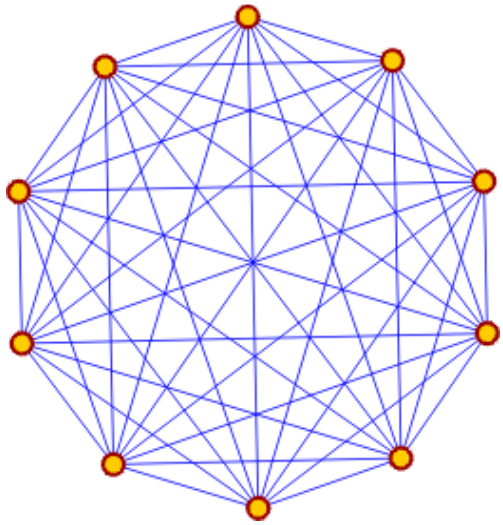


Figure 1. Complete graph.
Source:(Wałaszek, 2025)

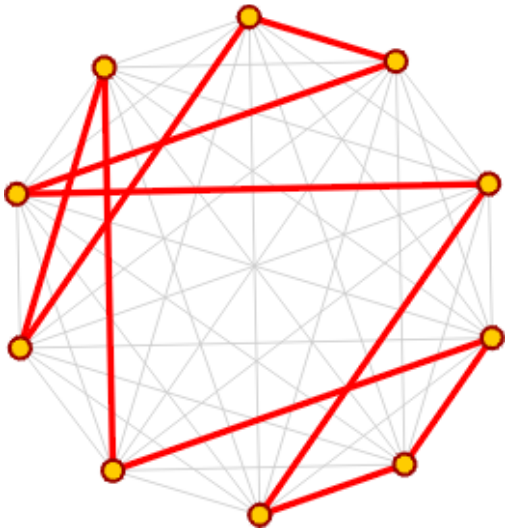


Figure 2. Complete graph with an overlayed solution.
Source: (Wałaszek, 2025)

Although complete graphs illustrate the worst-case scenario, real-world networks like road systems are typically sparse rather than complete. Despite these more realistic conditions, the computational challenge persists. Take a graph with 100 vertices, where each vertex connects to only four others. The potential number of Hamiltonian cycles remains staggering. Assuming a pessimistic branching factor of three (after the first choice), the approximate number of Hamiltonian cycles becomes (Wałaszek, 2025):

$$L_H \approx 4 \times 3^{99} \approx 5.15 \times 10^{47} \qquad (3)$$

Generally, for a graph with *n* vertices and a vertex degree of *s*, the potential number of Hamiltonian cycles can be estimated by:

$$L_H \approx (s-1)^n \qquad (4)$$

This exponential growth renders brute-force approaches computationally infeasible for large instances. Even powerful modern computers would require centuries to solve instances with only a few dozen nodes using exhaustive search. For example, generating 1,000 solutions per second would suffice to evaluate all possible cycles for a 10-node graph in under three minutes. However, a 20-node graph would take nearly four million years to solve using the same method (Macgregor, Ormerod, & Chronicle, 2000).

2. Related Works

Several related studies (Uddin et al., 2021; Andrea & Azahari, 2021) have tackled the TSP using different methods. Research by (Păcurar, Albu, & Păcurar, 2021)shows that various optimization challenges, like circuit design, data clustering, and job-shop scheduling, can be represented as TSP instances. These varied issues can be expressed as TSP problems, and the TSP can also be seen as a specific case within these broader categories. Therefore, approaching these challenges through the lens of the TSP frequently leads to the most precise and cohesive formulation.

Recent studies in tourism route planning have increasingly aimed at enhancing visitor experiences through algorithmic and data-driven methods. The domain of Tourism Route Optimization aligns closely with this research, as it focuses on identifying efficient tourist site visit sequences under various limitations like time, cost, or sustainability. Many researchers have used classical and heuristic optimization techniques to address this issue. For instance, Păcurar et al. (Păcurar, Albu, & Păcurar, 2021) investigated route optimization during the COVID-19 pandemic, highlighting safety alongside route efficiency. Various studies have leveraged Ant Colony Optimization (ACO) methods, including works by Li et al. and Liang et al., who introduced enhanced ACO variants tailored for context-aware and knowledge-based tourist path planning (Li, Luo, Wang, Xing, & Ren, 2022; Liang, Jiao, Du, & Qu, 2021). Other scholars have created urgency-based models to customize route sequencing based on personal priorities (Xu et al., 2023), while Divsalar et al. concentrated on formulating environmentally sustainable travel itineraries through green optimization strategies (Divsalar, Divsalar, Jabbarzadeh, & Sahebi, 2022). The incorporation of artificial intelligence in route planning is demonstrated by Li et al. (Li, Zhang, Sun, & Zou, 2024), who investigated the application of Large Language Models (LLMs) for optimizing travel routes, illustrating the utility of generative models in decision-making processes. Likewise, Yang employed the Floyd algorithm for coastal tourism route planning, showcasing how traditional graph algorithms can be modified for this sector (Yang, 2020). Kiruthika et al. (Kiruthika et al., 2023) presented a comprehensive and sustainability-oriented method for recommendation-based route planning. At the same time, research in related but separate fields offers additional insights. Personalized recommendation systems like TourMate utilize machine learning to recommend optimal tourist destinations, considering various user factors (Khan & Chowdhury, 2024). Gamified systems with NPCs, such as the Tenggarong City simulator, enhance user engagement in digital tourism (Andrea & Azahari, 2021). Travel logistics, including parcel delivery (Uddin et al., 2021) and traffic analysis (Fomy, Mahmud, Islam, & Rahim, 2022), contribute to broader transportation efficiency and planning frameworks that connect with tourism route design. These studies support using TSP algorithms in tourism (Włodarczyk, Morka, Nowicki, & Dudkiewicz, 2021; Bellman, 1962). Although heuristic and AI-driven methods are prevalent, ensuring computational reliability and interpretability in TSP optimization is crucial for creating practical routes.

3. Methods

Following the methodology described in (Saračević, Mašović, & Plojović, 2012), Unified Modeling Language (UML) diagrams are utilized to illustrate the architecture of the proposed system, which aims to help tourists find the most efficient travel route among selected landmarks. The initial diagram, the use case diagram, shows the system's main actors and their interactions in the context of optimizing tourist routes.

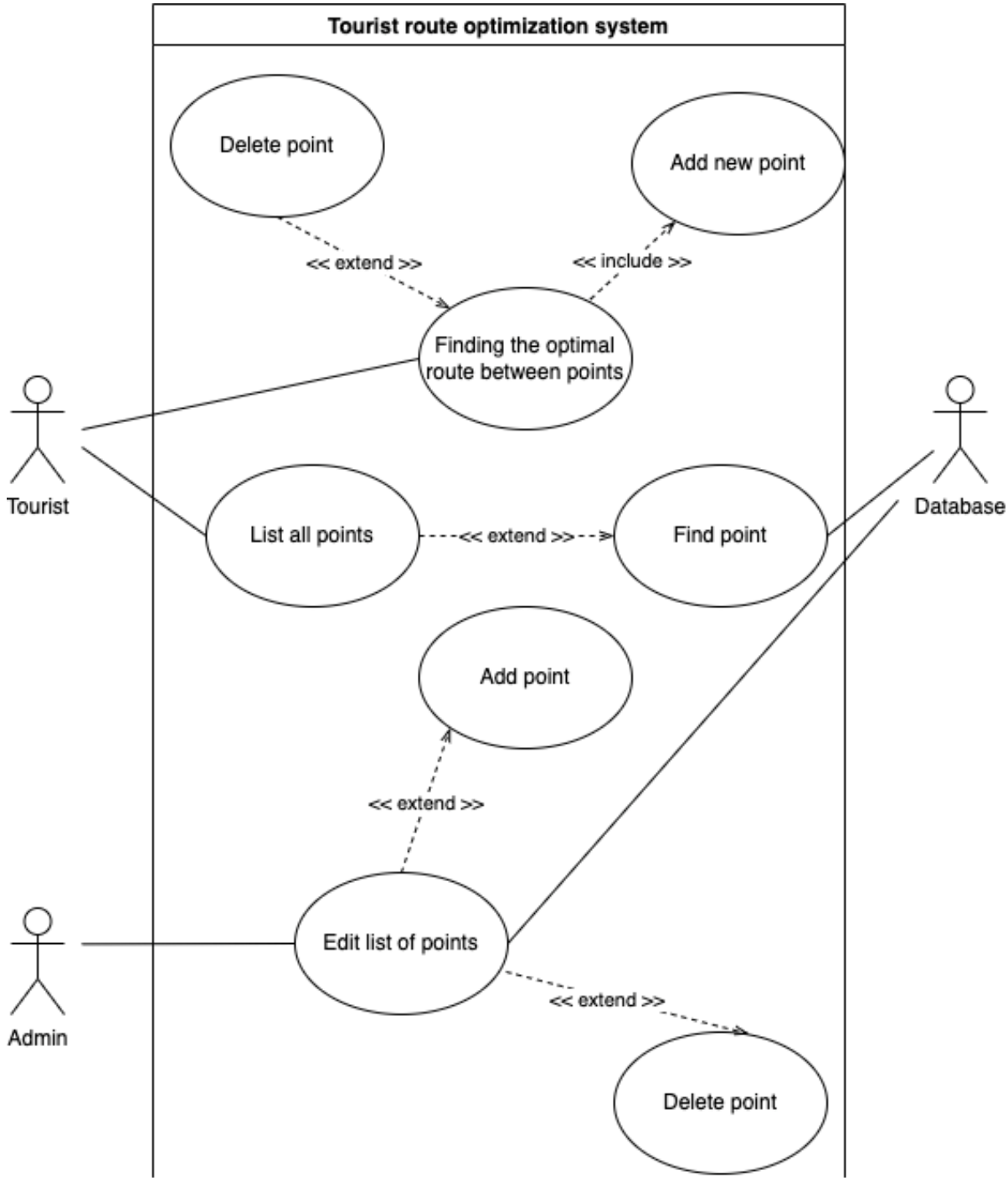


Figure 3. Use case diagram of the Tourist route optimization system.
Source: author's work (2025)

The Tourist is the end-user who employs the system to create an optimal sightseeing route. The Administrator is responsible for managing the system's dataset by adding points of interest from which the Tourist can choose later. The Database component ensures these points are stored persistently, keeping the information available for future processing and route generation.

Our app will cater to two user types:

- Tourist – our primary user group. Tourists will use our app to optimize their routes to attractions in Lodz. They will have access to a comprehensive list of monuments and attractions stored in our database, allowing them to view and select points for their routes. Additionally, tourists can remove points from their routes as needed.

- Admin – responsible for app maintenance. The admin will update the database by adding new attractions in Lodz or removing points if they are no longer available in the city.

Algorithm model ("business logic")

The distances between *n* locations can be rpresented using a distance matrix $\mathrm{D} = [d_{\mathrm{ij}}]$, where $\mathrm{i,j} \in \{1,2,\dots,\mathrm{n}\}$, and the diagonal entries d_{ij} are zero, indicating that there is no distance between a point and itself. A tour through these locations can be described as a cyclic permutation π of the set $\{1,2,\dots,\mathrm{n}\}$, where $\pi(\mathrm{i})$ denotes the location visited immediately after location i. The Travelling Salesman Problem (Aguiar-Melgarejo, 2016; Sharma, Mioc, Anton, & Dharmaraj, 2006) is thereby formulated as an optimization problem aiming to find the permutation π that minimizes the total tour length:

$$\min_{\pi} \sum_{i=1}^{n} d_{i,\pi(\mathrm{i})} \qquad (5)$$

As presented in (Aguiar-Melgarejo, 2016; Sharma, Mioc, Anton, & Dharmaraj, 2006) , this model can be further extended by incorporating time-dependent variables. The cost function *f* is formulated as a step function, where each time interval has a uniform duration *l*, resulting in a time-indexed cost matrix *T*. The system input is defined as follows:

- $n > 0$: the total number of locations (visits). The first location in the list is designated as the depot. For modeling purposes, this depot is duplicated to form a virtual visit $n + 1$, marking the end of the tour.
- A time horizon $H > 0$, a fixed number of time steps $\mathrm{m} > 0$, and a step duration $\mathrm{l} > 0$, such that $H = l \cdot m$
- A three-dimensional cost matrix T: $[1, n+1] \times [1, n+1] \times [0, m-1] \to \mathbb{R}^{+}$, where $T[i][j][t/l]$ denotes the travel cost from node *i* to node *j* when departure occurs at time *t*.
- A visit duration vector D: $[1, n] \to \mathbb{R}^{+}$, which assigns a time duration to each visit.

Due to the constraints of real-world road networks, where direct travel between two points may not always be feasible, we adopt the method described in (Breiding, Sottile, & Woodcock, 2022). Under this approach, a complete graph G is constructed using the node set V derived from the transportation network T. The algorithm proceeds as follows:

1. Compute the Minimum Spanning Tree (MST) of the graph *G*.
2. Identify all vertices in the MST with an odd degree.
3. Perform a minimum-cost perfect matching among these odd-degree vertices.
4. Construct a multigraph by combining the MST edges with the matching edges, ensuring that all vertices have even degree.
5. Execute an Eulerian circuit on this multigraph.
6. Replace each pair of consecutive nodes in the circuit with the shortest path between them based on the underlying transportation network.

The final path, constructed by substituting each segment with its corresponding shortest navigable path, yields an efficient tour that approximates optimality within the constraints of real transportation infrastructure.

The application architecture comprises three core components: the Map (View), Business Logic, and Database. The sequence diagram below shows the interaction flow among these components during a typical user session, specifically when a tourist uses the application.

When the app is started, the visitor sees the main interface, the map view. At the same time, the app sends a request to the business logic layer, which then runs a database search for a list of accessible points of interest. Once the database responds, this data is transmitted back through the business logic to the map component, where the points are dynamically displayed as markers.

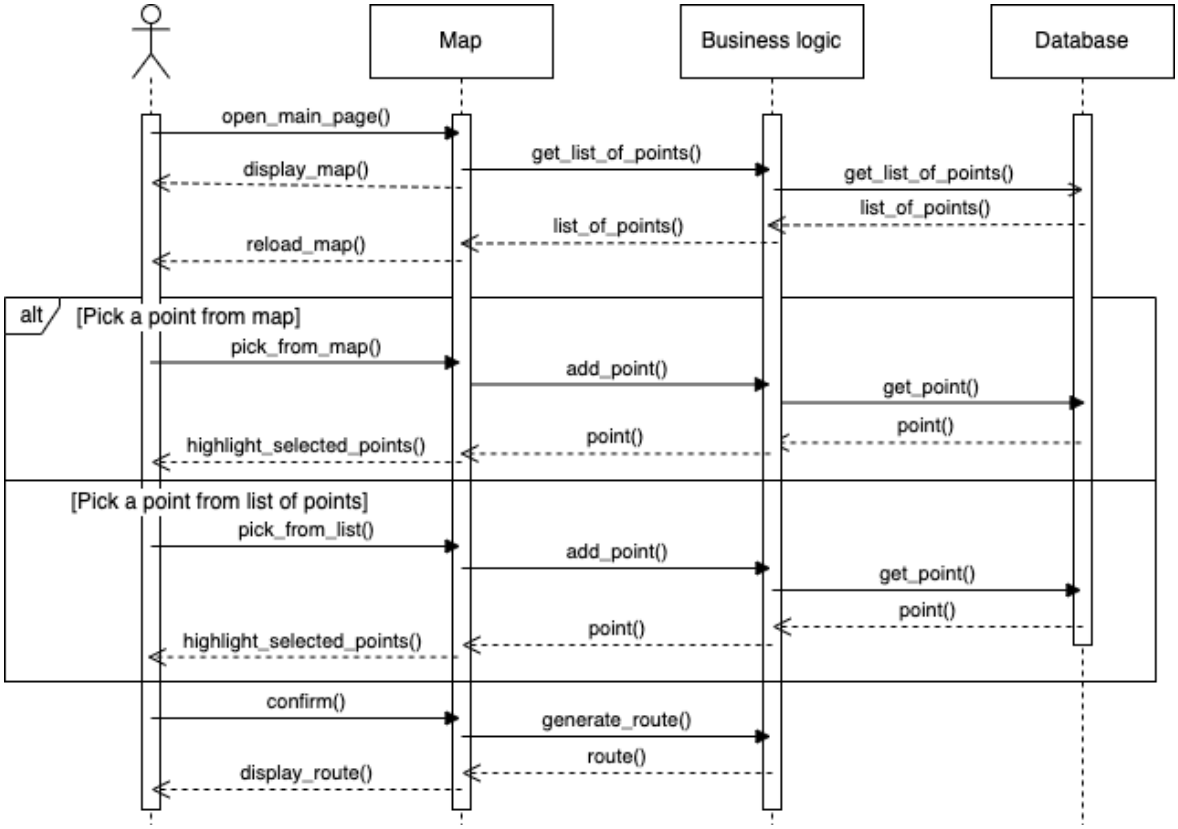


Figure 4. Sequence diagram of creating an optimal route by a tourist (user)

Following this initial setup, the tourist may select a point directly from the displayed list or interactively choose a marked location directly on the map interface.

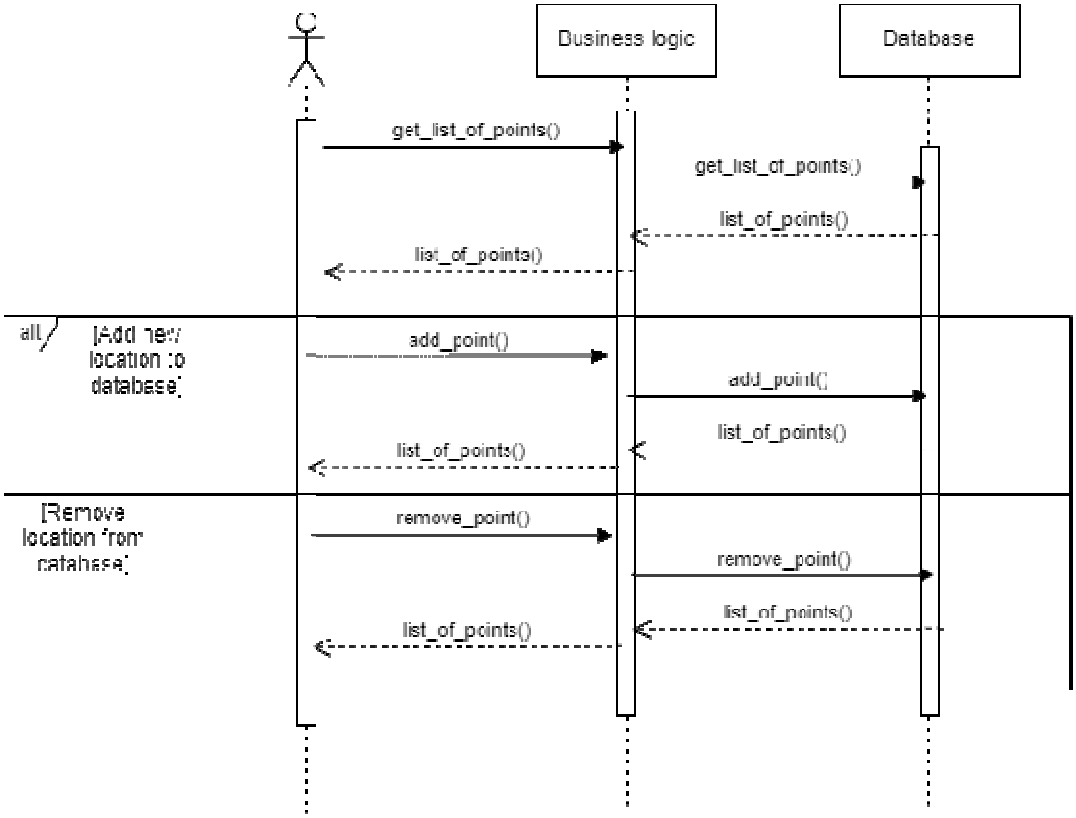


Figure 5. Sequence diagram of adding new locations to a database by the administrator

The sequence diagram outlines the Administrator's workflow, who updates the application dataset without using a graphical user interface. Instead, administrative tasks are performed via an API tool, like Postman, allowing direct HTTP requests to the business logic layer. Each request includes a security token to verify access. The Administrator can retrieve a list of sites and manage database entries through this interface. To enhance route optimization, this system employs Google OR-Tools, a leading open-source library for combinatorial optimization, including the Traveling Salesman Problem. Annual MiniZinc Challenge results show that Google OR-Tools outperforms other solvers through efficient search-space reduction and quality solutions. Its consistent success in competitions over the last five years highlights its reliability, justifying its use in optimizing tourist routes.

4. Results

A simple implementation of the project was prepared. It consists of a Python script, find_optimal_tourist_route.py, that takes the above-mentioned input data as a distance matrix between sample tourist objects, processes the data, and shows the optimal route as a console output. To solve the problem, it utilizes the Google OR Tools library. At first, points of interest locations are retrieved from the database. Then the distance matrix can be calculated using the Euclidean distance formula (Breiding, Sottile, & Woodcock, 2022). For location p and q and their coordinates it is calculated as follows:

$$d(p,q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2} \qquad (6)$$

However there is a dedicated open Open Source API maintained by Google, which does this calculations more precisely and was decided to be used instead (Breiding, Sottile, & Woodcock, 2022). Request with locations of the points is sent in a JSON form. JSON response is returned that contains all the data we need to construct the distance matrix after being parsed. Normalized sample distance matrix structure (Table 1):

Table 1. Normalized sample distance matrix structure

	Location 1	**Location 2**	**Location 3**
Location 1	0	100	250
Location 2	100	0	620
Location 3	250	620	0

Source: author (2005)

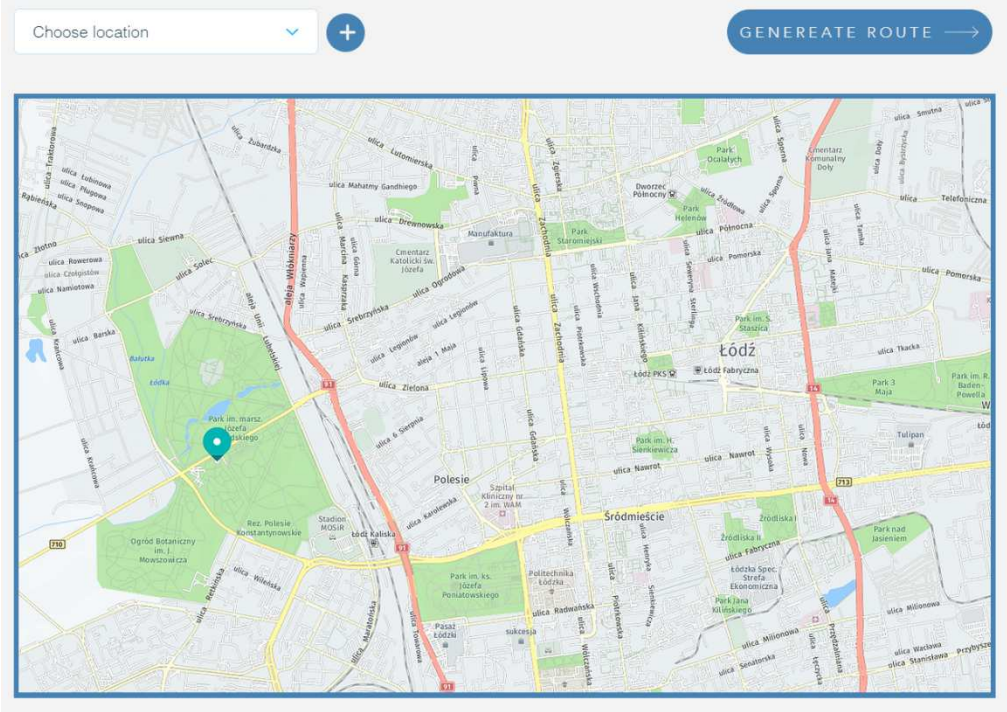


Figure 6. Application main screen

The objective of the implemented script is to minimize the cost function as defined in the preceding section. Upon execution, the script produces the optimal sequence of location identifiers as output, representing the order in which the tourist should visit the selected points to achieve the minimal travel cost.

This ordered sequence is subsequently processed to render the route on the map visually. Each location is connected to the next in the specified order by a line segment, effectively forming a continuous path. The resulting route ensures that all selected locations are visited efficiently and that the tour returns to the starting point. Example of a generated route: $0 \rightarrow 2 \rightarrow 1 \rightarrow 3 \rightarrow 0$

Upon launching the application, the map interface is automatically initialized and centered on the user's current geographic location, which is obtained via location services. The user may add the first point of interest either by selecting an entry from the dropdown list or by directly clicking on the desired location within the interactive map interface.

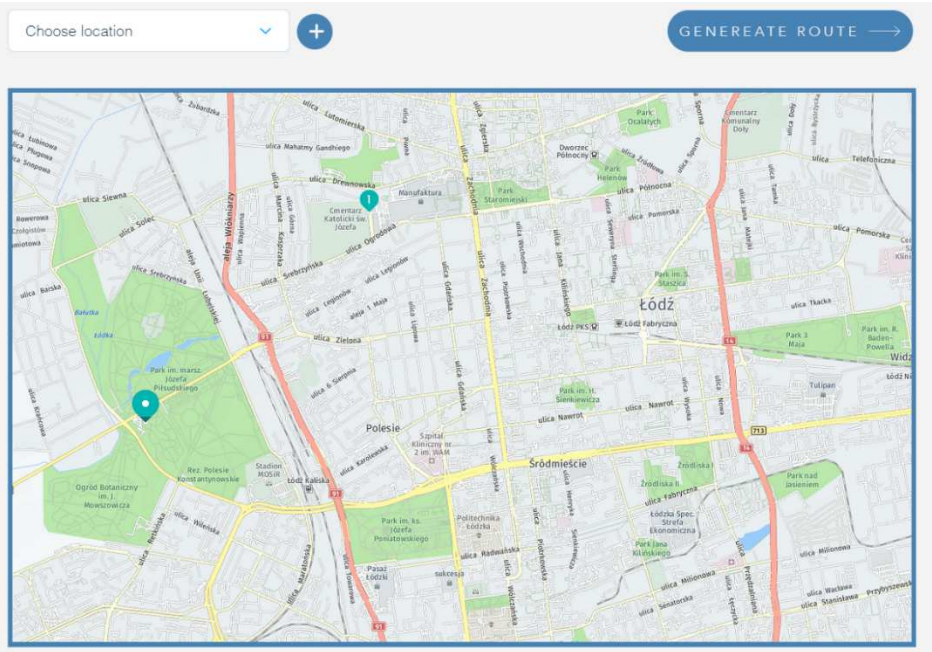


Figure 7. Application with one chosen point on the map

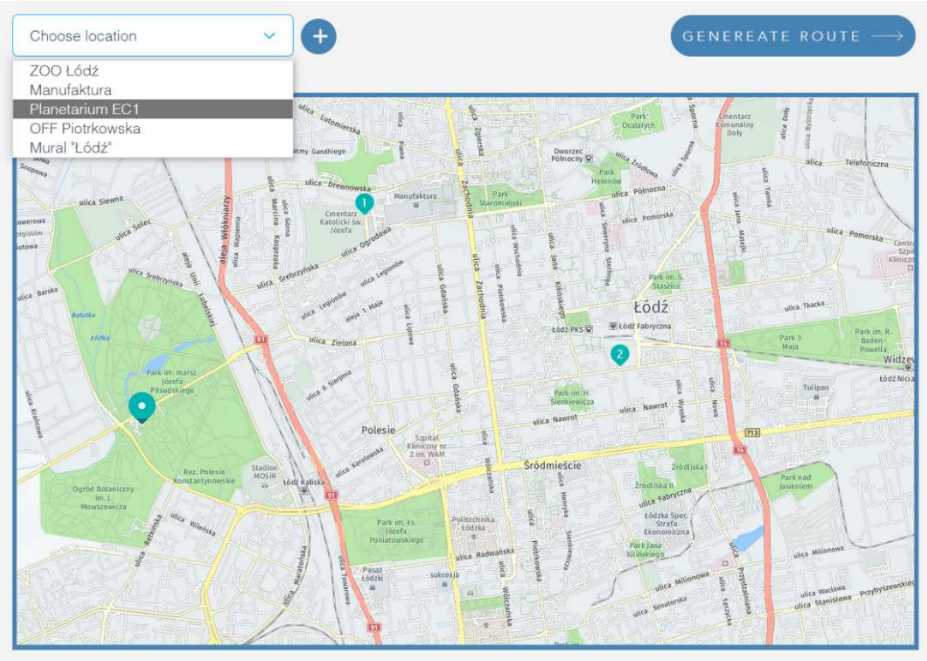
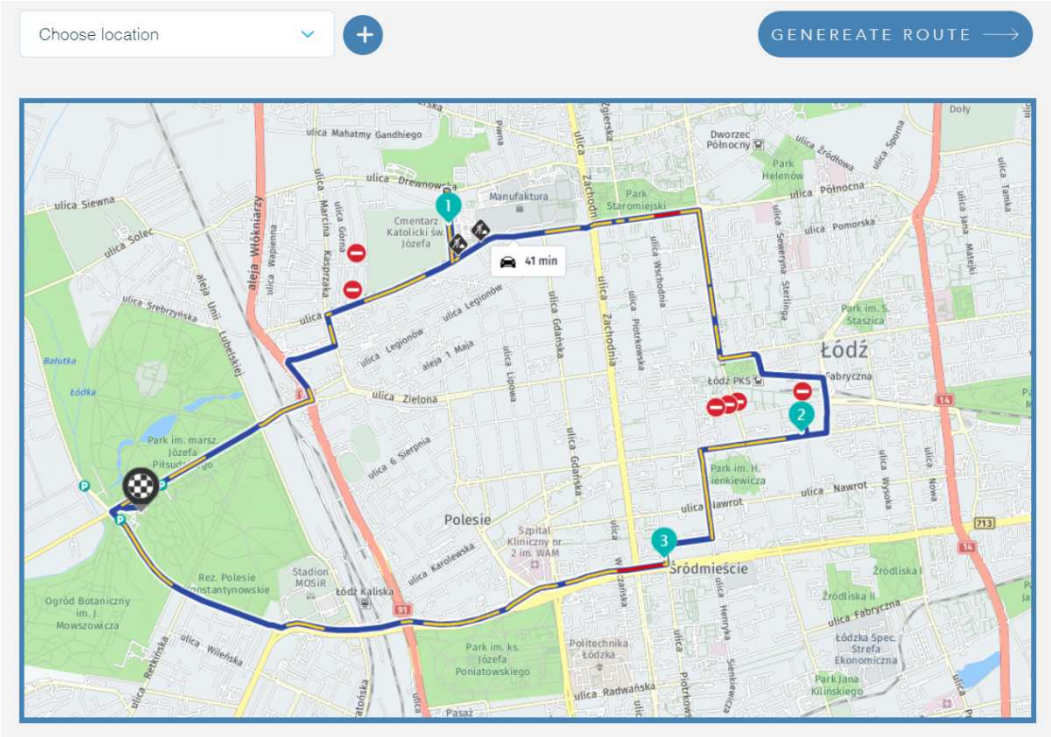


Figure 8. List of chosen locations

The user may continue adding points of interest iteratively until all desired tourist locations have been selected. Once the selection is complete, the route generation process is initiated by clicking the "GENERATE ROUTE" button. This triggers the underlying optimization algorithm, which computes the most efficient tour that visits all selected points and returns to the starting location.


Choose location
GENEREATE ROUTE
41 min
Łódź
Polesie
Śródmieście
Manufaktura
Park Staromiejski
Dworzec Północny
Cmentarz Katolicki św. Józefa
Szpital Kliniczny nr 2 im. WAM
Stadion MOSiR
Politechnika Łódzka
Łódź PKS
Park im. ks. Józefa Poniatowskiego
Park im. marsz. Józefa Piłsudskiego
Park im. H. Sienkiewicza
Park Jana Kilińskiego
Ogród Botaniczny im. J. Mowszowicza
Rez. Polesie Konstantynowskie
Łódź Kaliska
Pasaż
ulica Mahatmy Gandhiego
ulica Drewnowska
ulica Sienna
ulica Solec
ulica Srebrzyńska
aleja Włókniarzy
ulica Marcina Kasprzaka
ulica Legionów
aleja 1 Maja
ulica Zielona
ulica 6 Sierpnia
ulica Gdańska
ulica Zachodnia
ulica Wschodnia
ulica Piotrkowska
ulica Karolewska
ulica Wileńska
ulica Radwańska
ulica Nawrot
ulica Północna
ulica Pomorska
ulica Fabryczna
ulica Żródliska II
ulica Żródliska I
ulica Żródłowa
ulica Spółna
ulica Tamka
ulica Jana Matejki
ulica Wólczańska
ulica Wólczańska
ulica Wólczańska

Conclusions

The implementation and testing stages are proof of concept, showing that constraint programming, especially with the Google OR-Tools library, can efficiently calculate optimal travel routes between tourist destinations. Although our prototype validates the viability of this method, it's important to recognize the straightforward nature of the test case. The complexity of the Travelling Salesman Problem (TSP) escalates quickly as the number of locations increases. The problem includes only six possible paths in the example discussed, making the solution space relatively manageable. However, for ten locations (excluding the starting point), the number of potential routes expands factorially, which to $10! = 362{,}880$. When scaled to twenty locations, a number realistic and practical for the application's use case, the number of permutations, equal to 20 factorial, reaches $20! = 2.43 \times 10^{18}$. Exhaustive enumeration ensures the best solution; however, this approach quickly becomes impractical for anything larger than small cases. Considering the exponential increase in complexity, we expect to utilize no more than twenty locations in standard situations. For larger instances, advanced optimization methods are necessary to effectively explore the solution space and yield optimal or near-optimal solutions in a reasonable amount of time.

Although Google OR-Tools is a sophisticated tool that efficiently reduces the search space and frequently produces excellent results, it does not always guarantee the best results, especially when dealing with larger input sizes. The size of the problem increases the time required to find a solution exponentially, and occasionally the solution may yield a satisfactory but suboptimal result. Modifying the solver's search parameters may improve results by examining a larger range of solutions. It is crucial to remember that this study does not provide a comprehensive answer to the TSP in planning tourist routes. Future research might explore incorporating additional real-world limitations to enhance the modeling of locations with restricted accessibility, such as specific operating hours.

Acknowledgments

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