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**SPECIAL ISSUE OF THE IZVESTIYA JOURNAL OF THE UNIVERSITY  
OF ECONOMICS – VARNA OF COMMODITY SCIENCE RESEARCH  
“COMMODITY SCIENCE IN A CHANGING WORLD”**

**Guest Editor:**

**Associate Prof. Sabka PASHOVA, PhD<sup>1</sup>**

This special issue focuses on the Commodity Science and in particular on some of the following scientific areas: Achievements, Trends and Challenges; Protection and Satisfaction of Consumers; Economic, Commercial and Marketing Aspects of Commodity Science; Environmental Aspects of Commodity Science; Quality Management Systems, Standardization and Certification of Products; Supply Chain Management: Packaging and Logistics of Products; Technology and Innovation: Products and Processes Quality, Safety and Authenticity of Products. New theoretical discussions, projects and scientific analyses are necessary for the effective scientific work in the areas of new trends and challenges in the developing world.

The 20<sup>th</sup> IGWT<sup>2</sup> Symposium of Commodity Science and Technology is an international scientific forum, held for the first time in Bulgaria and hosted by the University of Economics in Varna. It gathers scientists from around the world and enables the presentation of the latest scientific and applied research related to the development, relevance and application of commodity science and technology. It gives the floor to the participants to present new research projects, to give rise to interesting discussions on current scientific topics and areas, to allow new contacts to be established and to open new ways of finding solutions to the commodity science and technologies in our rapidly developing and changing world.

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<sup>1</sup> University of Economics - Varna. Commodity Science Department, E-mail: [spashova@ue-varna.bg](mailto:spashova@ue-varna.bg), President of IGWT (<http://www.igwt-int.org>)

<sup>2</sup> Internationale Gesellschaft für Warenwissenschaft and Technologie

It is a tradition that IGWT meetings are held at different prestigious scientific centers all over the world. This is the longest-standing and largest conference of Commodity Science and Technology which gives the floor for discussions in the most important areas of contemporary commodity science and technology. The IGWT Symposium is a unique event because it is an international forum which gathers together experts and acknowledged researchers from different countries and puts current scientific topics to discussion. It gives the floor to the scientists not only to analyze the general situation and existing problems, but also to introduce advanced experience, exchange ideas on cutting-edge theories and major practices, and propose many constructive ideas and suggestions on finding solutions to the commodity science and technologies in our rapidly developing and changing world. The discussions made during the sessions of the symposium were a brilliant dialogue, a demonstration of shared wisdom and food for thoughts. The content of the issued books (Book of abstracts and Symposium proceedings) fully proves the prestige of this unique and unusual international event.

This special issue includes papers from the 20<sup>th</sup> IGWT Symposium “Commodity Science in a Changing World” held at the University of Economics - Varna, between September 12 and September 16, 2016. It was jointly organized by the Commodity Science Department at the University of Economics - Varna, Bulgaria, the University of Economics – Varna, Bulgaria, the International Society of Commodity Science and Technology and with the support of the sponsors: Pobeda Burgas; Varna COOP; Zaharni izdeliya Varna; Azalia Hotel and Spa, Varna; Ester Oil Nachevi Ltd.; Domain Boyar; Mladenovo Winery, Tutrakan; Glarus Craft Brewing Co, Varna; FOT Ltd; ACM; Institute of Mountain livestock breeding and agriculture – Troyan. The organizers and the editorial board of the Izvestiya Journal of the University of Economics – Varna put forward the idea of publishing a special issue with emphasis on “commodity science, quality and safety of goods, quality management system, sustainable production and consumption”. Papers from the symposium were selected, reviewed and included in this special issue. Papers to be included could be from any area related to the commodity science such as Achievements, Trends and Challenges; Protection and Satisfaction of Consumers; Environmental Aspects of Commodity Science; Quality Management Systems, Standardization and Certification of Products; Supply Chain Management: Packaging and Logistics of Products; Technology and Innovation: Products and Processes Quality, Safety and Authenticity of Products. All papers included in the special issue propose new insights and perspectives in the wide knowledge area of commodity science and technology.

We believe that this special issue enriches the scientific commodity science literature by exploring existing and new research topics from the perspective of new trends and challenges in the developing world and rapidly changing global economy. Given below is a summary information on the papers included in the issue.

The first paper is authored by Anatolii Mazaraki and Nataliia Prytulska. The title is “Commodity Science in Ukraine: Present and Future”. The paper examines the formation and development of commodity science and training specialists in this field in Ukraine. The most important components of training highly qualified specialists in commodity science in KNUTE<sup>3</sup> is analyzed. The basic tasks of commodity science development for the future are formulated. The results prove that the main task of the commodity science specialists came to the goods quality and safety management, identification of forgery, legislative activity in modern conditions. Providing highly qualified specialists is vital for the sustainable growth of trade. The leading role in this process belongs to the higher educational system. Cooperation with NGOs<sup>4</sup>, permanent dialogue with employers, government authorities, the mass-media and other institutions and organizations are the important parts of training highly qualified commodity science specialists in KNUTE.

The second paper is “The Assessment of the Risks Caused by Heavy Metals Contained in Consumer Products by the Use of Bio-indicative Measuring Method”. It is authored by Renata Salerno-Kochan. In this paper the author investigates the safety requirements that relate to consumer products such as clothes, shoes, toys, upholstered furniture and decorative items. The aim of the study is to establish whether the so called heavy metals included in products as components of chemical substances or used while finishing processes, might pose a real risk to consumers. The samples of materials, in which high amount of heavy metals were detected have been subjected to extraction in different kinds of solution extracts and then the extracts were analyzed for the presence of such elements as nickel, copper, lead, cadmium and chrome. To verify the toxicity effect of extracts the bio-indicative measuring method based on *ciliate sp.* test organisms was applied. Changes in test organisms’ behaviour were analyzed based on microscopic observations and spectrophotometric measurements. The research has shown that the so-called heavy metals, e.g. copper, lead, chromium or cadmium might not pose a high risk to consumers. The study has revealed the usefulness of the bio-indicative measuring method for safety assessment of nonfood products. This method may indicate the presence of harmful elements in

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<sup>3</sup> Kyiv National University of Trade and Economics

<sup>4</sup> Non-government organizations

materials that are susceptible to migration into aqueous environment and may inform whether the product poses a real risk to living organisms. It is stated that materials, which do not meet legal requirements may comply with ecological or standard requirements, and cannot have a toxic effect on living organisms.

The third paper deals with “Implementation of Management Systems as Competitive Advantage”. This paper is written by Marta Karkalíková and Dominika Noseková. It describes a study of system approaches of organizations to quality management, food safety and its continuous improvement through measurement and evaluation. It was found that they have strong positive effects on economic growth and competitiveness of food businesses. Implementation of food safety management systems into practice and their certification according to ISO standards becomes a precondition for achieving, sustaining, and enhancing companies’ competitiveness. It is observed that the application of standards of corporate management in the comprehensive integrated form brings significant benefits for the companies. Before implementing an integrated management system, it is important to determine the organization’s effectiveness and efficiency and to assess the various management systems that will be integrated. It is also important to specify the extent to which integration should be implemented, to assess the legal requirements and set the necessary competence and long-term objectives in the context of integration.

The fourth paper is “Proposal of Environmental Aspects Assessment of Products”. This paper is authored by Zbigniew Klos and Krzysztof Koper. The paper examines the use of Life Cycle Assessment (LCA) in the design stage of technical objects. The environmental analysis is done on the wrapping machine, with special interest given to its gear transmission. Using LCA, environmental profiles and environmental indices for different constructions of gear wheels are elaborated and on this basis, an optimal combination of materials for elements of transmission gear: shaft, gear wheels and body is proposed. The results of this study give suggestions and increase the interest of designers, constructors and technologists to include an eco-balancing methodology in their work, which in turn would result in: research and application of eco-friendly materials; minimization of energy input to technological processes; use of environmentally-friendly lubricants that reduce friction resistance in kinematic nodes of a machine and allow easier dismantling of elements. The analysis of results brings interesting observations and conclusions, important for both machine designers and producers.

The fifth paper addresses “The Current Problems of Sustainable Production and Consumption”. The author is Waław Adamczyk. The purpose of the study is to develop sustainable production and consumption in two areas. The factors of mutual



unsustainability between production and consumption within the cycle: environment – resources – production – distribution – consumption – waste – environment. Sustainable consumption and production is completed by four groups of strategies according to different industries and product systems. The aim of these strategies is to reduce resource consumption, while maintaining economic growth. The positive effects of sustainable development result primarily from the involvement in the design and manufacturing areas. Distributors and retailers play an important supporting role by shaping supply chains and consumer behaviors and generally agree that sustainable production and consumption give the chance to develop innovations and improve competitiveness. It is also necessary to perform informative and educational activities for consumers to make sustainable consumption in their lifestyle.

Paper six, entitled “The Quality in Corporate Sustainability Reporting” is written by Jadwiga Adamczyk. It investigates identification of quality in corporate sustainable development reporting. The quality occurs as a Global Reporting Initiative (GRI) rule and also as an integral part of reports. The fourth generation of GRI G4 guidelines, including an approach to quality management as an element of a report is discussed. Sustainability reporting includes information on economic, ecological and social performance. The GRI guidelines are used by most companies as a reference for sustainability reporting. 37 reports were examined awarded for the best social reports in 2015 the extent of information provided in sustainable development reports, in particular those related to quality management. The results indicates that the category of quality occurs both in the reporting process and in assessment of sustainable development effects. The analysis of reports allows to note that the most important question was the way of presenting the information, not its quality. Discretion regarding corporate sustainable development reporting, affects report quality and credibility. The main advantage of GRI G4 is its consistency with other standards related mainly to CRS, for example: OECD guidelines, UN Global Compact principles and Business and Human Rights guidelines as well as, that is important, ISO standards regarding environmental, quality and safety management and environmental protection.

The seventh paper “Perception of Extra-Virgin Olive Oil Certifications: A Commodity Market Perspective” is by Lolita Liberatore, Nicola Casolani and Federica Murmura. Using K-means cluster analysis, the paper investigates consumer attitudes toward the organic certifications in extra-virgin olive oil on Italian market. The main scope of the authors is to analyze extra-virgin-olive oil (EVOO) consumers’ perception of Protected Denomination of Origin (PDO) and organic certifications,

investigating differences and common points. Respondents were screened against the following these characteristics: they are olive oil consumers; they are Italian citizens and they are over 18 years old. The research was carried out between October 2014 and February 2015 in three different areas located in the Southern, Central and Northern Italy. The results show a market classification of EVOO consumers in three main clusters based on attitude toward certifications: the first includes PDO extra-virgin-olive oil (EVOO) consumers (27.2%), the second includes PDO and organic EVOO consumers (32.4%), while the third cluster comprises are indifferent to certifications consumers (40.4%). Finally, it is observed that the Italian system needs to improve communication tools in order to give more information to consumers about the value of PDO and organic certifications.

The final paper of this special issue is entitled “Motivation, Costs and Benefits of the Adoption of the European Ecolabel in the Tourism Sector: An Exploratory Study of Italian Accommodation Establishments”. Authors are Stefano Duglio, Stanislav Ivanov, Francesca Magliano and Maya Ivanova. The authors’ aim is to analyze Italian hospitality managers’ perceptions towards the European Ecolabel and to identify the factors that influence them. 36 Italian accommodation establishments with the European Ecolabel (out of 194, the 18.6% of the total) were studied and were analyzed their motivations, difficulties, costs, and benefits deriving from its implementations. The findings reveal both strong and critical point in the adoption of the European Ecolabel by the Italian accommodation establishments. On the one hand, the main motives for certification are the sustainability awareness by the hospitality managers and the aim to improve the image of the property among guests, confirming one of the main factors in joining this kind of tools. Furthermore, the certification costs do not seem to create a barrier. On the other hand, some difficulties in evaluating and, above all, quantifying the benefits persist among the Italian hospitality managers. The respondents’ opinions reveal a lack of balance between expectations (the improvement of the corporate image) and related benefits (in terms of increase in the number of guests) that drives the managers to affirm how their expectations are not satisfied. Another interesting finding is that Italy is the first country in Europe in terms of adhesion to the European Ecolabel while in other countries like Austria, Spain and France, only a limited number of properties are certified. Finally, suggestions are made for further research considering that different cultural groups and their diverse expectations and concepts of quality (investigate the differences in motivations, difficulties, costs and benefits of the European ecolabel in different EU countries and in other cultural contexts).

Closing this editorial, I'd like to mention that without the scientific papers and the hospitality of the Izvestiya Journal of the University of Economics – Varna (IJUE – Varna) Editorial Board it would have been difficult or even impossible to prepare and create this special issue. Many thanks also to the authority and the executive board of the International Society of Commodity science and technology for appointing the Commodity science department and the University of Economics - Varna to organize and host this prestigious scientific forum. In conclusion, I want to thank all the authors for their excellent work and especially to the IJUE – Varna for its important contribution.



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## IZVESTIYA

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### COMMODITY SCIENCE IN UKRAINE: PRESENT AND FUTURE

**Anatolii MAZARAKI<sup>1</sup>, Nataliia PRYTULSKA<sup>2</sup>**

<sup>1</sup> Kyiv National University of Trade and Economics; Rector Professor Tel. +38-044-531-49-49. E-mail: [knteu@knteu.kiev.ua](mailto:knteu@knteu.kiev.ua)

<sup>2</sup> Kyiv National University of Trade and Economics. First Vice-Rector, Professor Tel. +38-044-531-48-23. E-mail: [prytulska@knteu.kiev.ua](mailto:prytulska@knteu.kiev.ua). 19, Kioto st., 02156, Kyiv, UKRAINE.

**JEL A230+I230**

#### Abstract

#### Keywords:

commodity science, trade, training specialists, standards of higher education, competences, professionalization.

Formation and development of commodity science and training specialists in this field in Ukraine are shown. The most important components of training highly qualified specialists in commodity science in KNUTE is analyzed. The basic tasks of commodity science development for the future are formed.

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### Introduction

Training commodity science specialists in Ukraine has deep roots and more than a century-long unique experience starting from several specialized schools in the early twentieth century till now, when more than 150 educational establishments of different levels of accreditation successfully train specialists in commodity science (Mazaraki, 2008).

Commodity science is the knowledge that systematically examines goods at all stages of the life cycle, methods of evaluation of their consumer value, regularities of goods assortment and quality requirements for the efficiency of their production, turnover and consumption. The object of commodity science is the goods as products of work are aimed to meet customer needs and methods of their theoretical and practical evaluation. The subject of commodity science is the consumer value of goods, regularities of expression and conservation (Standard of Ukraine 3993:2000). The system of means and methods of the study factors in the formation and conservation of consumer properties of goods during the life cycle is the basis of commodity science methodology.

Scope, objectives and functions of commodity science specialists are greatly enhanced, the social significance of commodity science research has been increasing as a result of transformation processes in education and the economy of Ukraine, the reform of state supervision on the internal market, consumer protection, improvement of the legal and institutional framework for the implementation of the Association Agreement between Ukraine and EU, necessity for Ukrainian goods to enter into the new markets.

Apart from traditional evaluation of goods quality, commodity science specialists, among other came to the management of goods quality and safety based on introduction of international standards, identification of forgery, peer review of legislative acts, and in fact – to the system work of the formation of a high level of life quality of Ukrainian citizens as consumers.

### **Training commodity science specialists**

Providing highly qualified specialists is vital for sustainable growth of trade. The leading role in this process belongs to the higher educational system. Kyiv National University of Trade and Economics (KNUTE) is the leader in training commodity science specialists and it has been leading the development of appropriate higher education standards in Ukraine since 1993.

National state standards of education – educational qualification characteristics, educational professional programs, regulations evaluation of students' knowledge have been operating more than ten years. Standards of higher education are based on competence approach.

The new list of field of knowledge and specialties, according to which candidates for achieving higher education in Ukraine are trained, came into force in 2015 (Decree No. 266). According to this document training specialists in commodity science and trade entrepreneurship is carried out within the field of knowledge “Management and Administration” in the speciality “Entrepreneurship, trade and exchange activities”. In KNUTE training specialists is carried out in the following specializations:

#### ***Bachelor educational degree:***

- Commodity Science and Commercial Logistics;
- Commodity Science and Foreign Trade Organization;
- Wholesale and Retail Trade;
- Customs Affairs.

#### ***Master educational degree:***

- Organization of Wholesale and Retail Trade;
- Commodity Science and Commercial Logistics;

- Commodity Science and Foreign Trade Organization;
- Customs Affairs;
- Safety and Quality of Goods Management.

***Doctor of Philosophy (PhD), Doctor of Science educational degrees:***

- Commodity Science of Nonfood Goods;
- Commodity Science Food Products;
- Technology of Food Products.

In KNUTE the program of measures was created to implement provisions and recommendations of the European higher education aimed at developing autonomy and quality assurance of higher education to meet the requirements of the Law of Ukraine "On Higher Education" 2014 (Law No. 1556-VII). On April 28, 2016 according to resolution of KNUTE Academic Council was approved the following:

- Higher education standards of KNUTE on training Bachelor, Master and PhD candidates in the specialty "Entrepreneurship, trade and exchange activities" in the mentioned above specializations;
- Regulations on the educational process organization of higher education candidates in PhD degree in KNUTE;
- Regulation on the procedure of training of higher education candidates in PhD degree and Doctor of Sciences degree in the appropriate scientific specialties.

The conception of training higher education specialists in the field of commodity science includes:

- Safety and quality of goods management;
- Expert examination of the goods and services including customs purposes;
- Consumer protection at the state level;
- Supply chain management, logistics;
- Consumer product and services testing;
- Cooperation with employers, mass media, strengthening the social significance of scientific research and so on.

The role of commodity science is important for improving consumer products quality control, formation and improvement of the state policy on consumer protection as part of a social policy aimed at citizens and society social security formation.

A significant achievement is the preparation of the guidelines, which became the methodological basis for writing the final qualifying works by students in the specialty "Entrepreneurship, trade, exchange activities" in Master educational degree in KNUTE (Mazaraki, Prytulska, Osyka et.al, 2014).

Cooperation with NGOs, a permanent dialogue with employers (producers and retailers, industry associations etc.), government authorities, mass media and other

institutions and organizations is an important part of training highly qualified commodity science specialists in KNUTE.

### **Cooperation in the structure of non-government organizations (NGOs)**

The KNUTE scientists initiative and with the support of civil society NGOs have been established and have been working successfully in Ukraine.

*Ukrainian Society of Commodity Science and Technology (USCST)* registered in 2006 is a non-political, non-profit All-Ukrainian public organization. Representatives of USCST have significant experience of work in advisory bodies, public and scientific councils in the executive branch of power. USCST carries out ongoing work aimed at promoting the innovations in commodity science and technologies, ensuring consumer protection and other measures to improve standards of life.

The purpose of *All-Ukrainian Consumers' Federation "PULSE"*, established in 2008, is consolidation of the efforts of consumer associations from different regions of Ukraine for effective legal protection of consumer rights, equal access of consumers to quality and safe goods and services. The main tasks of the "PULSE" are to promote systematic consumer education of children and youth, expansion of the practice of effective protection by consumers their rights and strengthening the capacity of public associations of consumers and their partnership with consumers' organizations in the EU and the world.

Measures for the exchange of best practices, introduction of scientific developments to practice, modernizing training of specialists of all levels of education are being constantly held under *Ukrainian Culinary Union* that brought together experts from 36 organizations of restaurant and cleaning business. Cooperation with similar organizations worldwide allows to harmonize approaches and to enrich the content of the organization activity.

### **Assurance of the permanent dialogue with employers**

In KNUTE there has been developed and efficiently functioning information-analytical, scientific-discussion public platform of partnership "Trade of Ukraine", aimed at ensuring the balance of Producer-Consumer-Trade interests.

Actual trend of cooperation is participation in the professional standards development. Commodity science specialists are the members of developers of the first retail standard for the profession - professional standard for the position of "Seller of non-food goods". The standards for other key positions for the trade sphere are being prepared.

The Practical Manual "Marking of Household Electrical Television and Radio Appliances: Guide to Retail Workers" is one of the successful examples of cooperation between scientists, educators and business workers. The Manual was developed by scientists of the Commodity Science and Customs department of KNUTE according to the order of a group of companies "Foxtrot. Home Appliances". The Manual was positively assessed by the European Business Association, the trade networks of Ukraine "Metro" and "Auchan" and by official importers of home appliances "Sony", "Electrolux" and others.

KNUTE representatives are the members of the International Society of Commodity Science and Technology (IGWT), Public Councils of executive authority, the Commission Codex Alimentarius. They participate in tasting sectoral commission, meeting of technical committees for standardization. The technical committee for standardization in the sphere of services in trade, tourism, restaurant and exhibition operates on KNUTE base. Considerable work on harmonization of Ukrainian and European standards is being carried out.

The Educational Advisory Center in Safety and Quality of Goods management is successfully operating in KNUTE.

Attraction to work for the examination of legislative acts, documents and product samples; patent activity; numerous appearances in the mass media is a special directions of KNUTE teachers scientific competence.

### **The development of the commodity science theory and actualization of commodity science categorial apparatus**

The last decade has shown that commodity science goes beyond traditional objects and subject of research. The list of commodity science objects has grown considerably. It includes the following new goods: flowers; feed; packaging materials and tare; vehicles and other goods; and a large industry sector – services. Unifying the interpretation of the fundamental commodity science categories is important today.

Knowledge of commodity science is in demand in different spheres of social life. Particular specificity has commodity science competencies of specialists in customs and antimonopoly activities. The State Fiscal Service carries out the commodity science expertise to cases of customs regulations violation; identification at customs control and clearance of goods; prevent customs risks. The Antimonopoly Committee of Ukraine carries out activities to detect fraud, surrogate product, analysis of assortment etc.



### **Joint projects with foreign HEEs**

Considerable interest of KNUTE experts is in the realization of joint following activities with foreign HEE-partners: educational programs, scientific research, monographs and other scientific publications, preparing the base for the implementation of training programs for the degree of "EuroBachelor", "EuroMaster" in commodity science; getting a double degree diploma; modernization of training of commodity science specialists for certain specialties; teachers exchange aimed at giving lectures etc. Taking part in carrying out research in the field of education which is perspective for KNUTE and the priority for the EU.

### **Conclusion**

Apart from traditional evaluation of goods quality, commodity science specialists came to the goods quality and safety management, identification of forgery, legislative activity in modern conditions and so on. Providing highly qualified specialists is vital for sustainable growth of trade. The leading role in this process belongs to the higher educational system. Cooperation with NGOs, permanent dialogue with employers, government authorities, mass media and other institutions and organizations are the important parts of training highly qualified commodity science specialists in KNUTE.

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## **ASSESSMENT OF THE RISKS POSED BY HEAVY METALS CONTAINED IN CONSUMER PRODUCTS USING THE BIOINDICATIVE MEASURING METHOD**

**Renata SALERNO-KOCHAN<sup>1</sup>**

<sup>1</sup> Cracow University of Economics, Faculty of Commodity Science, Cracow, Sienkiewicza 4, Poland. E-mail: [salernor@uek.krakow.pl](mailto:salernor@uek.krakow.pl)

**JEL A230+I230**

### **Abstract**

The problem dealt with in this research work refers to not unequivocally defined safety requirements that relate to consumer products such as clothes, shoes, toys, upholstered furniture and decorative items. The aim of the study was to find out if any of the so-called heavy metals included in products as components of chemical substances used during finishing processes might pose a real risk to consumers. For the realisation of the research purpose the samples of materials in which high quantities of heavy metals were detected have been subjected to extraction in different kinds of solution extracts and then the extracts were analysed for the presence of such elements as nickel, copper, lead, cadmium and chrome. To verify the toxicity effect of extracts, the bioindicative measuring method based on ciliate sp. test organisms was applied. Changes in test organisms' behaviour were analysed based on microscopic observations and spectrophotometric measurements.

### **Keywords:**

safety of products, heavy metals, consumer products, toxicological assay.

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## **Introduction**

Consumer products comprise a large and diverse group of common or daily use items available on the market that are ordinarily bought by individuals for private consumption. Quite a considerable group of these products, such as clothes, shoes, toys, upholstered furniture, decorative items are made of fibres or leather. Leather and natural fibres are perceived as rather friendly raw materials, while synthetic materials and especially chemical additives that are used in manufacturing processes to improve the product appearance or its utility properties may pose health problems for consumers. Among substances that cause a number of scientific problems are the so-called heavy metals such as arsenic, cadmium, chromium, copper, lead, mercury or nickel. These ele-

ments and their compounds are known for their toxic effect on live organisms. They may have a negative influence on human metabolism and internal organs. They may cause heart disease, disorder to the nervous system or allergies (Senczuk, 2006; Shekhawat, Chatterjee, and Joshi, 2015). Due to their known negative impact on human beings the use of heavy metals is banned or limited by legal regulations. The most restrictive requirements are defined in the REACH regulation (Regulation (EC) No 1907/2006). In accordance with this document, such elements as arsenic, cadmium, mercury and lead should not be used as substances, constituents of preparations or colorants in textile and leather materials. Another approach to the presence of heavy metals in textiles and leather is presented in:

- standard EN 71-3+A1: 2014-12 that relates to toys
- and ecological requirements defined in:
  - criteria for the OEKO-TEX<sup>®</sup> Standard 100 that is a comprehensive, third-party testing and certification system for textile products at all stages of production ([https://www.oeko-tex.com/de/business/business\\_home/business\\_home.xhtml](https://www.oeko-tex.com/de/business/business_home/business_home.xhtml)),
  - EU Ecolabel criteria introduced with Commission Decision of 5 June 2014 establishing the ecological criteria for the award of the EU Ecolabel for textile products (OJ L174/45 13.06.2014).

They allow for the presence of heavy metals in these materials and specify limits values for element migration from a product into the acid sweat solution. In accordance with ecological criteria, depending on the kind of heavy metal and product purpose, the migration limits vary from 50 mg/kg for Cu in decoration materials, through 1 – 2 mg/kg for Cr; 0.2 – 1 mg/kg for Pb; 0.1 mg/kg for Cd to 0.02 mg/kg for Hg.

The presented above different approach to the requirements of heavy metal content in consumer products raises the question related to the real risk that these elements may pose to human beings, so the aim of this research was to find out if the heavy metals included in products as components of chemical substances used during finishing processes, might pose a real risk to consumers.

## **Material and methods**

### *Samples*

Experiments were carried out on 3 textile materials of the following intended use and raw material composition:

- SAMPLE A: clothing knitted fabric made of polyamide (PA), navy blue colour;

- SAMPLE B: furniture woven fabric made of polyester fibres and coated by polyvinyl chloride (PET & PVC), red colour;
- SAMPLE C: furniture woven fabric made of polyamide fibres and coated by polyvinyl chloride (64%) and polyurethane (34%) (PA & PVC+PU), and on 1 footwear leather material;
- SAMPLE D: cow split leather, natural colour.

The samples designed for mineralization were disintegrated by grinding and kept at a temperature of 60°C for 1 hour. Afterwards a 1g sample was placed in a Teflon vessel and 6ml of 70% nitric (V) acid was added. Then the samples were mineralized in a WX-6000 microwave oven. After mineralization and cooling dihydrogen peroxide was added, and then after the nitric oxides volatilised, water solutions of samples were prepared and subjected to FAAS analysis (EN 14084:2004).

For the realisation of the research purpose the samples in which high amount of heavy metals were detected have been subjected to extraction at three different extract solutions: water, HCl solution at concentration of 0.07 mol/L and 0.9% NaCl solution (physiological saline). The use of water as an extract was to simulate the contact of wet materials with the human skin. When using clothes or other textile products it does happen that textile is wetted more or less occasionally. Thus, it is necessary to investigate if such an event could lead to migration of harmful metals from wetted textile to the human body through contact with the skin. The use of hydrochloric acid was to determine a possibility of migration of trace elements in gastric acid that may be important in the context of children's products (e.g. toys) that may be swallowed. In turn the use of sodium hydroxide extract was to simulate conditions where a material is exposed to human sweat that is composed mainly of this compound (Salerno-Kochan, 2016).

The samples designed for extraction were prepared according to the procedure specified in EN 71-3+A1:2014-12. This consisted in placing 1 g of a sample in 50 ml of extracting solution and incubation at  $37 \pm 2^\circ\text{C}$  for 2 hours. The next step was to separate solids from the solution by using a membrane filter.

#### *Analytical method*

The mineralized samples and extracts were analysed by using *Flame Atomic Absorption Spectroscopy* (FAAS) for the presence of such elements as nickel, copper, lead, cadmium and chrome. Only extracts from samples where metals were found in its mineralizates were subject to FAAS analysis for the presence of these elements on the Thermo Scientific iCE 3000 spectrophotometer.

### *Bioindicative method*

To verify the toxicity effect of extracts the strain *Tetrahymena pyriformis* (Ehrenberg) Wolff 1947 of reference number CCAP 1630/1W, coming from the Culture Collection of Algae and Protozoa, Ambleside UK, was used. These organisms were selected due to the fact that *Tetrahymena pyriformis* meets most requirements for test organisms and is one of the bioindicators commonly used in laboratory tests. *Tetrahymena* belonging to protozoans is a unicellular organism with cell membrane of quite different structure than those of bacteria, yeasts or algae that form a barrier to toxic compounds. In the case of *ciliate sp.*, the interior of the cell is separated from its environment with a thin cell membrane only, thus causing ciliates to be very sensitive even to the trace presence of toxic compounds in their environment. In addition, in terms of vital functions, cellular structures and also gene functionality, *Tetrahymena* cells are closer to human cells than other model microorganisms (Gutierrez J.C. et. al., 2003).

Changes in test organisms' behaviour were analysed based on (Salerno-Kochan, 2011):

- direct readings of solution absorbance (optical density) measured at 330 nm after 4, 6, 8 and 24 hours;
- microscope observations of *Tetrahymena pyriformis* behavior in extracts;
- organoleptic assessment of color changes for cell vitality indicator.

The measurements were also performed for *Tetrahymena pyriformis* culture solutions in spring water and HCl and NaCl solutions. These measurements were treated as so-called control groups.

## **Results and discussion**

### *Results of analytical measurements*

The results of heavy metals contents in mineralized samples are presented in Table 1 and the amount of these elements in the extract solutions are presented in Figure 1.

*Table 1*

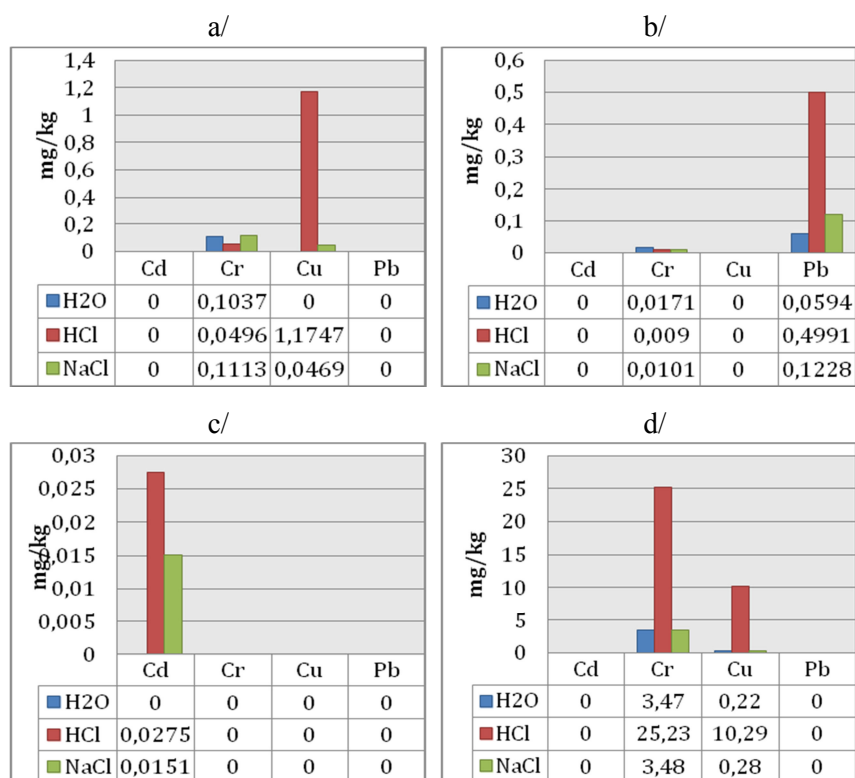
### **Heavy metals contents in the mineralized samples**

Element	Heavy metals contents (mg/kg)			
	<i>SAMPLE A</i>	<i>SAMPLE B</i>	<i>SAMPLE C</i>	<i>SAMPLE D</i>
<b>Cd</b>	0.51	0	10 537.26	0
<b>Cr</b>	285.67	1 042.19	0	18 437.81
<b>Cu</b>	335.06	6.00	2.78	1 088.18
<b>Pb</b>	0	6 466.91	0	0

*Source: own research.*

The data presented in Table 1 demonstrate the presence of heavy metals in all mineralized samples and indicate that these materials do not meet the requirements of the REACH regulation. It should be underlined that the content of banned elements in these materials was extremely high, especially in such materials as SAMPLE D, in which almost 18 500 mg/kg of chromium was detected, SAMPLE C which contains more than 10 000 mg/kg of cadmium and SAMPLE B, in which there were found lead and chromium in high concentrations.

Considering in turn the results presented in Figure 1, related to the amounts of these elements in the extracts of analysed materials, there was observed significantly low content of heavy metals in extract solutions.



Source: own research.

**Fig. 1. Heavy metal content in samples' extracts: a/ extracts of SAMPLE A; b/ extracts of SAMPLE B; c/ extracts of SAMPLE C; d/ extracts of SAMPLE D**

The amount of detected elements in the extracts didn't exceed 0.1% value of harmful elements found in mineralized samples. The highest migration capability has copper, contained in SAMPLE A. Compared to the content of this element in the mineralized sample, its presence in hydrochloric acid solution extract was at the level of 0.5% of copper content in the mineralized sample. Also chromium shows high migration capability and it easily extracts into aqueous environment and sodium chloride solution. In turn, in SAMPLE C, despite a significant cadmium content subjected to mineralization (10 537 mg/kg) the content of this element in extracts was 0.0275 mg/kg and 0.0151 in HCl and NaCl extracts, i.e. 0.00026% and 0.00014%, respectively, with reference to the cadmium concentration in the mineralized sample.

It has also been stated that among the three extract solutions used in the experiment, the hydrochloric acid solution shows the highest extraction capability, while the lowest amounts of harmful elements were extracted into water.

When analysing the research results related to extracts in the context of environmental requirements for textile and leather materials one should conclude that the amount of heavy metals detected in three of the analysed samples reached values substantially below the specified requirements limits. Only SAMPLE D does not comply with ecological requirements due to the high amount of total chromium content in all extract solutions used in the experiment.

### Results from the bioindicative method

The fundamental experiment aimed at estimating the toxicity effect of sample extracts on test organisms was preceded by the examination of HCl and NaCl solutions impact on *Tetrahymena pyriformis*. It showed the negative effect of these solutions on test organisms, so the main observations with the use of bioindicative method were performed only in water extracts. The results of spectrophotometric measurements are presented in Table 2.

Table 2

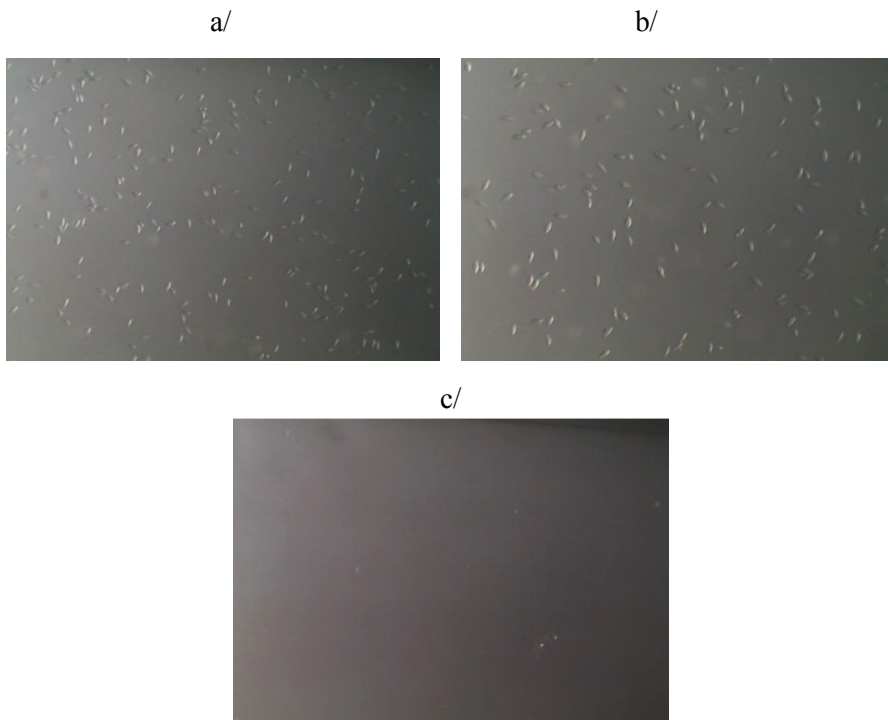
#### The proliferation rate of test organisms in extracts obtained from spectrophotometric measurements

Water extracts of the samples	Proliferation rate of <i>Tetrahymena pyriformis</i> , % of control			
	Obtained from the measurement of optical density		Obtained from the measurement of colour change	
	after 6h of incubation	after 24h of incubation	after 6h of incubation	after 24h of incubation
A	100	100	100	100
B	100	100	100	100

<b>C</b>	0	0	0	0
<b>D</b>	0	0	0	0

*Source: own research.*

The bioindicative method showed the negative impact of SAMPLES C and D water extracts on test organisms. The proliferation rate of *Tetrahymena pyriformis* culture growth in these two extracts, computed for spectrophotometric measurements, reached 0% of the control group (test organisms incubated in spring water), while in the extracts of SAMPLE A and B there was not observed any inhibition in test organism growth, what is more, the proliferation rate and behaviour of *Tetrahymena sp.* in these extracts was comparable to those in spring water (Figure 2a & 2b).



*Source: own research.*

**Fig. 2. The microscopic observations of the test organism proliferation after 24h incubation in water extracts of the samples in comparison to *Tetrahymena pyriformis* proliferation in spring water: a/ test organisms in spring water, b/ test organisms in extract of SAMPLE A, c/ test organisms in extract of SAMPLE C (as well as D)**



The negative effect of the extract of SAMPLE C on test organisms confirmed the harmfulness of this material, evaluated on the base of analytical measurements performed on the mineralized sample. As mentioned before, the FAAS method showed the high content of cadmium in this sample. On the other hand, it is worth underlining that in SAMPLE C there were not detected any amounts of heavy metals, even cadmium, as a result of their migration into the water. So, the question arises, why was there such strong impact of this extract on test organisms (the lack of living cells in the extract), visible in Figure 2c? To answer this question other analytical methods suitable for analysing other hazardous substances that were beyond this research subject (e.g. azo dyes, amines) should be applied.

The lack of *Tetrahymena pyriformis* culture in the extract of SAMPLE D (Figure 2c) may testify to its high toxicity to living organisms resulting from the chromium content (probably the presence of Cr(VI)) in leather as well as the high susceptibility of this element to the migration into aqueous environment from material that was proved by analytical measurements.

### **Conclusions**

The research has shown that the so-called heavy metals, e.g. copper, lead, chromium or cadmium might not pose high risk to consumers. Despite the substantial amount of heavy metals in mineralised samples, their content in extracts may be significantly low and their toxicity effect on test organisms may be unnoticeable.

The study has revealed the usefulness of the bioindicative measuring method for safety assessment of nonfood products. This method may indicate the presence of harmful elements within materials that are susceptible to migration into aqueous environment and may inform us if the product poses or not a real risk to living organisms.

The safety assessment of textile and leather materials as components of nonfood products, depends on the method of their analysis and requirements taken under consideration. It was stated that materials which do not meet legal requirements may comply with ecological or standard requirements, and may have no toxic effect on living organisms.

### **Acknowledgments**

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## **IMPLEMENTATION OF MANAGEMENT SYSTEMS AS A COMPETITIVE ADVANTAGE**

**Marta KARKALÍKOVÁ<sup>1</sup>, Dominika NOSEKOVÁ<sup>2</sup>**

<sup>1</sup> Department of Commodity Science and Product Quality, Faculty of Commerce of the University of Economics in Bratislava, Dolnozemska cesta 1, 852 35 Bratislava, Slovakia, +42126729139. E-mail: marta.karkalikova@euba.sk

<sup>2</sup> Department of Commodity Science and Product Quality, Faculty of Commerce of the University of Economics in Bratislava, Dolnozemska cesta 1, 852 35 Bratislava, Slovakia +420 773 114 185. E-mail: dominika.nosekova@gmail.com

**JEL Q180**

**Abstract**

### **Keywords:**

ISO 22000, food safety management systems, competitive advantage, motives, benefits and barriers.

Production of quality and safe food has become not only a priority requirement for the participants of the food chain but it has also become consumer right. System approaches of organizations to quality management and food safety in the company necessarily require an understanding of the interrelationship of the processes within the system and its continuous improvement through measurement and evaluation. They have strong positive effects on economic growth and competitiveness of the food businesses. Implementation of food safety management systems in practice and their certification according to ISO international standards becomes a precondition for achieving, sustaining, and enhancing the companies' competitiveness.

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## **Introduction**

Customer care, healthy and safe food as well as environmental performance are some of the requirements that modern business requires from food producers. Food safety management systems are available for all subjects in the food chain, from farm, through processing plants up to the operators of catering facilities. Organizations that are using the systems are considered to be highly reliable and responsible, with a strong commitment to protect the health of the society. Food safety management systems according to *ISO 22000 Food safety management systems. Requirements for any organization in the food chain* present a comprehensive set of tools, methods and procedures that enable the monitoring of foodstuffs and early identification of potential risks throughout the process of their production, processing and distribution to the final consumer. They also present an instrument providing assurance that the organiza-

tion has incorporated the system into the corporate culture, has harmonized it with its policy and takes account of it in the strategic planning. Their implementation leads to a risk reduction that could endanger the health of potential customers. The systems also provide the compliance with the requirements of the audit institutions and government regulations and ensure the security of products during their delivery to the final consumer. The paper analyzes the implementation and certification of food safety systems with regard to the basic companies' information and identification of the main incentives, benefits and barriers arising from the implementation of these management systems.

The globalization of food production and trade, the development of the food industry, the increasing concentration of producers and traders in the market significantly contributes to an increased incidence of risks to food safety (Fernández- Segovia et al. 2014). While requirements increase for food businesses to act in accordance with "due diligence" (corporate social responsibility) arising from legislation in the food safety sphere. Companies are forced to strengthen their commitment to food safety, to be more attentive to social responsibility as a tool of differentiation and improvement of their market position. In this context, the organizations urgently need to eliminate the risks that could result in damage of the sold food products or corporate image and endanger of market position (Escanciano , C. Santos- Vijande , M. L. 2014).

### **Methodology and data**

For the purpose of our survey we used the book publications, scientific and technical journal articles, studies and statistics published electronically. The data were obtained by method of questioning, through questionnaires that were sent to enterprises in printed or online form. The research sample consisted of 100 companies that were divided into two homogeneous groups: group A- 50 companies with established food safety management system according to ISO 22000 and group B - 50 companies using different systems to ensure food safety. We applied similar division in case of the composition of companies' country of origin, where the first half consisted of Slovak companies and the other half of the companies from V4 countries, Sweden, Greece, France, England etc. Other important criteria included the size of holdings composed of 28 micro, 41 small, 19 medium and 12 large enterprises. Categorization of companies by subject of their activities identified 13 groups of activities within the food chain, from farming through processing, to distribution to the final consumer. The obtained data were processed by using the methods of analysis and synthesis.

The data were evaluated by using the method of comparison in which we investigated the similarities or differences in obtained evaluations and results of the partic-

ipants within defined groups A and B. The comparison should serve to confirm or refute the existence of a competitive advantage arising from the implementation and certification of food safety management systems according to *ISO 22000 Food safety management systems. Requirements for any organization in the food chain*.

Through mathematical and statistical methods we summarized analyzed data and transformed them into a chart by upward shifting of individual respondents' answers.

### **1. Impementation of food safety management systems and their importance**

Achievement of the food safety requirements requires complementary effort of all subjects involved in food production. It applies to all companies in the food chain from farmers to catering companies and all companies directly or indirectly associated with this chain, food manufacturers, carriers, equipment manufacturers, packaging materials, additives and the like. Any suspicion concerning food safety is a test of stability in the food chain, including business organizations, with particular responsibility are manufacturers and distributors. In case of failure they retain full economic, criminal, moral and ethical responsibility. For this reason, businesses need a sophisticated and internally coherent system of food safety, which can be achieved through meeting the requirements of the standard ISO 22000 food safety systems that are functional tools protecting the trademark, business name and consumer health (Bilska, A. Kowalski R. 2014).

The requirements of *ISO 22000 Food safety management systems. Requirements for any organization in the food chain* are applicable throughout the whole food chain, with regards to all stakeholders involved into this chain, who are interested in building an effective functioning of the system. The standard specifies requirements for company system management that is focused on food safety. It contains objective criteria for assessing natural or legal person established in some part of the food chain and if it effectively controls risks of food safety, i.e. if the product care and the conditions of its implementation is sufficient to produce food that is safe and meeting the requirements of food law, established processes, which may lead to maintain and grow customer confidence in the safety of food offered and delivered.

One of the benefits of food safety systems implementation is also increased legal protection of the entire organization, as well as the brand itself, which is one of the main objects of interest of senior management or company owners. It helps to ensure successful presentation of the company or product line on the market. It also contributes to more effective creation and maintenance of marketing the company's position in the segment, easier penetration on new markets and facilitates the introduction and enforcing of new products in these markets (Karkalíková , M. 2014).

On the other hand, some companies refuse to implement and certify their food safety systems beyond the obligatory requirements set by the legislation. The reason of this attitude can be caused by barriers of their application and use, for example increased costs of implementation and certification system; missing control instruments; verification whether after the introduction of the system its principles are fulfilled; lack of necessary equipment, materials for education, training, personnel training in the field of food safety; lack of knowledge and low awareness of employees and management leading to low interest in food safety; variety of food and culinary procedures used; human resources issues- the level of education and high staff turnover; time-consuming that affects the company decision to introduce the system in a negative way (the system will not be applied in the company), respectively if the system is established, managers do not pay sufficient attention to its maintenance (Sharma, A. et al. 2011).

Constantly increasing consumers' requirements, stricter legal requirements and the globalization of food production evoked the need to develop a uniform quality assurance and food safety (Newslow, D. 2013).

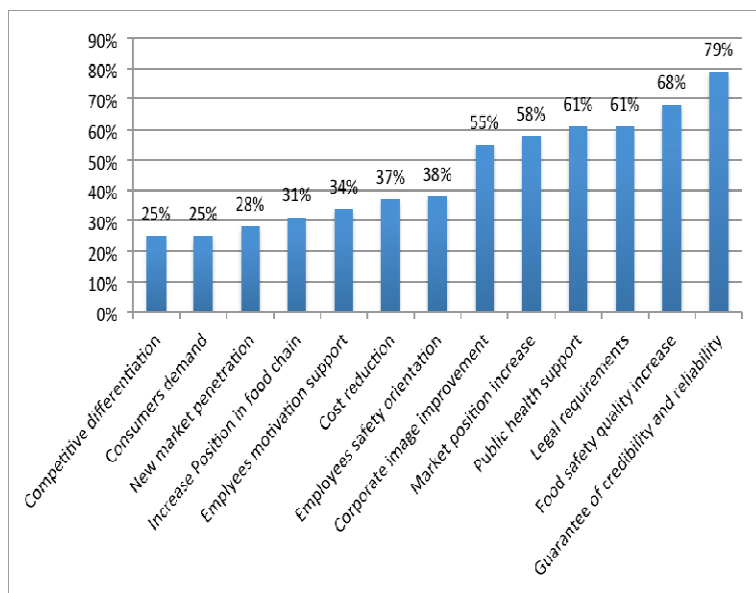
## **2. Food safety management systems implementation in practice**

Not only globalization of the world market, accompanied by increasing requirements for quality and safety of food products, but especially the benefits arising from the use of food safety management systems lead to the fact that many businesses are adjusting their production according to specified requirements and apply for certification according to *ISO 22000 Food Safety Management systems. Requirements for any organization in the food chain*.

Implementation of food safety management systems according to ISO 22000 appeared characteristic especially for larger organizations that have demonstrated 100% of the application systems. Micro and small enterprises have shown in this case, low values - 5 and 14 companies benefiting from the management of the total 40 respondents. Regarding the implementation of food safety management systems according to ISO 22000 in territorial terms, clearly higher frequency was found in foreign companies, with 70% share of the total and the strongest representation of Sweden, Greece and France. When identifying competitive advantage based on the scope of activities of organizations held a leading position in the area of catering, distribution, transportation and storage. After analyzing the introduction of food safety management systems according to ISO 22000 with respect to general corporate information, we will focus on identifying the motives of their applications in 100 selected food businesses.

From the results considered in Fig. 1 we can see that from a total of 100 enterprises for up to 79% of respondents the most important aspect is guarantee of prod-

ucts credibility and reliability for their customers. 68% of voters set as the main motive for systems application the quality and safety enhancement of food produced. 61% of research participants introduced the systems into their corporate culture in order to meet obligatory legal requirements.

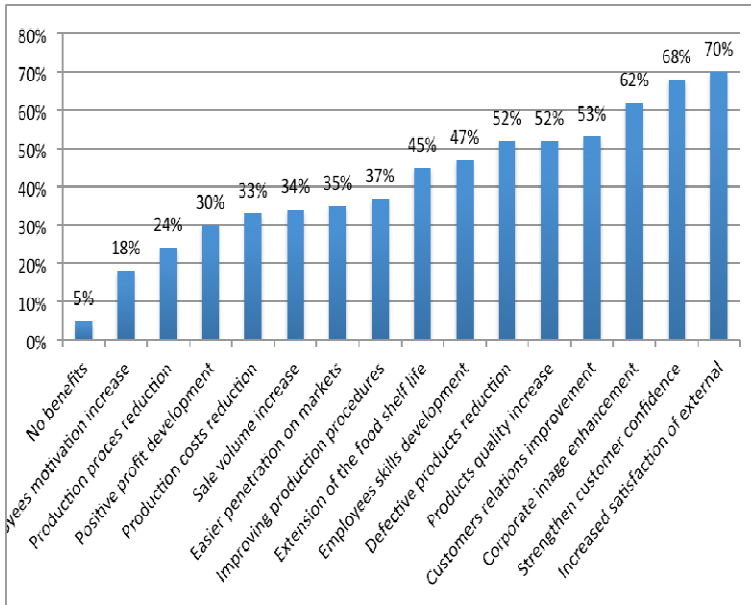


*Source: Author's own studies.*

**Fig. 1. Motives for introducing food safety management systems in enterprises**

61% of survey participants have chosen promotion of public health as the main motivator. Other important stimuli to the implementation of food safety management systems included the market position strengthening (58%), strengthening of corporate image (55%), strengthening the orientation of workers on food safety (38%), cost reduction (37%). A surprising finding was the low proportion of companies (25%), identifying the implementation of food safety management systems as tools for competitive differentiation.

Benefits of food safety management systems application have been assessed on a sample of 100 food businesses. Fig. 2 presents the 15 most commonly defined benefits of these systems. For 71% respondents the most significant advantage of management systems in food safety was increased satisfaction of external subjects - suppliers, customers, regulators and supervisors, and others.



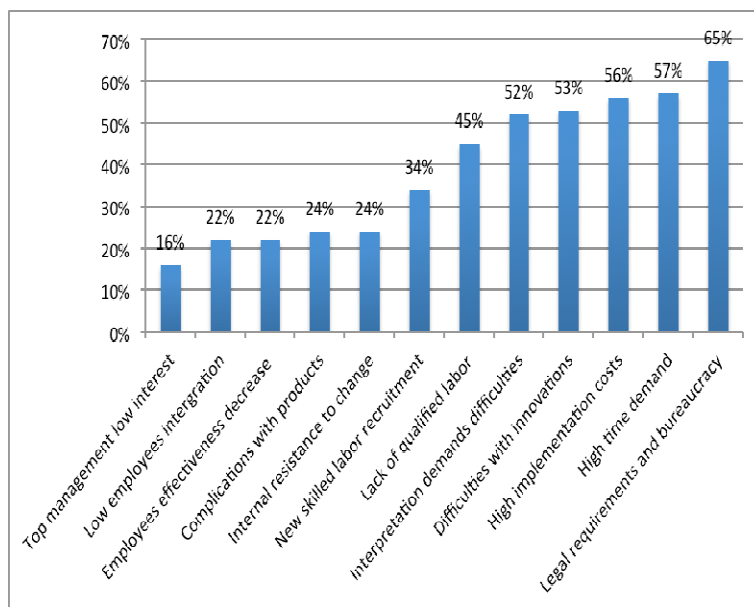
*Source: Author's own studies.*

**Fig. 2. The benefits of the introduction of food safety management systems for enterprises**

With a tight lead of 2% followed by strengthening customer confidence, which leads to the improved image of the company, ranking, recognized as the third most significant benefit - 62% of votes. Further followed group benefits with roughly the same percentage value - customer relations improvement (53%), increased quality of manufactured products (52%) and reduction of defective products (52%). The least significant benefits that food safety management systems bring to the companies were identified as an increased employee motivation (18%), production process reduction (24%) and positive profit development (30%).

The usage of food safety management systems brings many benefits not only for firms, but their implementation into the company is also accompanied by certain difficulties. Fig. 3 shows the 12 barriers that were identified as most serious by survey sample of 100 respondents in total.





*Source: Author's own studies.*

**Fig. 3. Barriers to food safety management systems implementation in enterprises**

As the most serious barrier of systems application the burdensome legal requirements and time-consuming bureaucracy was considered by 65% of participants. In 57% of enterprises, significant complications were caused by high time demand and high implementation costs (56% of companies). Other barriers were difficulties in the implementation of new tools, processes and methods for food safety management systems (53%) and difficulties with the interpretation and understanding of the requirements placed on implementation and certification systems (52%). Last barriers were mainly related to human resources in the company, namely the low integration of employees into the process (22%) and lack of interest and commitment of the company management (16%).

Implementation of food safety management systems according to ISO 22000 appeared characteristic especially for larger organizations that have demonstrated 100% of systems applied. Micro and small enterprises have shown low values - 5 and 14 organizations using these management systems, from 40 respondents in total. Regarding the implementation of food safety management systems according to ISO 22000 in territorial terms, clearly higher frequency was found in foreign companies, with

70% share in total and the strongest representation of Sweden, Greece and France. When identifying competitive advantage based on the scope of activities of organizations held a leading position organizations established and operating in the area of catering, distribution, transportation and storage. The most significant motivator for application and certification of food safety management systems according to ISO 22000, for 79% of respondents, was strengthened credibility and confidence among their consumers. 68% of participants chose as the main motive quality and safety of produced food. 61% of research participants introduced the systems into their corporate culture in order to meet legal requirements. The three most important benefits of food safety management systems included an increased satisfaction of external entities (70% of companies), strengthening customer confidence (68% of respondents) and improving corporate image (62% of organizations). 65% of participants considered the most serious barrier of the systems application burdensome legal requirements and tedious bureaucracy. For 57% of enterprises the reasons of considerable complications were also high demands on time and implementation costs (56% of firms).

### **Conclusions**

Safety and quality have become central notions within the food sector and they determine the success and prosperity of the organizations. In order to build competitive advantage, the food businesses began to apply their own voluntary schemes that add value beyond the basic legislation that secure the production of healthy and safe goods.

The current trend in this area is becoming the introduction and certification of food safety management systems according to ISO 22000, which sets requirements for food products safety for all operators in the food chain. It is an instrument that provides assurance that the organization has integrated the system into the corporate culture, unified with its policy and take account into its strategic plans. Its implementation also leads to a reduction of risk to the customers' health. The use of ISO 2200 is also useful for ensuring compliance with the requirements of the audit institutions and government regulations, and for ensuring safety of food products during their delivery to the final consumer.

The most effective food safety system can be created and managed in the framework of a structured management system that will be linked with other management activities of the company and so an integrated management system will be implemented. ISO 22000 is aligned with *ISO 9001 Quality Management Systems Requirements* and with other management systems in order to increase their mutual compatibility.

Businesses are realizing that application of standards of corporate management in the comprehensive integrated form brings significant benefits. Before implementing an integrated management system it is important to generally determine the organization's effectiveness and efficiency and assess the various management systems that will be integrated. It is also important to specify the extent to which integration should be implemented, to assess the legal requirements and set the necessary competence and long-term objectives in the context of integration.

### **Acknowledgments**

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## **PROPOSAL OF ENVIRONMENTAL ASPECTS ASSESSMENT OF PRODUCTS**

**Zbigniew KLOS<sup>1</sup>, Krzysztof KOPER<sup>2</sup>**

<sup>1</sup> Professor, *Poznan University of Technology, Faculty of Machines and Transportation, Piotrowo 3, 60-965 Poznan, Poland.* [zbigniew.klos@put.poznan.pl](mailto:zbigniew.klos@put.poznan.pl)

<sup>2</sup> Assistant, *Poznan University of Technology, Faculty of Machines and Transportation, Piotrowo 3, 60-965 Poznan, Poland.* [krzysztof.koper@put.poznan.pl](mailto:krzysztof.koper@put.poznan.pl)

**JEL Q56**

**Abstract**

**Keywords:**

ecodesign, eco-decisions,  
LCA, materials, food  
processing machines.

The use of Life Cycle Assessment (LCA) in the design stage of technical objects is presented in this paper. The environmental analysis is done on the wrapping machine, with the special interest given to its gear transmission. Using LCA, environmental profiles and environmental indices for different constructions of gear wheels are elaborated and on this basis, an optimal combination of materials for elements of transmission gear: shaft, gear wheels and body is proposed. The analysis of results brings interesting observations and conclusions, important for both machine designers and producers.

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### **Introduction**

Designers can play a crucial role, by using proper algorithms – design algorithms – based on ecobalancing methods, in minimizing the environmental impact of technical objects. Until recently, an engineer's main task was to find solutions for practical problems including conditions (limitations) of mainly material, technological and economical nature. Ecological aspects need to be included as well in any design algorithm to provide low environmental impact profile of any technical object at earliest stages of its life cycle (Klos et al. 2005). Due to legislative pressure, customer requirements or even manufacturer's environmental policy, ecodesign is currently gaining in popularity in all industrial sectors. Although a lot of product environmental impact assessment and Design for Environment (DfE) tools already exist, already exist, environmental aspects are unfortunately rarely routinely integrated into product development process in the industry (Mathieux F. et al. 2007).

Ecodesigning is a process of designing products and product systems in order to minimize environmental impacts over the total product life cycle (ISO 2002). Most environmental impacts are “locked in” at the design stage, which is when key decisions are made on materials, manufacturing methods and how the product will be used and operated. Addressing environmental impacts at the design stage will produce solutions that are likely to be environmentally positive and cost effective (Design Institute of Australia 2004). The syllable “eco” refers to both economy and ecology (Schischke K. et al. 2005). This introduces additional dimension to traditional design. Still, important part is played by such aspects as: functionality, safety, ergonomics, endurance, quality and costs. The additional criterion is a project estimation taking into account its environment influence (Nowosielski R. et al. 2007).

Although it is not the only parameter to be considered in ecodesign, material selection obviously plays an important role in the developing the environment-friendly products. Material choices have an impact on costs, manufacturing, recyclability, etc. The main factors upon which the designers rely when considering materials choice are: the relationship between materials specifications and technical, economic and environmental performance of the product, the practice of industrial design embedded in the product and its functionality (Field III F.R. et al. 2001).

This paper aims to show the use of the Life Cycle Assessment methodology in the decision process concerning design of elements, subsystems and systems of an exemplary food processing machine. First, chosen elements will be assessed against a possibility to improve the environmental profile of the machine. Then the subsystem and the system will be considered, and a complex assessment will be possible and the most favorable solution chosen. The stated problem is important in the area of pro-environmental development of technical objects (e.g. required by certain EC directives) and in the specific area of food production sector, in area of the industrial processes.

## **1. Object of analysis**

The machine considered in this research is a wrapping machine dispensing pasty products into cubes, including butter, lard, cottage cheese, minced meat, ice cream or baker’s yeast. All the functions related to package shaping, product portioning, wrapping a cube and passing it to bulk package are performed automatically. Applied cam drive allows for reliable work in even very hard conditions and yields high output that can be accordingly reduced. The machine allows for packaging products in parchment or aluminum foil and uses stamp for coding single units with necessary information including date of production or factory code. By default, the machine is

equipped with butter cube sized units, but it can be easily refitted for a range of package dimensions. Basic technical information on the machine is presented in Table 1.

*Table 1*

**Basic characteristics of the exemplary machine**

<b>Output</b>	<b>Up to 90 pcs/min</b>
Butter, lard, cottage cheese and ice cream cube size - 250g cube - 125g cube	100 x 75 x 35 mm 75 x 50 x 35 mm
Margarine cube size - 500g cube	120 x 83 x 54 mm
Overall dimensions	2800 x 2800 x 1900 mm
Bulk weight	2500 kg

In the design process, the designer makes many decisions on which durability, economic and environmental costs of the designed object are decided. Decision making process is dependent on many different factors, like: designer's knowledge and experience, available construction materials, machining methods (accessible technologies), environmental protection regulations etc. Basic decisions are always made, irrespective of problem type and complexity, other are helpful when solving unusual problems and happen very rarely. Some actions in the decision making process are one-time, others are recurrent, until a specified result is achieved. To systematize these activities, algorithmic methods have been found useful. They give the designers a possibility to ergonomically design machines and appliances. A design of a given object needs to be characterized first of all with a capability to meet basic needs to produce it in a possibly optimal way with no redundancy. It is not only connected with economical savings, but also with increased environmental friendliness of an object (Kurczewski P. Lewandowska A., 2008).

A tendency towards low environmental profile of a machine expressed by its future users can be recently observed. The industry tries to include this requirement right from the beginning of the conception process, finding and neutralizing possible areas where the environmental impact could prove to be highest, for example by using:

- appropriate selection of materials needed to manufacture given machine part,
- choice of adequate technological processes, providing lower energy consumption and in effect, minimizing the formation of toxic chemicals etc.

That is why not only the whole concept of the designed object is important, but also the concept of individual parts, mechanisms and nodes. Those, after passing through applicable environmental procedures contribute to the machine as a whole, becoming more environmentally friendly.

In the presented example, various decisions need to be made, concerning different elements of the transmission, some of those are listed below:

1) Transmission type: choice between belt drive, chain transmission and gear transmission. Environmental consequences are connected with vibration levels, noise emission, danger of lubricant spill, energy consumption. Gearing transmission was chosen, in spite of worst environmental performance (large dimensions, need to lubricate, precise machining of elements). This is due to some advantages that other types of drives do not possess, like high precision, high efficiency (~99%) and known high reliability and durability. In general, the choice of transmission was decided mostly by operating conditions of the designed machine.

2) Gearwheel type: choice between homogenous and modular wheel. Environmental consequences are connected with energy consumption during the machining processes and noise levels during wheel operation. Homogenous wheel was chosen because of its better mechanical characteristics and endurance. However, some aspects need to be taken into account, like more complicated disposal (presence of minerals and basic elements in cast alloys). On the other hand, the machining process for modular wheels takes more time to complete, consumes few times more energy and leaves various pollutants (like heavy metals) that due to their toxicity need to be neutralized quickly. One of the reasons to support the decision for using cast steel wheels is their smaller cost when produced in larger numbers.

3) Gearwheel material: choice between steel, cast steel and polyamide. Although polyamide does not corrode, it is not resistant to high temperatures (melts at 180-250 °C). As many plastics, it originates from petroleum, and petrochemical processes tend to produce very high environmental impacts. When it comes to damping vibrations that occur in operating transmission, cast steel and polyamide are known to work like that and steel only serves as propagator of vibrations. All the materials can be easily recycled. The decision which material to choose is therefore dependent on technological aspects of designed machine operation processes. Assuming moderate workload and corrosive environment, polyamide would be a good choice, but it is a material that generates higher environmental loads during transformation processes than steel or cast steel.

4) Body type: choice between homogenous or compound. The decision is based on responsibility of designed transmission: if it is crucial to the machine operation,

cast steel homogenous body should be used. In other cases, compound body made of easily accessible and cheaper materials is an optimal solution. It also creates lower environmental loads.

5) Body material: choice between cast steel and aluminum alloy. In this case, various factors need to be taken into account by the designer to provide high durability of the construction, low price and environmental impact. These factors, among others, are: mechanical characteristics of the material, its cost, availability, ease of treatment and influence on human and environment health. Cast steel, possessing higher endurance than aluminum allows to create smaller and more durable constructions. On the other hand, it is more susceptible to corrosion and needs to be protected from it. When taking into account operating conditions, if they are stable and moderate, aluminum can be used. This results in lower mass of the construction and easier disposal (aluminum scrap is more desirable), although aluminum processing creates higher environmental impacts than in the case of cast steel.

## **2. Methodology**

There are many methods that support the pro-environmental design or designing of an object or a process. A few can be named, for example: EIA (environmental impact assessment), SFA (substance flow assessment) or TA (technology assessment). Among those the Life Cycle Assessment (LCA) can be best, focused on a single object, following it through its whole life cycle, from the resources gathering up to disposal, so called cradle-to-grave approach. LCA's inherent feature to calculate and compare environmental indicators that can be put into measurable values is especially convenient in relation to the stated characterization of an object through the materials its elements consist of.

According to the ISO 14040 and 14044 standards, a Life Cycle Assessment is carried out in four distinct phases that are often interdependent in that the results of one phase will inform how other phases are completed (ISO, 2006): goal and scope definition, inventory analysis, impact assessment and interpretation.

## **3. Results**

The structure of the following chapter reflects subsequent phases of Life Cycle Assessment procedure as stated above, in relation to the exemplary object.

### ***3.1. Goal and scope definition***

In the presented application of LCA, only the gear transmission with simple gear wheels was analyzed. The reason for choosing this subsystem is its universality and



widespread use in food processing machines. As it was presented above, first and basic problem a designer comes across is the gearwheel itself. The decision problem at his stage is the choice of its type and material it is made of. Chosen solution causes consequences on the next links of the kinematic chain in the considered transmission. It is not only changes in dimension and mass of elements, but also specific, measurable environmental impacts.

### ***3.2. Inventory analysis***

In this phase of analysis, which is very important from the methodological point of view, gathering of available data concerning transmission is performed. Elements on which the data are gathered include: a pair of gearwheels, two shafts on which the wheels are set and the body in which the shafts are installed. Modifications including 12 different materials used for these elements will be taken into account in the LCA. This way, a large number of possible combinations will be available to choose from in the design process.

In the presented calculation case, each of possible transmission solutions works in the same conditions and bears the same workload. It is assumed that because of the distances between gearwheels, the distances between shafts have to be the same. This limitation causes the diameters of cooperating wheels to be the same, with only possible alterations in the width of the wheels.

To allow a comparison of environmental impacts generated by different versions of the transmission, its elements were created from different construction materials from the same group of stainless and acid-proof steel and cast steel: 1H18N9T, 3H13, 3H17M, 2H13, 2H17N2, 1H13, 0H18N9, H17, 00H17N14M2, 0H13J and GX12Cr14, GX5CrNi19.

The choice of material solutions affects the changes in design of the whole model of transmission. Strength characteristics of selected materials result in different width of gearwheels to carry the same workload. The change in width results in increase of dimensions and mass of elements. All these alterations cause different environmental impacts.

As all the selected materials are from the same group, the durability calculations were not taken into account (chemical composition of chosen materials did not vary too much).

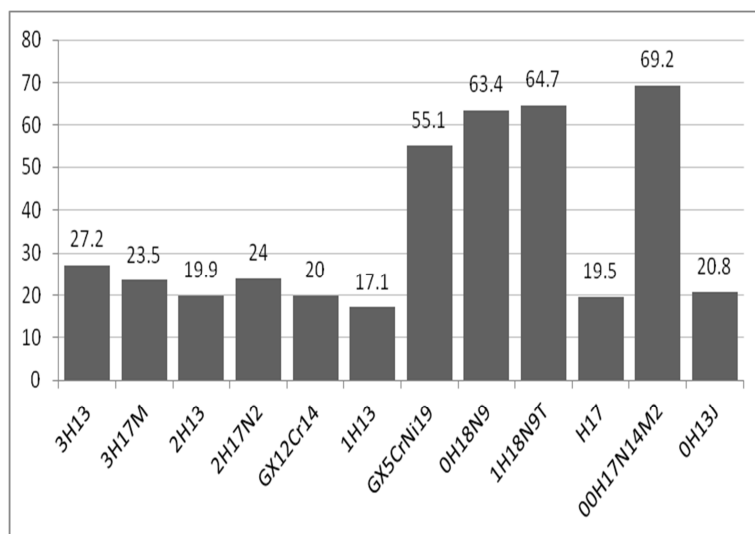
To eliminate a very great number of possible material combinations, sample analyses (in reference to 1 kg of each material) were conducted at the beginning. After verification of environmental impacts of chosen materials, those that are characterized with extreme (high and low) and mean environmental impacts have

been chosen for further analysis, as well as those typically used for construction of food processing machines. Achieved results are presented in relation to the environmental point unit (Pt) and its  $10^{-3}$  aliquot (mPt).

### 3.3. Impact assessment

Achieved LCA results allow for multi-aspect comparison of gearwheels in respect of generated environmental impacts and in turn, formulating the following conclusions:

1) Values of environmental indicators for each of proposed material solutions indicate that the use of 1H13 steel results in the lowest environmental impact (17.1 mPt), the second lowest is coming from the 2H13 steel (19.9 mPt) and GX12Cr14 cast steel (20.0 mPt). The complete results are presented in the graph below (Fig.1).



**Fig. 1. Comparison of environmental indicators (mPt) for selected steel and cast steel gearwheels**

2) Detailed analysis of the assessed gearwheels environmental profiles identifies as dominant the result of their use – ecosystem destruction (soil acidification) induced through emissions of sulfur compounds, nitric oxides and ammonia in their life cycles. Materials with highest environmental impacts include 00H17N14M2, 1H18N9T, 0H18N9 and GX5CrNi19, the remaining having five times lower impact levels. Another crucial consequence is the human health hazard, induced mostly by dusts and

the emission of sulfur dioxide (impact levels similar as in the case of soil acidification). Also important to note is the aspect connected with creation of heavy metals in the life cycle of chosen materials, which is similar in all cases. Impact levels in remaining categories (greenhouse effect, eutrophication, carcinogens and summer smog) are low when compared to the categories discussed.

Achieved LCA results for the most and least favorable solution of cooperation between shaft, body and gearwheels give the following conclusions:

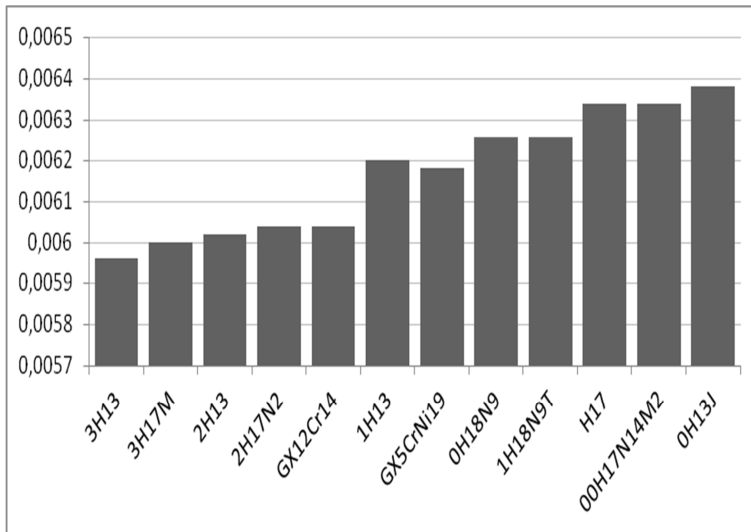
1) Total environmental impact of transmission using 3H13 steel shaft and body (most favorable solution from the environmental point of view) is 0.06236 Pt. Small differentiation between impact values can be observed in case of the shaft and the body while using different gearwheels – it is 0.00596 Pt and 0.0564 Pt respectively (see Fig.2 and Fig.3).

2) Total environmental impact of transmission using 00H17N14M2 shaft and 1H18N9T body (the least favorable solution in means of environmental impact) is 0.4748 Pt. Also in this case small differences can be observed when compared against different proposed gearwheels – 0.0188 Pt and 0.456 Pt respectively (see Fig. 4 and Fig. 5)

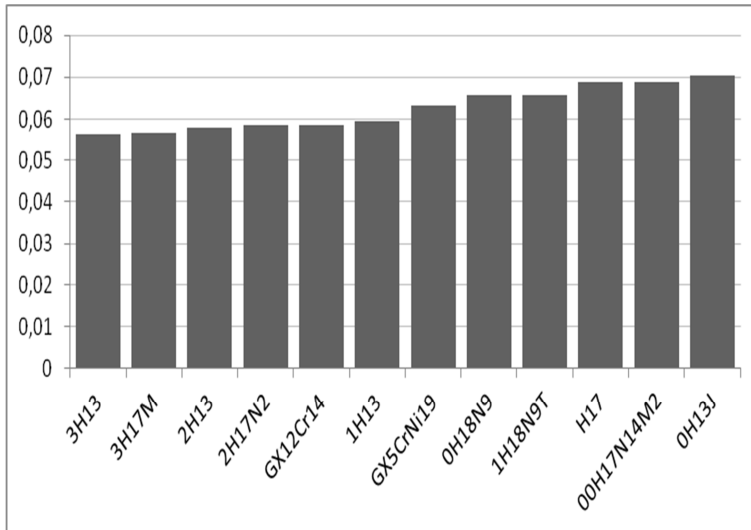
3) Among the environmental impacts generated by a transmission composed of 3H13 shaft and body (most favorable solution in means of environmental impact), heavy metals creation is the category that burdens the natural environment the most. About half of that is generated in connection with soil acidification. Other categories have marginal impact.

4) Most of the environmental burdens when using 00H17N14M2 shaft (least favorable solution in means of environmental impact) are connected with soil acidification due to the emission of sulfur compounds, nitric oxides and ammonia in the life cycle. It can also be observed that when using 0H13J, 3H17M and (what is somewhat surprising) 3H13 steel leads to 20-30% higher level of environmental impacts than in the remaining impact categories. Essential categories of impact in terms of volume include also the creation of heavy metals and winter smog; all the other categories are insubstantial.

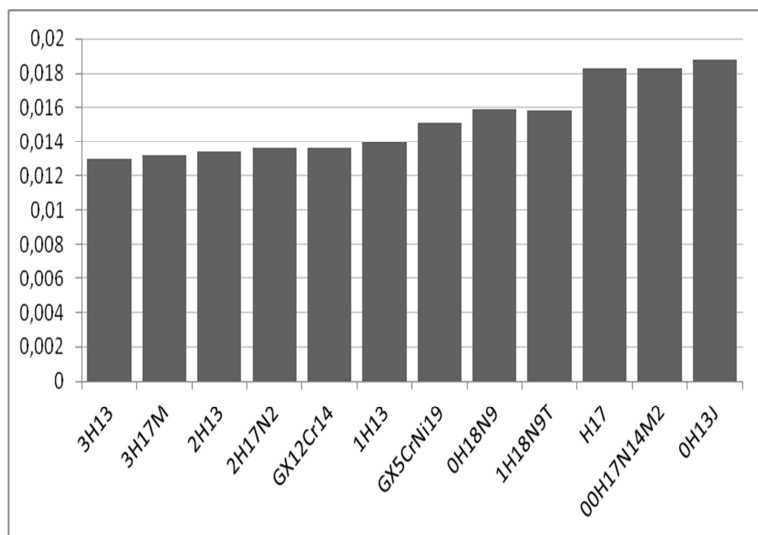
5) In case of using 1H18N9T body in the transmission (least favorable solution) impact levels are high in soil acidification and winter smog categories, with other categories having only slight importance.



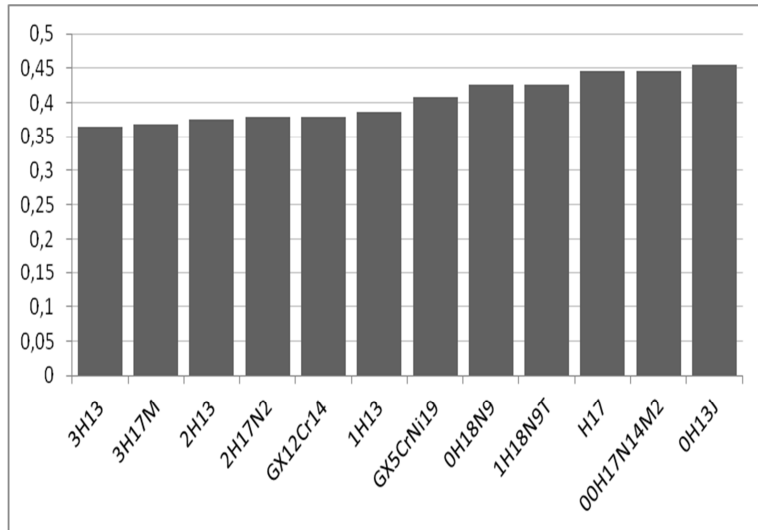
**Fig. 2. Comparison of environmental indicators (Pt) generated by 3H13 shafts in transmissions using different gearwheels (most favorable solution)**



**Fig. 3. Comparison of environmental indicators (Pt) generated by 3H13 bodies in transmissions using different gearwheels (most favorable solution)**



**Fig. 4. Comparison of environmental indicators (Pt) generated by 00H17N14M2 shafts using different gearwheels (least favorable solution)**



**Fig. 5. Comparison of environmental indicators generated (Pt) by 1H18N9T bodies using different gearwheels (least favorable solution)**

### 3.4. Interpretation of results

After the ecobalance analysis of transmission elements and versions, environmental impacts for proposed combinations can be presented. This includes the most and the least favorable in terms of environmental impacts as well as a typical one used in the food processing machines. Criteria for choosing three specifications were based on results of previous LCA analyses of chosen variants, and those three are:

- 1) 1<sup>st</sup> transmission – 00H17N14M2 gearwheels and shafts, 1H18N9T body (the least favorable solution in means of environmental impact)
- 2) 2<sup>nd</sup> transmission – 2H17N2 gearwheels and shafts, 1H18N9T body (typical)
- 3) 3<sup>rd</sup> transmission – 1H13 gearwheels, 3H13 shafts and body (the most favorable solution in means of environmental impact)

The aggregated LCA results for the chosen variants are presented in Table 2.

Table 2

#### Comparison of chosen transmissions models environmental profiles (unit: points)

No	Impact category	Most favorable solution 1H13/3H13/3H13	Typical solution 2H17N2/2H17N2/ 1H18N9T	Least favorable solution 00H17N14M2/ 00H17N14M2/ 1H18N9T
1	Climate change	0.00761	0.0156	0.0203
2	Ozone layer depletion	5.553E-05	7.11E-05	5.91E-05
3	Soil acidification	0.0241	0.23	0.334
4	Eutrophication	0.00267	0.00392	0.00491
5	Heavy metals	0.0412	0.0416	0.0423
6	Carcinogens	0.00887	0.00773	0.00956
7	Winter smog	0.0108	0.134	0.197
8	Summer smog	0.00118	0.00143	0.00181
Eco-Indicator		0.0966	0.434	0.610

Achieved results allow for multi-aspect comparison of three transmission variants being under consideration and in turn, formulation of conclusions:

- 1) Environmental indicator values for each proposed material solution of a transmission show that using 1H13 steel for gearwheels and 3H13 steel for shafts and body results in the lowest environmental burden (96.6 mPt). Nearly four times worse (434 mPt) is the result for a typical solution used by designers in food processing machines: 2H17N2 steel gearwheels and shafts with 1H18N9T steel body. The least

favorable solution, earning 610 mPt is the use of 00H17N14M2 steel for gearwheels and shafts with 1H18N9T steel for the body.

2) Detailed analysis of proposed solutions environmental profiles identifies the destruction of the ecosystem due to emissions of sulfur compounds, nitric oxides and ammonia as the dominant negative aspect of their application in the manufacturing as well as other life cycle phases.

### ***3.5. Final conclusions***

Most important conclusions are:

1. Undertaken analysis shows that implementation of environmental aspects in the design process – ecodesign – can substantially reduce the environmental impacts of any technical object. This was presented on the case of a transmission system installed in a food processing machine, but it is also valid for any other element, subsystem or a system of the object.

2. In the analyzed case, the manufacturing of transmission bodies has the greatest share in negative environmental implications of the life cycle of a transmission system. It also shows that the levels of environmental impact may vary greatly according to the type of material used, reaching up to 300% in the exemplary case (e.g. comparing 1H13 to 1H18N9T steel).

3. Among the most important factors influencing the environmental impact of materials, two can be distinguished: the selection of materials and intake of energy for the manufacturing processes of machine elements.

4. What is important in the context of food processing industry is that existing solutions of subsystems may have, as shown in the exemplary comparison of transmission system, as much as four and a half times more negative environmental impacts than the most favorable of the presented combination of materials. This only gives an idea of how much there is to do in the field of ecological awareness when choosing material composition of machines and appliances.

Identification of environmental impact sources in relation to every element, subsystem and system of a machine should lead to undertaking actions aimed at improvement of current situation. This relies on the increase of interest of designers, constructors and technologists to include ecobalancing methodology in their work, which in turn would result in:

1) Research and application of eco-friendly materials that guarantee the creation of lightweight, durable elements and systems; this can be done by proper selection of materials (e.g. composites instead of metals, because due to their near-immunity to corrosion, they can be reused),

2) Minimization of energy input to technological processes, mainly accompanying the machining of elements,

3) Use of environmentally friendly lubricants that reduce friction resistance in kinematic nodes of a machine and allow easier dismantling of elements.

All these activities should be supported with popularization of the idea of quantitative characterization of environmental impacts caused by technical objects. This should result in easier access to the related data, allowing designers to use them to create environmentally friendly machines and appliances or to improve existing solutions.

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## THE CURRENT PROBLEMS OF SUSTAINABLE PRODUCTION AND CONSUMPTION

**Wacław ADAMCZYK<sup>1</sup>**

<sup>1</sup> Professor, Head of Department of Technology and Ecology of Products, Cracow University of Economics, Kraków, Rakowicka 27, [adamczyk@uek.krakow.pl](mailto:adamczyk@uek.krakow.pl)

**JEL Q56**

**Abstract**

Sustainable development is linked to balancing consumption with sustainable production. When considering its interrelations and cause-and-effect relationship, sustainable consumption and production should be expected. In practice, it is impossible and paradoxically, the existing discrepancy between mutual non-matching of production and consumption is deepened by the same factors that enhance sustainability individually within production and consumption spheres. Moreover, this discrepancy is deepened by such positively perceived factors as the process and product innovation being a motive power for launching new products on the market and increasing competitiveness. This is noticeable when considering an increasing quantity in product supply and developing new ranges of hitherto unknown products as well as accompanying global increase in consumption of raw materials, energy and waste. Production brings a strong stimulation of consumer needs and demands but it also puts pressure on consumers through marketing activity, advertising and promoting consumption lifestyle patterns. In this paper, the actions targeted at developing sustainable production and consumption in two areas are described. The factors of mutual unsustainability between production and consumption within the cycle: environment - resources – production – distribution – consumption – waste - environment.

**Keywords:**

consumption, design,  
production, sustainable  
development, technology.

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### Introduction

Achieving sustainable development requires consistent actions of economic, ecological and social actions to be undertaken in many areas of human activity that can be defined as follows:

- economic prosperity and continuity for business and its stakeholders,
- environmental protection and resource conservation,
- social well-being and equity for both employees and affected communities.

Economic actions include economic growth and creating value for shareholders through securing a competitive return on investment, protecting the company's assets and

enhancing the company reputation and brand image through integration of sustainable development thinking into business practices. Also, capacity building for economic development in the communities, regions, and countries in which the company operates is to be expected.

Environmental actions comprise environmental impact reduction by minimizing and striving to eliminate the adverse environmental impacts associated with operations, products and services and natural resource protection by promoting the sustainable use of renewable natural resources and conservation, and sustainable use of non-renewable natural resources, including ecosystem services.

Social actions involve spheres covered by business ethics by supporting the protection of human rights within the company's sphere of influence and promoting honesty, integrity and fairness in all aspects of doing business. They also significantly improve employee well-being as an effect of protecting and preserving the fundamental rights of employees, promoting positive employee treatment and contributing to employee health, safety, dignity and satisfaction (Clark 2007).

These also help increase the quality of life working with public and private institutions to improve educational, cultural and socio-economic well-being in the communities in which the company operates and in society at large (Rumpala 2011). Achieving these objectives require a comprehensive approach and compromise solutions necessary to reach a synergistic effect.

### **Sustainable production and consumption and product design strategies**

The expected synergistic effects result primarily from actions in the areas of sustainable consumption and production based on the Life Cycle Thinking (LCT) paradigm of complex profiles in the triad of sustainable development.

#### **1. Economic life cycle thinking:**

- total life cycle costs incurred by the enterprise, including capital and operating costs, and impact on long term profitability;
- total cost of ownership to the customer, including purchase or leasing of equipment and ongoing supplies or services;
- economic efficiency in terms of resource productivity and net energy production over the product life cycle;
- economic growth or entrepreneurship opportunities enabled by the product introduction;
- regional economic benefits of production due to sourcing of materials, suppliers and services;
- new jobs created both directly and indirectly via the multiplier effect.

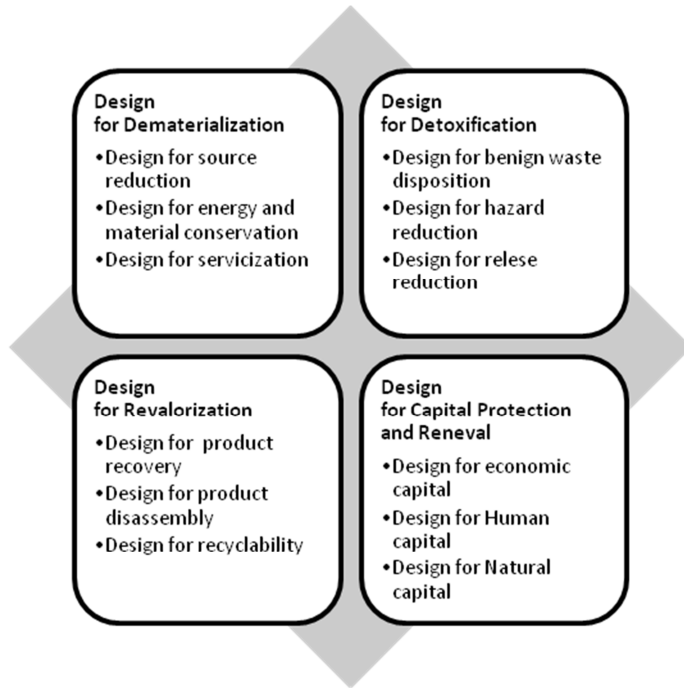
2. Ecological life cycle thinking:

- energy consumption and energy efficiency of supply chain operations;
- depletion of non-renewable resources, including materials and fuels, involved in transportation, production and distribution;
- impacts upon local and regional ecosystems, including habitat integrity, biodiversity and distribution of natural cycles;
- potential loss or degradation of agricultural lands, forests, water bodies, fisheries or other natural resources critical to human subsistence;
- airborne emissions, including hazardous air pollutants, particulates, smog forming chemicals and greenhouse gases;
- solid or liquid waste streams associated with supply chain operations, maintenance and disposable supplies;
- potential risks associated with accidental spills, leakage, fire, explosion or other incidents that could threaten human safety or ecosystem integrity.

3. Social life cycle thinking:

- benefits of product or service availability upon community quality of life, including improvements in health, nutrition, education, access to resources, sanitation, mobility and recreation;
- impacts upon employees and families, including skill development, education, and personal health and safety;
- potential adverse effects of new business operations and facilities upon existing cultural and community activities;
- potential impacts upon aesthetics, including landscape changes, noise, odour or other effects of industrial activities.

It is easy to see that the production (product) side of sustainable manufacturing in LC convention consists in coexistence of physical and business cycles (KOM(2008)). In practice, LCT is accepted and completed by designers, constructors and technologists. The premise of LCT also comprises the sphere of consumption but according to studies, this more likely results from design assumption rather than conscious consumer's choice. The natural consequence of LCT is Design for Environment (DfE). This design concept, being of crucial importance for sustainable consumption and production, is completed by four groups of strategies according to different industries and product systems. The aim of these strategies is to reduce resource consumption, while maintaining economic growth. (Fig. 1).



*Source: own research.*

**Fig. 1. General strategies of Design for Environment**

Design for Dematerialization consists in minimizing consumption of raw materials, energy and other resources at each product life cycle stage that should lead to an extended product usability period, downsizing and simplified regeneration/recovery and recycling.

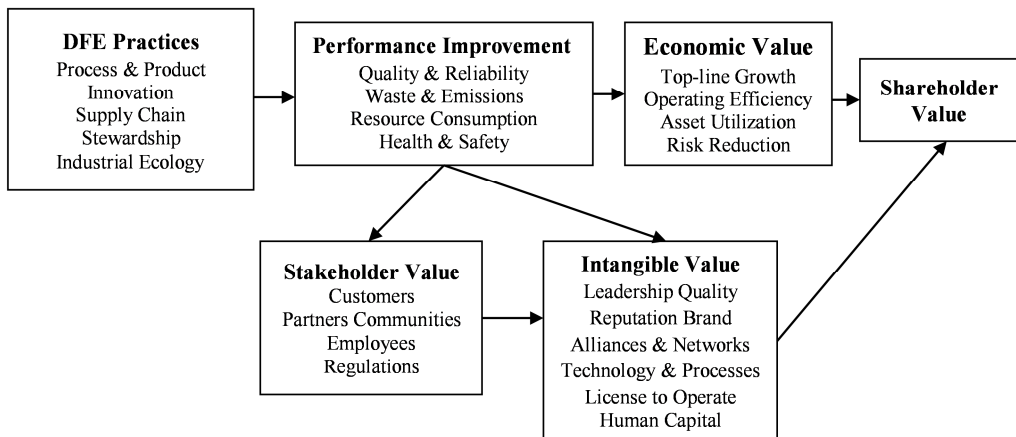
Design for Detoxification – serves to reduce adverse impacts on humans and the environment at each stage of product life cycle by eliminating toxic and hazardous materials, implementing cleaner production, reducing hazardous substance emissions and waste neutralization.

Design for Revalorization – is targeted at recovery residual value from materials and resources used, thus reducing consumption of primary raw materials. This can be achieved by making easier disassembly of used products and its components and separating materials for revitalization or extracting raw material groups for an economically efficient recycling. Similarly to Design for Revalorization, this design strategy is targeted at multiplying recirculation of primary raw materials, thus protecting natural resources.

Design for Capital Protection and Renewal – is aimed at securing access to various forms of capital (human, economic, natural) enhancing well-being. Capital protection assumes continuity and effective use of existing capital, whereas capital renewal requires capital to be reinvested or newly generated. An example of capital renewal is acquiring talented employees, creating new jobs and ecological revitalization.

The product design process realization is based on design dichotomy, assuming consistency between these two design forms as a necessary condition for success. This consistency relates both to the selection of means for achieving the goal, i.e. the transition from quality of design and manufacturing to product quality. At each of these stages ecological issues understood not only as a direct environmental impact but also its indirect consequences remote in time and space. At this point it is necessary to refer to the important role of LCT, especially life cycle design, assessment and analysis (LCA), modeling methods and scenario techniques that together with Environmental Management Systems and ISO/TR 14062 general guidelines (2002) create another system, influencing both sustainable production and consumption (Bostrom&Klintman 2008).

Achieving the DfE strategy may be seen as troublesome and costly undertaking, however its effect is not only an idealistic desire for sustainable production and consumption (Keane 2011). DfE initiates a complex process that finally creates value for the enterprise and shareholders (Fig. 2).



**Source:** own research on: Fiksel J., Low J., Thomas J., (2004), *Linking Sustainability to Shareholder Value, Environmental Management* (6).

**Fig. 2. Process from design for environment to shareholder value creation**

Achieving DfE requires various tools accompanying preparation and the design process. These are mostly concepts and tools used in realization of the concept of sustainable development in many sectors (Table 1).

The concepts that integrate production and consumption such as QFD (quality function deployment) integrate consumer preferences with the process preparation activities so that the required level of product quality, in particular eco-labeling and its inspiring manufacturers and consumers take an important role.

*Table 1*

**Concepts, tools and sectors of activities  
for sustainable production and consumption**

Concept	Tool	Sector
<ul style="list-style-type: none"> <li>• Circular economy</li> <li>• Clean technology -cleaner production</li> <li>• Climate change mitigation</li> <li>• Consumer engagement and communication</li> <li>• Corporate social responsibility</li> <li>• Eco-efficiency</li> <li>• Eco labeling</li> <li>• Ecosystem services</li> <li>• Ethical investment and consumption</li> <li>• Green public procurement</li> <li>• Green/sustainable chemistry</li> <li>• Industrial ecology</li> <li>• Intra/Intergenerational equity</li> <li>• Life cycle management</li> <li>• Life cycle thinking</li> <li>• Life cycle sustainability assessment</li> <li>• Producer responsibility</li> <li>• Rebound effect</li> <li>• Supply chain management</li> <li>• Sustainable design</li> <li>• Sustainable lifestyles</li> <li>• Sustainable policies</li> <li>• Sustainable procurement</li> <li>• Sustainable products and services</li> </ul>	<ul style="list-style-type: none"> <li>• Carbon and water foot-printing</li> <li>• Analysis of consumer preferences and attitudes</li> <li>• Economic instruments</li> <li>• Integrated product policies</li> <li>• Internalization of environmental and social costs</li> <li>• Life cycle assessment</li> <li>• Life cycle costing</li> <li>• Material flow analysis</li> <li>• Multi-criteria decision analysis</li> <li>• Quality function deployment</li> <li>• Scenario analysis</li> <li>• Social life cycle assessment</li> <li>• Stakeholder analysis</li> <li>• Sustainability indicators</li> <li>• System optimization</li> </ul>	<ul style="list-style-type: none"> <li>• Chemicals</li> <li>• Construction and buildings</li> <li>• Energy</li> <li>• Financial</li> <li>• Food</li> <li>• Health</li> <li>• Manufacturing</li> <li>• Resources and feedstocks</li> <li>• Retail</li> <li>• Tourism</li> <li>• Transport and mobility</li> <li>• Waste</li> <li>• Water</li> </ul>

*Source: own research.*

### **The role of eco-labeling in achieving sustainable production and consumption**

Across the EU there are numerous solutions enhancing sustainable production and consumption recommended by the Commission of the European Communities (KOM 2011). In addition to eco-design, it is also recommended to use ecological product marking, green public procurements and an encouraging system supported by member states and creating the global market for ecological products (Vollmer 2010).

Eco-labeling is an activity initiated in the area of sustainable production, but also functioning in the target area of consumption. An integrated eco-labeling consists in generating effects targeted at sustainable production by meeting product environmental requirements, and then at influencing consumer preferences under market conditions, while supporting sustainable consumption.

Within this scope, eco-labeling supports decision making on:

- individual purchase, individual and green public procurements
- analyses related, inter alia, to economic growth and competitiveness
- raw material recovery and waste management.

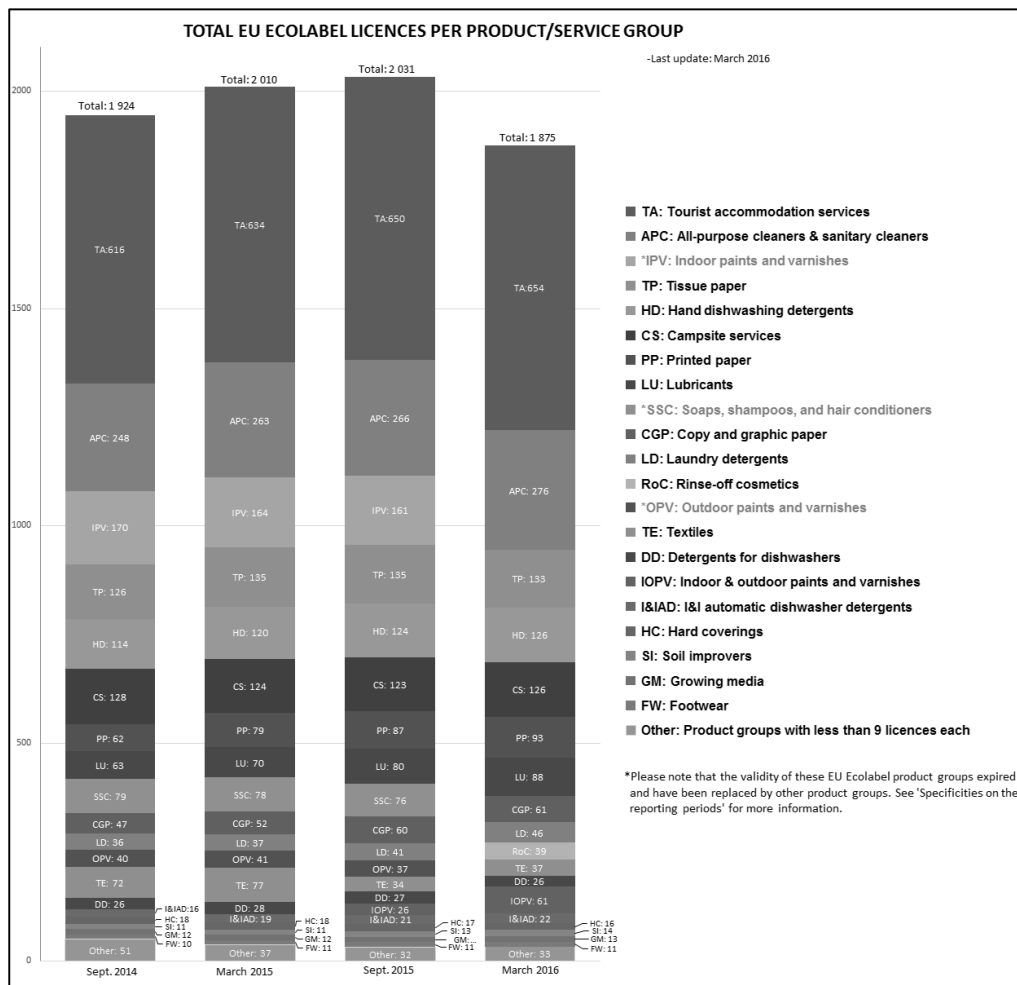
Through eco-labeling the manufacturers communicate to consumers and other stakeholders the message that the product meets certain ecological criteria. In order to gain the right to use eco-signs some activities are deemed necessary pertaining to design and manufacturing processes as well as product features. Life Cycle Thinking (LCT) and use of LCA computer aided techniques is an essential paradigm. The rules of ecological marking were established in the EU with Regulation No. 66/2010 of the European Parliament and of the Council of 25 November 2006 (EC/ 66(2010)).

The popularity of European eco-labeling is confirmed by the number of licenses and products/services awarded with the EU Ecolabel (Fig. 3 - 6).

During the reporting period (March 2016), the largest number of EU Ecolabel licenses were awarded in France (28%), Italy (18%) and Germany (12%). Iceland and Croatia have not been awarded any EU Ecolabel licenses.

Out of the total number of licenses during the reporting period (March 2016), the majority of products/services comprised within this total are from Italy (46%), France (10%) and Spain (9%). Iceland and Croatia have not been awarded any EU Ecolabel products or services.

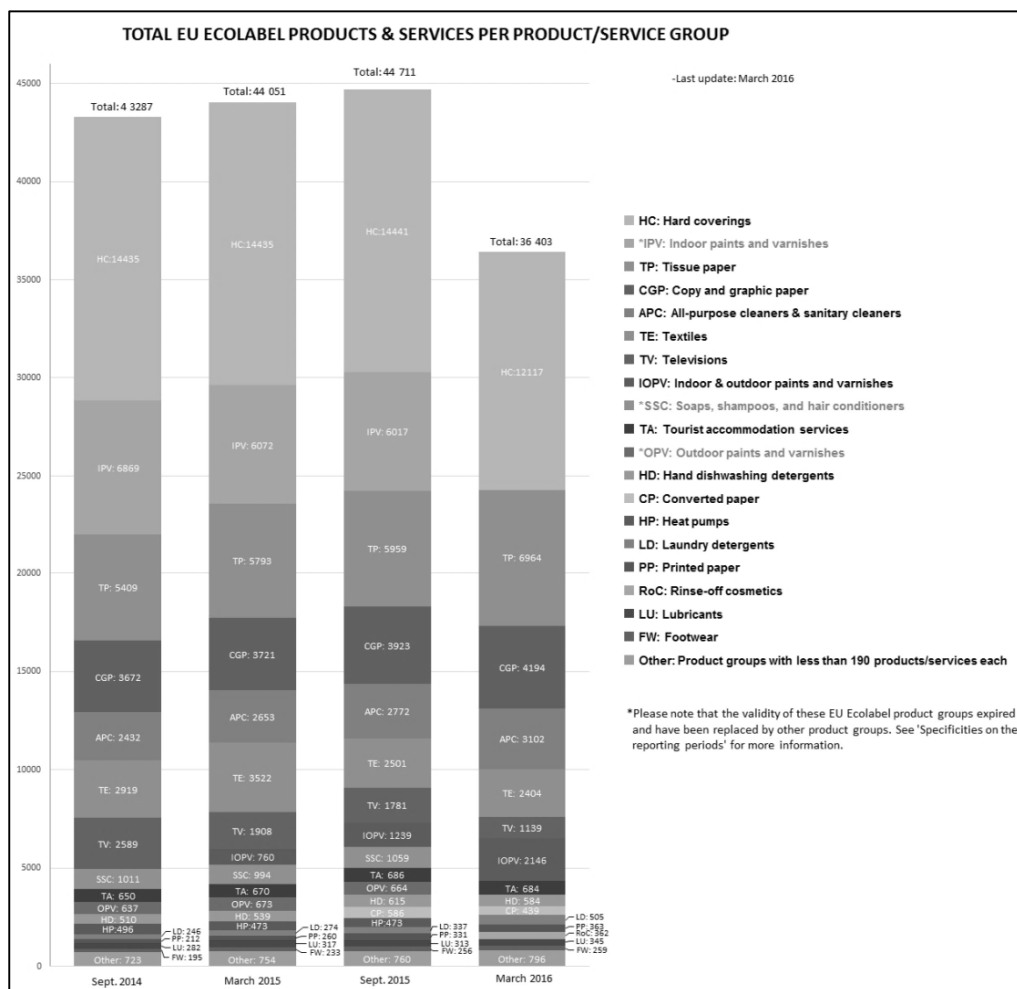
Over the decade, a number of studies on label functioning were carried out taking into account not only organizations and procedure performance but also the attitude of stakeholders. The group of respondents included manufacturers, consumers, traders and representatives of governmental and non-governmental organizations.



Source: <http://ec.europa.eu/environment/ecolabel/facts-and-figures.html>

**Fig. 3. Total ecolabel licenses by products and services group**



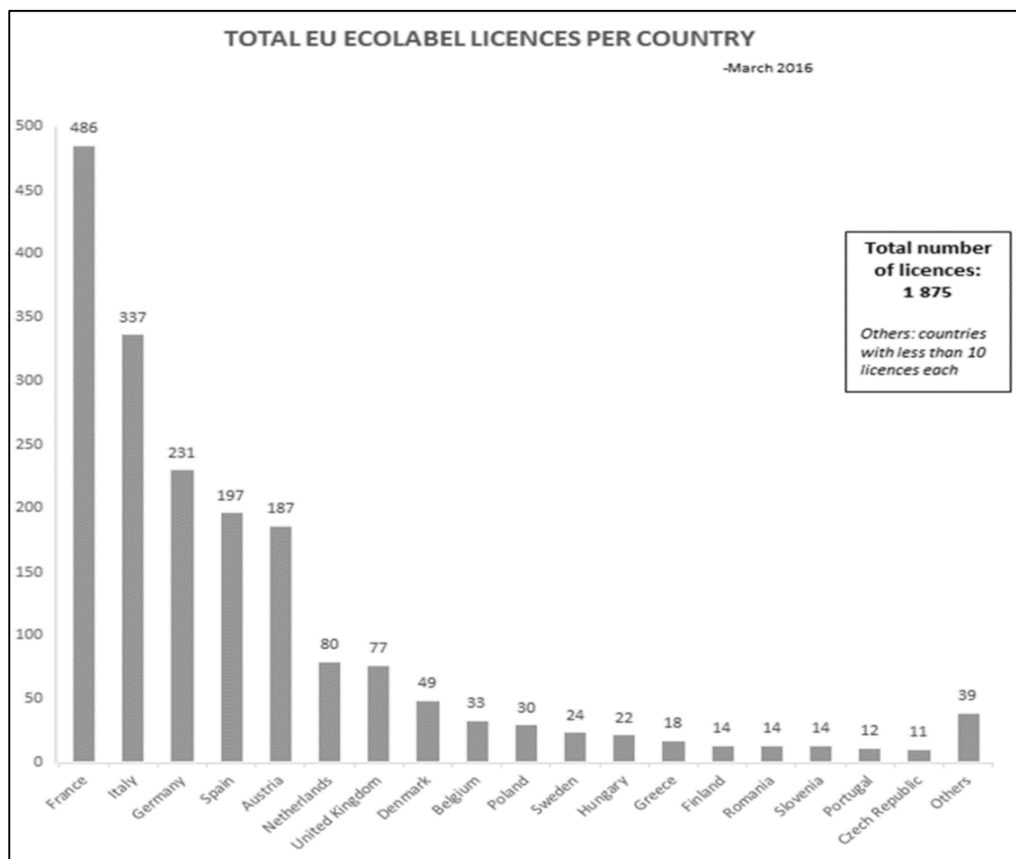


**Source:** <http://ec.europa.eu/environment/ecolabel/facts-and-figures.html>

**Fig. 4. Total ecolabel products and services**

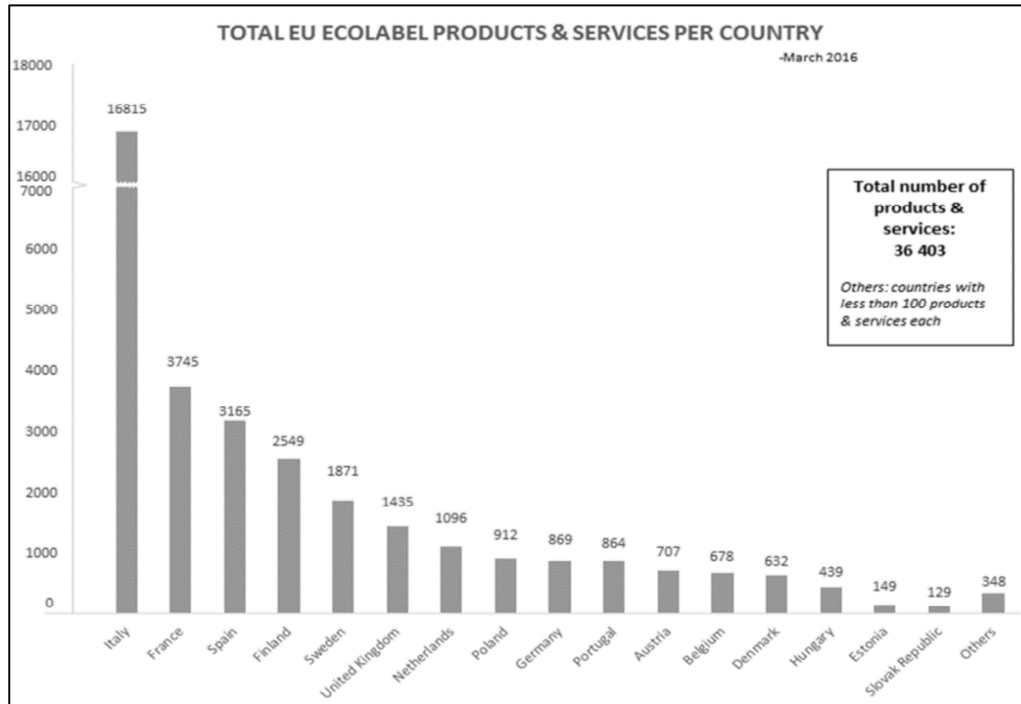
The execution of activities related to eco-labeling has been confirmed by the results of a survey ordered by the EU in 2014 (EU Ecolabel Survey, 2014). The results indicated that up to 79% of respondents considered EU labeling an important sales tool, while 66% of respondents recognize the ecolabel as the most important factor in taking a purchasing decision. In fact, individual EU member states assign different degree of significance to ecological labeling when making purchasing decisions.

The results of our survey, carried out on a representative random sample in Poland show that only a small group of consumers actually pay attention to eco-labeling when making their purchasing decisions (3%). More than half of the respondents (52%) declare that they use an eco-mark when making decisions, while the rest of them pay no attention to eco marking.



**Source:** <http://ec.europa.eu/environment/ecolabel/facts-and-figures.html>

**Fig. 5. Total EU Ecolabel Licenses per Country**



**Source:** <http://ec.europa.eu/environment/ecolabel/facts-and-figures.html>

**Fig. 6. Total EU Ecolabel Products and Services per Country**

The EU surveys indicate that small and medium sized enterprises (87%) pay more attention to eco-labeling as compared to large companies (74%). In addition, the concept of common market requirements for EU labeled products was highly appreciated (87%), although individual interest groups present a relatively differentiated opinion. The highest consistency was shown by representatives of governmental organizations (100%) as well as consumers (92%); however, the concept gained little appreciation by those who held no ecolabel certificates (75%). Responses to eco-labeling by prospects brought some interesting information too. More than half of the respondents (54%) point out the necessity to improve the Ecolabel system, (41%) to leave it unchanged, while the remaining (5%) propose to liquidate it.

### **Controversy about the effect of activities related to sustainable production and consumption**

Already by the turn of the last century, some authors (Dowell et.al 2000) expressed skepticism about the effects of sustainable production and consumption. Still,

the pre-production and production activities that remain in the domain of manufacturers cause not only favorable but also adverse environmental impacts. This paradox has occurred with the development of innovation and design under conditions of strong competition. The implementation of technical innovations, e.g. innovative design or products, even with the occasional face lifting applied to them, increases a stream of products entering the market, shaping new product groups. As a result, a more intensive use of raw materials and power resources is observed, all the more this is not accompanied by removal of old products. Thus, the imbalance between production and consumption becomes even greater.

Evidence of unethical cost cutting practices in order to achieve microeconomic objectives together with manipulations in Lean Production to improve productivity have also caused negative effects. Such practices often entail replacement of high quality materials (that are basically more expensive), with their cheaper substitutes, while increasing performance characteristics to indicate product innovation. This leads to the cutting down on the service life of parts and sub-assemblies, limiting it to the warranty period only. The situation is further aggravated by the so-called “Design for Service” consisting in introducing irreparable sub-assemblies or making repairs more complicated by using designs and connections that require specialized tools and equipment, which makes the whole process more labor-consuming. As a result, the repair itself becomes unprofitable, stimulating a demand for new complete sub-assemblies or even new products. This is witnessed both in food production and non-food products.

An example of such practice, which is easy to show due inherent product features such as intended use of relatively long service life and the possibility of product assessment after use, is the automotive industry. The public has long been aware of recurring problems with cars, e.g. faulty TSI engines,<sup>1</sup> gearboxes, valve timing gears or DPF filters. A peculiar design “achievement” was placing the valve timing gear between the engine block and the gearbox in BMW N47 engines. Such practices make servicing more difficult and expensive and shorten service life, although they could create a short-term driving force for sales growth in the automotive market. What is more, solutions targeted at mitigation of harmful environmental effects of transportation are of end-of-pipe technologies (e.g. soot after-burning). One can see no activities whatsoever aimed at improving combustion processes and emission reduction by eliminating some diesel oil components, while at the same time bio-fuels

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<sup>1</sup> To reduce friction between the piston and cylinder, piston rings of reduced friction area, thus less resistant and tight were introduced.

that are being introduced, have their ecological features originating in plant raw materials; it is true however that their potential to replace oil is rather limited. (Smith 2009). Not to mention that some counter-innovation activities such as hydrogen powered engines or the development of hydrogen fuel cell technologies are thought provoking.

Among activities that only seemingly lead to sustainable production are practices used by highly developed countries which eliminate use of raw material technologies and are based on importing pre-processed raw materials from countries where costs of labour and raw materials are low. These practices have negative impacts on the environment due to an increase in consumption of raw materials and energy and harmful emissions, and related costs beyond their boundaries, usually outside the EU territory. This too results in technological stagnation in some countries, which in order to increase profits, intensify extraction and sales of raw materials, while suffering losses from emission costs.

### **Conclusion**

Despite common interest in sustainable development and supporting strategies covering specified areas of activities, their current performance cannot be considered satisfactory. The pursuit of sustainability is never-ending. The positive effects of sustainable development are primarily brought about by the involvement in the design and manufacturing areas, i.e. production, and to a smaller degree by consumers who attach insufficient significance to environmental issues when making buying decisions. Distributors and retailers play an important supporting role by shaping supply chains and consumer behaviors. Moreover, manufacturers and retailers often agree that sustainable production and consumption offer a chance to develop innovations and improve competitiveness. It is also necessary to perform informative and educational activities among consumers to make sustainable consumption their lifestyle. Long-range activities should bring in a positive effect in the form of sustainable consumption, even though this is a long-lasting process. Low environmental awareness, lack of understanding of the concept of sustainable production and consumption and a growing consumerism induced by a wide market can postpone sustainable development.

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## THE QUALITY IN CORPORATE SUSTAINABILITY REPORTING

**Jadwiga ADAMCZYK<sup>1</sup>**

<sup>1</sup> Prof. dr hab., Department of Economics and Organization of Enterprises. Cracow University of Economics, Rakowicka str. 27, 31-510 Kraków Poland. [jadwiga.adamczyk@uek.krakow.pl](mailto:jadwiga.adamczyk@uek.krakow.pl)

**JEL Q56**

**Abstract**

An increase in social awareness of modern stakeholders causes that they expect to be informed about all aspects of corporate activity. Such information should include not only financial performance, but also provide the non-financial data.

Sustainability reporting includes information on economic, ecological and social performance. The GRI guidelines are used by most companies as a reference for sustainability reporting. Quality is an important issue in the sustainability reporting process.

The role of quality in corporate sustainable development is presented in this paper. Quality occurs as a GRI rule and also as an integral part of reports. The fourth generation of GRI G4 guidelines, including an approach to quality management as an element of a report is discussed.

Based on 37 reports awarded for the best social reports in 2015 the extent of information provided in sustainable development reports, in particular those related to quality management is examined.

**Keywords:**

sustainable development,  
GRI guidelines, report,  
quality.

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### Introduction

Corporate sustainability reporting becomes very popular, although it is not mandatory. Many companies increase the extent of information by voluntary disclosures to give fuller picture of their activities. More and more companies publish information on adherence to the principles of sustainable development (SD). Since there are no mandatory requirements related to elaboration and disclosure of information on sustainability development, there is discretion regarding the amount of results, level of detail and forms of presentation. Standards and guidelines became a reference in selecting SD principles, areas of evaluation and reporting. The most important of these are Global Reporting Initiative (GRI) guidelines.

At corporate level sustainable development deals with and equilibrium between company economic, ecological and social activities. This is connected with the process of effective manufacturing of socially desired products and services, while reducing the use of natural resources and obeying environmental protection and meeting social expectations of stakeholders. Corporate management in compliance with the principles of sustainable development meets the needs and interests of employees, customers, suppliers, shareholders and the local community.

Quality is connected with corporate sustainable development. The quality category is most often identified with characteristics of products and services by which products can meet customer expectations. Quality applies to the whole enterprise management, including reporting and presenting results to a wider group of stakeholders.

The aim of this paper is identification of quality in corporate sustainable development reporting. The role of quality as the GRI principle of sustainability reporting and reference to quality assessment in GRI G4 reports.

### **The role of quality in enterprise sustainable development**

To reach and keep its competitive edge on the market any modern enterprise must consider increasingly stricter requirements posed by enterprise surroundings. Quality becomes one of factors determining the enterprise success. Quality is defined as the entirety of properties and characteristics of a given product or service in design, manufacturing, operation and marketing stages by which products meet customer expectations (Beckford (1998)). Simultaneously quality is the entirety of properties and characteristics of a given product and service deciding on its ability to meet identified or potential needs (Griffin 2002). Quality should be identified with the process of coordinated and effective actions related to organisation management and making current and strategic decisions, thus we can say about the quality of management. It is assumed that almost all enterprises have their own action strategies but only some of them are efficient and bring success, thus meeting the expectations of their environment. Quality management depends to a large extent on leadership, thus more and more often the term "quality leadership" is used (Lock (2003)). The quality effects shaped in managing processes are achieved in actual product manufacturing processes and services provided.

In variable and unstable conditions the safety of business activity is based on good relations with concerned entities, including customers that is a decisive stakeholder group (Rodriquez, Ricart 2002). Customer satisfaction is a measure of the degree to which the customer's quality-related expectations are met.



The ISO series 9000 standards is one of basic quality management systems. In ISO 9000 eight quality management principles were defined, namely: customer focus, leadership, involvement of people, process approach, system approach to management, continual improvement, factual approach to decision making and mutually beneficial supplier relationships. System approach to processes means creating value added to concerned parties, while ensuring that an organisation achieves permanent success. Process approach means that all management functions are executed at each stage as a defined and orderly process.

Quality of products and services relates to many features and properties that determine the level of customer satisfaction, e.g.

- reliability, service life,
- usability, suitability,
- conformity to requirements, standards,
- durability, service life,
- easy operation and quick repairs,
- appearance, aesthetics, odour and perception,
- product brand-related quality perceived by a customer (Griffin (2002)).

Total Quality Management (TQM) is currently the most advanced approach to system quality management. The TQM concept gives priority to quality management and places it at a strategic level. Quality is considered as one of main sources of competitive edge. The TQM model developed by John Oakland distinguishes three pillars: quality management system, people teams and quality management methods and tools (Oakland (2000)). These pillars are backed by organizational culture, communication and commitment. This means that value system, communication between employees and stakeholders and commitment to implementation of organization activities affect organization quality.

Achievement of the desired quality is connected with a responsibility for a product and its users. Total Quality Management should ensure continual improvement in achieving desired quality. This is the concept of general quality with commitment of all staff, not only the top management. This is the management process implemented into all enterprise functions and product manufacturing stages for achieving customer satisfaction. Such a management process includes not only product improvement, but also the improvement of labour quality, i.e. staff qualifications, technology, processes, marketing and planning activities. Total Quality Management is a new method of thinking and operation to create an organization for meeting stakeholder expectations (especially customers) in the present and future.

Such enterprise management aspects are pointed out also by the concept of sustainable development. Sustainable development monitoring and assessment can proceed more efficiently within the framework of existing processes and organizational structures as well as enterprise quality management system. Linking quality management and sustainable development is caused by the transition from meeting customer needs and expectations to creating value for a wider group of stakeholders. An important TQM element is paying more attention to quality of links between an enterprise and its environment that is demonstrated in safety and working conditions as well as environmental protection and meeting other social goals. All these management aspects are areas of interest in corporate sustainable development reporting.

### **Prerequisites for measuring the results of corporate sustainable development**

So far the main source of information about enterprise activity and its results were financial statements (Clark, Feiner, Viehs (2015)). However, the international dimension of business activity induces the need to provide information that could be interesting not only to investors, but also to different stakeholder groups such as customers, local communities and social organizations. Reports should provide information on an effect of enterprise decisions on the society and environment. At present reporting to stakeholders is becoming a standard procedure. This applies in particular to sustainable development reporting to enhance corporate transparency. Disclosure of information on implementation of economic, social and environmental goals improves competitive advantage and increases the enterprise investment attractiveness to investors. The enterprise reporting system includes a complex of information designed for enterprise management at different management levels and internal and external stakeholders.

Reporting of economic, environmental and social effect is done voluntarily, but is becoming more and more common (Dilling (2010)). Corporate sustainability reporting means the measurement of the effects considering economic, environmental and social dimensions and disclosing them into the internal and external environments. With reports an enterprise can inform concerned parties about its activities related to sustainable development. Sustainability reporting is the voluntary initiative more often undertaken by enterprises.

### **GRI guidelines in sustainability reporting**

Lack of generally applicable standards for disclosure of non-financial results implies the scope and quality of published data. These needs are met by *Global Reporting Initiative* guidelines that set generally available unified sustainability report-

ing rules. Preparing a report according to these guidelines that specify the extent of published information and the opportunity of independent verification increases the credibility of disclosed data.

*Global Reporting Initiative* (GRI) sustainability reporting guidelines belong to fundamental reporting standards. The first version of GRI guidelines was published in 2000, the third version, so called G3 in 2006, and the fourth integrated version G4 was completed and published in 2013 (Global Reporting Initiative (2013)). At the same time, a two-year transitional period for enterprises has been established, after which all reports will be prepared in compliance with G4 guidelines.

The overarching principle of GRI sustainability reporting guidelines is transparency in economic, social and environmental protection effects as a fundamental component of effective relations with stakeholders, investment decisions and other market decisions (Global Reporting Initiative (2006)). The aim of G4 guidelines is to support sustainable development of the world economy by balancing economic, environmental and social activities.

The G4 guidelines were divided into two parts (G4 Sustainability Reporting Guidelines (2014)):

- part I: Reporting Principles and Standard Disclosure that establishes principles and criteria to be met for reporting according to the Guidelines, and its scope.
- part II: Instruction, so called the Implementation Manual that details how to apply individual principles, how to prepare information and how to interpret concepts contained in Part I.

The GRI Guidelines contain fundamental reporting principles that specify how to present information related to implementation of sustainable development. It defines three type of standard presentation of information concerning:

- strategy and organization's profile (viewing the sustainable development concept with respect to strategy adopted);
- approach to management (enterprise's approach to economic, social and environmental effects);
- performance indicators (more than eighty indicators are proposed to measure an enterprise's performance relative to sustainable development).

### **The quality of reporting and disclosure of effects according to GRI**

Sustainable development reporting determines not only the quality of enterprise's management, but it also concerns quality assurance issues. The *Global Reporting Initiative* provides reporting principles, reporting guidelines and standard disclosure. The significance of GRI is manifested by keeping with the principles of report-

ing quality assurance as well as by including management quality into reports. The reporting principles are intended to ensure the transparency of disclosure of issues and indicators in the report (Fig. 1). The GRI principles are divided into two groups:

- principles for defining report quality and proper presentation of information,
- principles for defining report content, i.e. issues and indicators to be disclosed in the report.



**Fig. 1. GRI reporting principles**

Assurance of report quality requires the following principles to be applied: balance, comparability, accuracy, timeliness, clarity and reliability.

According to the principle of balance the report should contain information reflecting positive and negative aspects of the enterprise's activities to enable an assessment of overall performance. The report should avoid selections and omissions, but should possibly provide a well- balanced assessment of the enterprise's effects. The report prepared in compliance with GRI principles should:

- contain both advantageous and disadvantageous effects,
- enable assessment positive and negative tendencies over time,
- present information according to its significance.

It is important to adhere to the principle of comparability in the report. Information related to economic, social and environmental effects should enable comparing these data against assumed objectives, enterprise's past performance and the performance of the other organizations (benchmarking). Maintaining consistency in methods and assumptions of presentation of information allows to compare them over time. For comparative analysis it is important to give not only indicators (e.g. rejection rate in manufacturing), but also absolute values (e.g. the amount of waste in tonnes).

Assurance of report quality requires the principle of accuracy to be observed: The presented information should be, to the degree possible, sufficiently accurate to reflect the actual state, while being understandable for the most numerous group of

stakeholders. The optimal accuracy level should be kept in the report. The report should contain:

- results of measurements,
- measuring techniques and methods for indicator determination,
- description of adopted assumptions and the source confirming qualitative assessment.

According to the principle of timeliness the reports should be prepared on a regular schedule and contain up-to-date effects. Timeliness refers both to the regularity of reporting and its proximity to the actual events described in the report. The best solution would be a combination of the GRI reports with the financial statements.

The report quality is also determined by its clarity. Information contained in the report should be comprehensible and have a readable form. The report should contain information at a specified specificity level to stakeholders to be easily and properly used. The information aggregation level should not affect its generality. Therefore the possibility to get more detailed information through references to data source enhances the report quality.

The principle of reliability means that information should be gathered, analysed and disclosed in a way that enables internal and external auditors to verify their veracity. Stakeholders should have confidence that a report contains data that can be verified by external entities and original data exist.

When identifying issues and appropriate indicators the following principles are used: significance, stakeholder inclusiveness and sustainable development context. In sustainable development reporting the term significance is equally important as in financial reporting. Defining significance is not limited to those aspects that have importance for an enterprise's financial performance, but cover also the enterprise's economic, social and environmental impacts. When determining the significance of information both internal factors (e.g, mission, strategy) and external factors, i.e. the organization's impact on stakeholders and entities in the value chain are taken into account.

The principle of significance applies not only to selection of items to be reported, but also to selection of indicators for effect assessment, considering different data complexity and specificity levels. When assessing outer factors the issues pointed out by stakeholders or wider social expectations are of essential importance.

Reporting should keep the principle of stakeholder inclusiveness, all stakeholders. At first, when preparing the report an organization should define its stakeholders. Stakeholders are entities or persons on which enterprise's actions or products have a

significant impact, and they can affect the organization's ability to effective implementation of strategies and goal achievement. Stakeholders are entities and persons for which an enterprise's operation is of especial importance (e.g. employees, shareholders, suppliers) and external entities (e.g. customers, local community). Stakeholder expectations are the reference point of many enterprise's decisions that should be taken into account in the report preparation process. They refer to the scope, range and application of indicators and its verification. Expectations, and even claims of some stakeholder groups must consider expectations of stakeholders altogether. To identify stakeholder expectations different forms of stakeholder engagement in enterprise activity are used. The stakeholder engagement process should be included into the report. A reporting organization should document the adopted way of stakeholder engagement and its impact on report content and sustainable development implementation.

The report prepared according to the GRI guidelines should present an organization's effects in a wider sustainable development context. The report should consider whether the organization contributes to increase or decrease economic, social and environmental effects at local, regional and global levels. Thus the environmental results should be presented with reference to limits of resource use and permissible pollutant levels. In turn, information considering wages and allowance should be referenced to the minimum wage and average remuneration level.

### **Corporate sustainability report content**

The fundamental reporting principles specify how to present information related to implementation of sustainable development. The GRI report arranges subjects in two categories:

- *Disclosure on Management Approach*
- A range of effects divided into subject indicators (*General Standard Disclosure*) and specific (*Specific Standard Disclosure*).

General standard disclosure gives a view on the significance of sustainable development from the perspective of the enterprise. It contains standardized presentation of general information, such as:

- Organization strategy and vision of sustainable development,
- Organizational profile - name, primary brands, products, location of headquarters,
- Corporate governance - supervisor board structure and composition and bodies responsible for economic, environmental and social effects,
- Stakeholder engagement - stakeholder group map and way of their engagement in the reporting process, basic stakeholder problems,

- Report profile - reporting period, date of recent report, contact person,
- Ethics - organization's values, principles and standard procedures contained in ethical codes.

The further part of the report contains the performance indicators (Table 1).

*Table 1*

**Sustainable development reporting categories and aspects in GRI guidelines**

Symbol	Categories of sustainable development	Sustainable development aspects
G4-EC	ECONOMIC	Economic effects Market presence Indirect economic impacts
G4-EN	ENVIRONMENTAL	Raw materials and materials Energy Water Biodiversity Emissions, effluents and waste Products, services Transport Compliance with environmental regulations
G4-LA G4-HR G4-SO G4-PR	SOCIAL Labour Human Relations Society Public Relations	Employment and decent work Observance of human rights Impacts on society Product responsibility

**Source:** *Global Reporting Initiative, Sustainability Reporting Guidelines 2006*, [www.gri.org](http://www.gri.org)

Subject indicators relate to basic report topics (Colding, Peattie (2005)). The GRI G4 Guidelines offer more than 80 universal performance indicators that are extended by sectoral indicators that consider its specificity.

### **Quality in corporate sustainability reporting**

In its general part the GRI report presents the structure of business and individual customers, customer locations, offers addressed to customers, methods for measuring customer satisfaction, customer right observance practices and percentage of received and settled complaints (Table 2).

Quality assessment appears in the GRI G4 report with respect to:

- product quality,
- labour quality,
- product responsibility, including effects related to:
  - product impacts on customer health and safety,
  - product labelling,
  - customer satisfaction,
  - customer right protection,
  - customer claims,
- personnel training and education,
- the environment (especially ecological quality of products).

Quality is an important issue not only in the process of report information preparation, in particular for evaluating effects of sustainable development. In the report prepared according to the GRI G4 guidelines, quality occurs not only in general part, but also as quality assessment included into performance indicators (Table 2).

Reporting the effects of sustainable development is conducted more efficiently in enterprises that have implemented quality management systems (ISO 9001 standards related to products), environmental management systems (ISO series 14000 and occupational health and safety standards). Meeting customer needs and expectations within the framework of quality management fits in creating value for stakeholders in corporate sustainable development. Achieving a desired product quality is linked with responsibility for the product and its user, that is subject to assessment in sustainability reporting according to GRI G4.

The responsibility for the environment and its protection is also the subject of evaluation in the GRI report. The implementation of ISO 14001 environmental management systems leads to continual monitoring and improvement of corporate environmental management, thus enabling sustainable development environmental goals to be achieved.

The next aspect is occupational safety and health that includes a number of actions providing better working conditions to take care of employees. The scope of assessment is specified in GRI Guidelines under social goals (Labour).



Table 2

**Quality in corporate sustainable development reporting according to GRI G4**

<b>Performance area</b>	<b>No.</b>	<b>Performance indicators</b>
<b><i>Economic indicators</i></b>	EC1 EC6 EC8	Sales value Market share Number of claimants
<b><i>Environmental indicators</i></b> Product and services	EN27	Assessment of product ecological quality
<b><i>Social indicators</i></b> Education and training	LA11 LA21	Number of hours of pro-quality training courses for employees labour quality assessment
<b><i>Product responsibility</i></b> Customer health and safety	PR1 PR6 PR7 PR8 PR9	Percentage of product and services subject to assessment due too health and safety Programmes for observance of marketing communication and sponsoring law, standards and codes Number of incidents of non-compliance with regulations and codes Number of substantiated claims for breaching customer privacy and loss of personal data Fines or penalties for non-compliance with law and regulations concerning delivery and use of products and services

**Source:** Own research.

Since 2007 in Poland the Responsible Business Forum has organized the Social Reports competition (Responsible Business Forum (2015)). In the period 2007-2015 the number of submitted reports increased. In 2015 was the ninth edition of the Social Reports competitions. Social reports are prepared according to different standards and guidelines concerning sustainable development and social responsibility. These concepts are congenial but not identical, that translates into other reporting areas hard to comparison (Adamczyk (2014)). 37 reports took part in the competition, with 10 of them being prepared for the first time. The scope and quality of information disclosed in reports are increased. Most companies (even 31) used the GRI G4 Guidelines, 4

companies used its own descriptions and 2 enterprises prepared reports according to Global Compact principles.

The scope of subject information in sustainable development reports depends on the business sector (Table 3). The highest reporting level was noted in banks and chemical industry. A considerable part of information is related to economic, effects, including product sales data that can indicate indirectly its quality and market share. Information on the number of claimants is disclosed less often.

Table 3

**Share of subject information in corporate sustainability reports in Poland**

Effects disclosure	Banking	Industry	Commerce
Economic effects			
– sales income	●	●	●
– market share	○	●	●
– number of claimants	•	•	•
Environmental effects			
– assessment of product ecological quality	•	●	○
Social effects			
– number of hours of pro-quality training courses	○	●	○
– labour quality assessment	●	○	○
Product responsibility			
– customer health and safety	•	●	○
– programmes, standards, codes	●	●	●
– number of non-compliances	•	•	•
– number of claims	•	•	•
– penalties	•	•	•

Legend: ● - considerable, ○ - moderate, • - modest

Source: Own research.

Environmental effects, including product ecological quality assessment, were disclosed by industrial enterprises to whose activity external stakeholders are vulnerable. Information on the number of training courses and work quality assessment was often disclosed, mainly in connection with the requirements for implementation of ISO 9001 quality management systems.

In the product responsibility aspect the reports presented programmes, standards and codes of good practices and care of customer health and safety. However, there was very small share of information on the number of non-compliances, claims and

penalties. It follows from the analysis of reports that information that companies wish to disclose is presented.

The effects of actions in different areas are presented. However, there is no information about related legal requirements (norms). If information on disposal of a specified volume of waste (or packaging utilization) is communicated without information whether such activity is on a voluntary basis or resulting from a legal obligation, it is possible to assess a contribution to sustainable development but without assessing decision prerequisites.

### **Conclusion**

The GRI Guidelines are the most common unified standard for sustainable development reporting principles in the world. These are used for corporate sustainable development reporting. Reporting includes economic, environmental and social aspects. The category of quality occurs both in the reporting process and in assessment of sustainable development effects.

Within the area of product responsibility information related to standards, programmes and codes as well as customer health and safety was disclosed. However, information on the number of claimants was disclosed less often. This follows from the consistency of GRI G4 with other standards, e.g. quality, environmental and safety management. The analysis of reports allows to note that the most important question was the way of information presentation, not its quality. Discretion regarding corporate sustainable development reporting affects report quality and credibility.

An advantage of GRI G4 is its consistency with other standards related mainly to CRS, for example: OECD guidelines, UN Global Compact principles and Business and Human Rights guidelines as well as, that is important, ISO standards regarding environmental, quality and safety management, and environmental protection.

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## **PERCEPTION OF EXTRA-VIRGIN OLIVE OIL CERTIFICATIONS: A COMMODITY MARKET PERSPECTIVE**

**Lolita LIBERATORE<sup>1</sup>, Nicola CASOLANI<sup>1</sup>, Federica MURMURA<sup>2</sup>**

<sup>1</sup> Department of Economic Studies. University of G. d'Annunzio Chieti-Pescara, Viale della Pineta 4, 65127, Pescara. [l.liberatore@unich.it](mailto:l.liberatore@unich.it); [nicola.casolani@unich.it](mailto:nicola.casolani@unich.it).

<sup>2</sup> Department of Economics, Society, Politics. University of Urbino Carlo Bo, Via A. Saffi 42, 61029, Urbino. [federica.murmura@uniurb.it](mailto:federica.murmura@uniurb.it).

**JEL Q180**

**Abstract**

Nowadays Protected Denomination of Origin (PDO) and organic certifications constitute an effective form of differentiation and can represent an important cue that guide consumer's Quality evaluation. This paper investigates, through K-means cluster analysis, consumer attitude toward these certifications in extra-virgin olive oil Italian market. The results showed three main clusters; the first includes PDO extra-virgin-olive oil (EVOO) consumers (27.2%), the second includes PDO and organic EVOO consumers (32.4%), while the third cluster comprises indifferent to certifications consumers (40.4%).

### **Keywords:**

extra-virgin olive oil;  
organic food; PDO;  
traditional food;  
certification.

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## **Introduction**

Extra-virgin olive oil is an important product in the Mediterranean diet and also major agricultural crop for Southern European countries in terms of both farm income and cultivated area (De Graaff & Eppink, 1999). In recent years, due to growing popularity of the Mediterranean diet among consumers in the US, Canada, Australia and large parts of Asia, EVOO consumption has increased (International Olive Oil Council 2012). Various attributes influence EVOO consumers' perception. One of the main factors is represented by the geographic origin, whose importance in consumer decision-making is highlighted in various studies (Schnettler et al., 2008). Many researchers suggest that EU geographical indication labels play an important role in signaling olive oil quality (Aprile et al., 2012). Protected Denomination of Origin (PDO) or Protected Geographical Indication (PGI) certifications can offer effective differentiation tools in food markets. Additionally origin is an important attribute for both

consumer and industrial product evaluations, due to its role as a quality indicator (Di Vita et al., 2013; Casolani et al., 2015). In recent years the European Union (EU) has recognized the provenance of many EVOO and has certified a total of 43 Italian products in the oils and fats categories as PDOs (Ministry of Agriculture, 2014). Espejel & Fandos (2008) studied the relationship between the perceived quality of an agro-food product with Protected Designation of Origin (PDO) as a criterion for loyalty and buying intention of the Aragonese consumers. A clear distinction was established between quality perceived through intrinsic and extrinsic attributes: results showed that consumers measured quality through the intrinsic attributes. The PDO and the region of origin are a significant determinant in food choices; indeed, consumers who are experienced or familiar with a particular region of origin tend to consider it as key in their product evaluation and choice (Fotopoulos & Krystallis, 2001). Geographical Indications constitute an effective differentiation tool in food markets and, at the same time, origin is an important attribute for both consumer and industrial product evaluations (Di Vita et al., 2013). Moreover, Cicia et al. (2009) claim that organic certification has a twofold value for the consumer: it indicates attention toward health and preservation of the natural environment. In line with previous research work, the main scope of this paper is to analyze EVOO consumers' perception of PDO and organic certifications, investigating differences and common points.

### Materials and methods

Respondents were screened following these characteristics: they are olive oil consumers; they are Italian citizens and they are over 18 years old. The research was carried out between October 2014 and February 2015 in three different areas located in the Southern, Central and Northern Italy. The survey was conducted on 1,200 consumers. Data have been analyzed using the SPSS 21.0 program, Statistical Package for Social Science. The k-means cluster analysis technique was used to identify market segments taking into account socio-demographic characteristics, PDO and organic EVOO statements. The k-means clustering aims to partition  $n$  observations into  $k$  clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster; the objects are clustered around the centroids  $\mu_i \forall i=1, \dots, k$  which are computed by minimizing the following objective (Johnson and Wichern, 2007):

$$V = \sum_{i=1}^k \sum_{x_j \in S_i} (x_j - \mu_i)^2$$

where  $k$  is the number of clusters i.e.  $S_i, i=1, 2, \dots, k$  and  $\mu_1$  is the mean point or centroid of all the points  $X_j \in S_i$ .

## Results and discussions

The socio-demographic composition of the sample is reported in Table 1.

Table 1

### Socio-demographic composition of PDO and Organic EVOO consumers compared with the total sample

		Total sample n=1200		PDO EVOO consumers (43.0%) n=516		Organic EVOO consumers (39.1%) n=496	
		%	n	%	n	%	n
Gender	Male	47.9	575	47.7	246	51.0	253
	Female	52.1	625	52.3	270	49.0	243
Age	Between 18-35 years old	23.9	287	22.6	117	21.8	108
	Between 36-45 years old	18.8	225	19.3	100	17.1	85
	Between 46-60 years old	25.9	311	23.0	119	22.4	111
	Over 60 years old	31.4	377	35.1	181	38.7	192
Education	Above high school	22.4	269	24.7	127	19.2	95
	High school or lower	77.6	931	75.3	389	80.8	401
Average household income	Less than € 15.000	27.9	335	15.9	82	12.9	64
	€ 15.000- € 30.000	44.1	529	33.9	175	29.8	148
	€ 30.001- € 45.000	20.0	240	35.1	181	40.1	199
	Over € 45.000	8.0	96	15.1	78	17.1	85

K-means cluster analysis technique was used to identify market segments (Table 2 and 3). The first cluster is the smallest consumer segment accounting for the 27.2% of the sample; it was called “Traditional” EVOO consumers; it’s composed by the 36.2% of consumers over 60 years, the education of 18.1% is above high school; it is the only cluster in which males (53.1%) outnumber females and the percentage of PDO consumers is highest (82.0%). Consumers within this cluster consider important aspects largely related to traditions; they mostly believe - compared to other clusters - that PDO EVOO olive oil is important to preserve historical and cultural traditions, helps to develop the typical Italian food system and the Italian economy; they also think that PDO EVOO has an appropriate price. The second cluster represents 32.4% of the sample. It was called “Healthy” EVOO consumers because it is linked to healthy aspects of certified EVOO in the broadest sense; in fact, consumers in this cluster believe that PDO and organic EVOO, compared with the conventional one,

are safer, healthier, better from a nutritional point of view and their purchase is considered to be useful for environmental protection; this cluster is dominated by young people (49.5% of the sample is 45 years old or younger). The concepts of health, environmental protection and safety are strongly perceived by organic EVOO consumers in comparison to the others (Aertsens et al., 2009). The third cluster (called “Indifferent to EVOO certifications”) represents 40.4% of the total sample.

Table 2

**Socio-demographic market segmentation through K means cluster analysis. Different letters (a – b – c) indicate statistically different score**

		Segment 1 “Traditional” EVOO consumers (27.2%)	Segment 2 “Healthy” EVOO consumers (32.4%)	Segment 3 “Indifferent” consumers (40.4%)
Gender (%)	Male	53.1 <sup>a</sup>	45.8 <sup>b</sup>	46.0 <sup>b</sup>
	Female	46.9 <sup>a</sup>	54.2 <sup>b</sup>	54.0 <sup>b</sup>
Age (%)	Between 18-35 years old	17.0 <sup>a</sup>	26.3 <sup>b</sup>	26.7 <sup>b</sup>
	Between 36-45 years old	17.3 <sup>a</sup>	23.2 <sup>b</sup>	16.0 <sup>a</sup>
	Between 46-60 years old	29.5 <sup>a</sup>	23.2 <sup>b</sup>	25.8 <sup>b</sup>
	Over 60 years old	36.2 <sup>a</sup>	27.3 <sup>b</sup>	31.5 <sup>b</sup>
Education (%)	Above high school	18.1 <sup>a</sup>	28.2 <sup>b</sup>	20.7 <sup>a</sup>
	High school or lower	81.9 <sup>a</sup>	71.8 <sup>b</sup>	79.3 <sup>a</sup>
Consumers (%)	Organic EVOO consumers	40.2 <sup>a</sup>	58.0 <sup>b</sup>	23.2 <sup>c</sup>
	PDO EVOO consumers	82.0 <sup>a</sup>	62.0 <sup>b</sup>	42.6 <sup>c</sup>

Table 3

**K means cluster analysis. Different letters (a–b–c) indicate significantly different scores using ANOVA and Duncan post hoc tests**

Statements (Likert scale from 1 to 7, where 1=strongly disagree, 4=neither agree nor disagree, 7=strongly agree).	Segment 1 “Traditional” EVOO consumers (27.2%)	Segment 2 “Healthy” EVOO consumers (32.4%)	Segment 3 “Indifferent” consumers (40.4%)
A1. PDO EVOO is better than the conventional one from a nutritional point of view.	4.0 <sup>a</sup>	4.8 <sup>b</sup>	3.3 <sup>a</sup>
A2. PDO EVOO is healthier than the conventional.	3.2 <sup>a</sup>	4.5 <sup>b</sup>	3.4 <sup>a</sup>



A3. PDO EVOO certification helps to protect the environment.	3.5 <sup>a</sup>	4.4 <sup>b</sup>	3.5 <sup>a</sup>
A4. PDO EVOO has an appropriate price.	3.3 <sup>a</sup>	4.3 <sup>b</sup>	3.4 <sup>a</sup>
A5. PDO EVOO certification helps the Italian economy.	4.3 <sup>a</sup>	3.0 <sup>b</sup>	3.0 <sup>b</sup>
A6. PDO EVOO olive oil is important to preserve historical and cultural traditions.	4.2	4.0	4.1
A7. PDO EVOO olive oil helps to develop the typical Italian food system.	5.3 <sup>a</sup>	3.8 <sup>b</sup>	4.2 <sup>b</sup>
A8. Organic EVOO is safer than the conventional.	5.4 <sup>a</sup>	4.0 <sup>b</sup>	4.1 <sup>b</sup>
A9. Organic EVOO is better than the conventional from a nutritional point of view.	3.2 <sup>a</sup>	4.5 <sup>b</sup>	3.6 <sup>a</sup>
A10. Organic EVOO is healthier than the conventional.	3.1 <sup>a</sup>	4.4 <sup>b</sup>	3.6 <sup>a</sup>
A11. Buying Organic EVOO certification helps protect the environment.	3.2 <sup>a</sup>	4.5 <sup>b</sup>	3.1 <sup>a</sup>
A12. Organic EVOO has an appropriate price.	3.7 <sup>a</sup>	4.5 <sup>b</sup>	3.6 <sup>a</sup>
A13. Organic EVOO tastes better than the conventional	4.0 <sup>a</sup>	4.6 <sup>b</sup>	3.8 <sup>a</sup>
A14. Organic EVOO helps the Italian economy.	3.2	3.0	3.0

## Conclusion

The main product certifications in the olive oil field are PDO and organic ones; this study suggests a number of interesting points. Results showed a market classification of EVOO consumers in three main clusters based on their attitude toward certifications. Traditional aspects perceived by consumers are prevalent in PDO consumers, while concepts related to health are mainly common to organic ones. This confirms the main results present in the international literature. A piece of policy advice resulting from this study is that the Italian system needs to improve its communication tools in order to provide more information about the value of PDO and organic certifications.

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## **MOTIVATION, COSTS AND BENEFITS OF THE ADOPTION OF THE EUROPEAN ECOLABEL IN THE TOURISM SECTOR: AN EXPLORATORY STUDY OF ITALIAN ACCOMMODATION ESTABLISHMENTS**

**Stefano DUGLIO<sup>1</sup>, Stanislav IVANOV<sup>2</sup>,  
Francesca MAGLIANO<sup>1</sup>, Maya IVANOVA<sup>2</sup>**

<sup>1</sup> Department of Management, University of Torino, 218 bis, Corso Unione Sovietica – 10134 Torino (Italy), stefano.duglio@unito.it, francesca.maglian345@edu.unito.it

<sup>2</sup> School of Hospitality Management, Varna University of Management, 13A Oborishte Street, 9000 Varna (Bulgaria), stanislav.ivanov@vumk.eu, maya.ivanova@vumk.eu

**JEL Z320 + Q560**

**Abstract**

In the last 20 years, the tourism industry has witnessed the proliferation of many ecolabels with different scopes and criteria and sometimes with a limited area of recognition, which has caused confusion among guests. In order to offer a tool useful for consumers and recognised all over Europe, in 2001 the European Union decided to extend its official ecolabel to the hospitality sector. Fifteen years since its introduction, Italy represents the first country in Europe in terms of adhesion to the European Ecolabel while in other countries like Austria, Spain and France, only a limited number of properties are certified. This paper aims at presenting a study of 36 Italian accommodation establishments with the European Ecolabel (out of 194, the 18.6% of the total) and analyses their motivations, difficulties, costs, and benefits deriving from its implementations.

### **Keywords:**

Tourism, Italian accommodation, European Ecolabel, Cost Benefit Analysis.

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### **Introduction**

In 2015, international tourism marked a record of about 1,200 million tourists (UNWTO, 2015) and 50 million more tourists travelled to international destinations, meaning an increase of 4%, compared to the previous year. Within Europe “arrivals reached 609 million, or 29 million more than in 2014” (UNWTO, 2015: 13), with an increase in all the European macro areas and, in particular, Central and Eastern Europe (+6%) and Northern Europe (+7). These data, and the provisions for the cur-

rent 2016, show the importance of tourism as a driver for the economic development in the world, and in Europe. On the other hand, however, the same data show the importance of taking into consideration the implications of the tourist activities on the environment and the local communities.

Starting from the end of the 1980, when the first definition was introduced by the Brundtland Commission, the concept of sustainability has been widely debated. ICLEI (1994) defined sustainable development as a “(...) *development that delivers basic environmental, social, and economic services to all, without threatening the viability of the ecological and community systems upon which these services depend*”, and pointed out the three basic pillars of sustainability: the environment, economy and society.

The sustainable development paradigm, therefore, started to permeate all the economic activities and, from the mid-1990s, when the Lanzarote Chart was signed, there has been a growing interest in the policy-making process related to sustainability in the tourism sector (UNWTO-UNEP, 2005; Borges et al., 2013).

In this field, sustainability started to become a key element of the debate on the management of the tourist destinations (Lopez-Sánchez et al., 2013) as well as in the tourist enterprises in general (Font and Wood, 2007; Font et al., 2014) and the accommodation establishments in particular (Bohdanowicz and Zientara, 2008; Ivanov et al., 2014). In this specific context more than in others, and due to a lack of knowledge showed by managers on the real “meaning” of sustainable tourism, it is necessary, as Lopez-Sánchez et al. (2013) point out, “(...) to develop effective tools that enable the translation of the ideals and principles of sustainability into actions” (p. 58). Among the useful tools able to “translate the principles of sustainable development into action”, the implementation of environmentally friendly labels and/or certification systems has been considered by the European policymakers as an important instrument. The European Commission, therefore, published the European Ecolabel in order to improve the environmental profile of the tourist establishments and stimulate consumers to choose “environmental friendly” services and products (Beltramo and Pandolfi, 2013). From the managers’ point of view, the reasons why a hotel may be interested in this theme are attributable to different factors: Park, Kim and McCleary (2014) underline manager’s disposition, whereas Bohdanowicz (2005) stresses the affiliation to a hotel’s chain and the location of the hotel (Bohdanowicz, 2006).

With regard to these considerations, this paper aims to analyse Italian hospitality managers’ perceptions towards the European Ecolabel and identify the factors that influence them. The rest of the paper is organised as follows: Section 2 comprises a

literature review that starting from the phenomenon of the ecolabels in hospitality, focuses its attention on the European Ecolabel. Section 3 presents the methodology adopted to evaluate the application of the European Ecolabel in the Italian context. Section 4 concentrates on the main results from a study of 36 out of 194 Italian accommodation establishments with the European Ecolabel and analyses their motivations, costs and benefits deriving from the certification. The final section wraps-up the main findings, discusses the limitations of the research, provides the future research directions and concludes the paper.

### **Literature review**

Ecolabels first appeared in the 1980s (e.g. Blue Flag) but they proliferated in the last 20 years (Buckley, 2002; Font, 2002; Pliß et al., 2012). The aim of ecolabels is to certify the environmentally friendly products and/or practices of a company. In doing so ecolabels provide numerous benefits for the tourist companies, tourists and society as a whole. Dabeva (2013) summarises the benefits of ecolabels in the hotel industry as follows: improved image of the company, increased product and company competitiveness, a signal for the tourists about the product characteristics, improved product quality. In this way, the ecolabels help to curb some of the negative impacts of tourism (see Sasidharan et al., 2002). Furthermore, Buckley (2002: 185) points out that the ecolabel “becomes one of many characteristics a consumer may weigh, according to individual priorities and preferences, when comparing price and features for alternative tourism products”. On the other hand, ecolabels are associated with costs – not only for the certification, but for the compliance with the ecolabel’s standards as well. Sasidharan et al. (2002) emphasise the large expenses for environmentally friendly technology that are not within the budgets of small companies; thus, predominantly large companies can afford such certification. That is why the authors are relatively sceptical towards the ecolabels and think that they are “likely to function as nothing more than marketing gimmicks for large-scale enterprises” (p. 172). Furthermore, the increase in the number of the ecolabels for tourist accommodation, with different scopes and criteria and sometimes a limited area of recognition, has historically caused confusion to guests (Duglio and Beltramo, 2014).

#### *The European Ecolabel*

The first European Ecolabel was created in 1992 with the European Regulation CEE 880 of 23<sup>rd</sup> March 1992 on a Community eco-label award scheme in order to “promote the design, production, marketing and use of products which have a reduced environmental impact during their entire life cycle” and “provide with better infor-

mation on the environmental impact of products” (EU, 1992: p. 2). Following its first revision, in 2001 the product groups were officially extended, including the hospitality sector and creating the ecological criteria for two new categories: tourist accommodation and camping (EU, 2000). As far as the tourist accommodation is concerned, the current set of criteria is divided into two main categories: mandatory (29 criteria) and optional (61 criteria) (EU, 2009). An accommodation establishment has to comply with all the mandatory criteria, whereas it has to follow a sufficient number of optional criteria in order to acquire a fixed number of points, indicated by the Regulation: a minimum of 20 points and 3 more points based on the presence of some additional services. Table 1 contains the macro areas in which the mandatory and the optional criteria have been defined.

*Table 1*

**Number of mandatory and optional criteria of the European Ecolabel**

Area	Number of mandatory criteria	Optional criteria	
		Number	Achievable points by area
Energy	10	20	38.5
Water	5	13	20
Detergents and disinfectants	1	7	13
Waste	4	4	8
Other services	2	12	29
General management	7	5	11
<b>Total</b>	<b>29</b>	<b>61</b>	<b>119.5</b>

**Source:** Authors’ elaboration based on EU (2009).

The degree of adhesion to the European Ecolabel in Europe shows great differences among the EU members. Official data provided by the European Commission indicate 650 certified accommodation establishments (EU, 2016). In many European countries, however, the ecolabel has not been able to attract the interest of hospitality managers; in several cases, in fact, there are maximum of 1 or 2 accommodation certified as in Romania and Poland and in Bulgaria and Croatia official statistics do not indicate any certified properties. By contrast, with 194 certified accommodation establishments (or 29% of the total number of certified properties at European level), Italy represents the first country for diffusion of the European Ecolabel, which as interests every kind of accommodation, even the simplest in terms of services, the mountain huts (Campisi et al., 2014).

Methodology

Data collection and sample

Data were collected via online questionnaire sent to the managers of all 194 European Ecolabel certified accommodation establishments in Italy. After the first mailing, 19 accommodations responded (9.8%) and after a reminder 17 more responded (8.8%), leading to a final sample of 36 accommodation establishments representing 18.6% of the population. Table 2 presents the sample characteristics.

Table 2

Sample characteristics

	Population		Sample	
	Number	%	Number	%
<i>Type of certified accommodation establishment</i>				
Hotels	136	70	22	61
Other accommodation establishments	58	30	14	39
<b>Total</b>	<b>194</b>	<b>100</b>	<b>36</b>	<b>100</b>
<i>Location of certified accommodation establishments by geographic area</i>				
North	74	38	20	56
Centre	34	18	7	19
South and Islands	86	44	9	25
<b>Total</b>	<b>194</b>	<b>100</b>	<b>38</b>	<b>100</b>

As Table 2 reveals, the sample structure presents very well the structure of the certified accommodation establishments by type, while it slightly overrepresents the Northern regions (e.g. Trentino Alto Adige, Veneto, Friuli Venezia Giulia, Piedmont, Lombardia) and underrepresents the Southern Regions and the Islands (Sardinia, Sicily). Nevertheless the sample covers 18.6% of the population size, hence results could be generalised for the whole population of ecolabel certified accommodation establishments in the country.

Questionnaire

The questionnaire contained 18 questions related to motivations, difficulties, costs and benefits of the adoption of the European Ecolabel, based on previous experiences in other similar researches (Provincia di Torino, 2005). The motivation, difficulties and benefits were evaluated by a set of statements, measuring respondents'

level of agreement on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Costs of the certification were measured by interval scale (up to 2000, 2001-4000 and over 4000 euros). Additional questions related to the characteristics of the accommodation establishment (type, location), the year of certification, and the initial expectations of the respondents.

### *Data analysis*

The Kolmogorov-Smirnov z-test revealed that the answers of the respondents were not normally distributed. Therefore, we used the non-parametric Mann-Whitney U-test and Kruskal-Wallis  $\chi^2$  test to identify the role of accommodation establishment's type (hotels and other) and location (North, Centre, South and the Islands), respectively, on its managers' motivation, and perceived difficulties and benefits of the ecolabel certification (Baggio and Klobas, 2011). Paired samples t-test was used to identify any statistically significant differences in respondents' answers to some questions.

### **Findings**

Table 3 presents the motivation for the European ecolabel certification of the accommodation establishment. The main motivation for certification are related to the personal awareness of the sustainability issue ( $m=4.69$ ) and for improving the corporate image ( $m=4.03$ ) and the paired samples t-test values with the levels of agreement with the other statements are significant at  $p<0.01$ . On the other hand, the role of the tour operators in requesting the label ( $m=1.59$ ) does not seem to be influential. Even the opportunity of buying products at a lower cost ( $m=2.18$ ) is not within the main motivations indicated by the respondents. The geographic location of the accommodation establishment does not influence the motivation for certification (none of the  $\chi^2$  values is statistically significant). The type of the property has only marginal impact – managers of hotels were more motivated by the potential subsidies to be received by the public authorities ( $m=3.00$ ) than the managers of the other types of establishments ( $m=1.57$ ) and the difference between their responses is significant at  $p<0.01$ .



Table 3

**Motivation for certification**

Motive	Number of responses	Mean	Standard deviation	Differences by type (Mann-Whitney U-test)	Differences by region (Kruskal-Wallis $\chi^2$ )
Due to my own awareness of sustainability	36	4.69	0.789	122	2.452
To decrease the costs related to the supply of natural resources	34	3.09	1.583	90.5*	2.008
To decrease the costs related to the purchase of products	34	2.18	1.218	124	0.533
To improve the corporate image	33	4.03	1.104	120	0.025
To increase profitability	34	2.35	1.390	140	1.234
To receive benefits and/or subsidies from the Italian public authorities	34	2.41	1.520	66.5***	4.132
It was requested by the tour operators	34	1.59	0.821	121	4.454

*Note:* Levels of significance: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$

The respondents have indicated nearly the same level of agreement with statements related to the difficulties of the certification process (Table 4) and none of the paired samples t-test values is statistically significant. All means are below the middle value of 3 meaning that in general the respondents did not find any significant difficulties with the certification. The label seems to be clear in its comprehension as well as in its initial implementation (compliance with the criteria) and retention (improvement programme). Even facing the cost does not seem to create particularly concerns to managers ( $m=2.51$ ). The type of accommodation establishment is not influencing its manager's perceptions of the difficulties of the certification while the location has a minor effect – the managers of properties in the central regions found it more difficult to show to the tourists that their properties were adhering to the ecolabel's standards ( $\chi^2=6.818$ ,  $p < 0.05$ ).

Table 4

**Difficulties of the certification**

Difficulty	Number of responses	Mean	Standard deviation	Differences by type (Mann-Whitney U-test)	Differences by region (Kruskal-Wallis $\chi^2$ )
I had difficulties in understanding the criteria	35	2.54	1.379	140.5	1.155
I had difficulties in covering the costs	35	2.51	1.011	117.5	0.314
I had difficulties in implementing the criteria	35	2.29	1.100	106	1.219
I had difficulties in showing property's compliance with the criteria	35	2.31	1.157	121.5	6.818**
I had difficulties in implementing the improvement programme	35	2.29	1.226	97*	0.988

**Note:** Levels of significance: \*\*  $p < 0.05$ , \*  $p < 0.10$

In regard to the financial costs associated with the certification we see a clear division of the accommodation establishments by their type (Table 5). Most of the hotel managers indicated that they had spent over 4000 euros on the certification, while most of the managers of other types of properties reported financial costs of less than 2000 euros. The difference between their responses is significant, as shown by the test statistics in Table 5. This result was expected because hotels have usually a larger number of rooms than guest houses, bed-and-breakfasts and other types of accommodation establishments, hence more expenses are required for hotels to adhere to the ecolabel standards.

Table 5

**Financial costs of the certification**

		Costs (in euros)			Total
		Up to 2000	2001-4000	Over 4000	
<b>Type of accommodation establishments</b>	<i>Hotels</i>	5	4	10	19
	<i>Other</i>	7	3	2	12
<b>Total</b>		12	7	12	31
<i>Statistics</i>	<i>Value</i>	<i>df</i>	<i>Asymptotic significance</i>		
Pearson $\chi^2$	4.456	2	0.108		
Likelihood ratio	4.706	2	0.095		
Linear-by-linear association	4.249	1	0.039		
Mann-Whitney U-test	66.5		0.039		
Number of valid cases	31				

Table 6 presents the benefits of the ecolabel certification as perceived by the respondents. It is noteworthy that the only major benefits relate to energy efficiency ( $m=3.56$ ) and water saving ( $m=3.2$ ) and the paired samples t-test between them and the other benefits are all significant at  $p<0.01$  or  $p<0.05$ . The type and location of the establishment do not seem to influence significantly the perceived benefits. Furthermore, despite the fact that 12 properties out of 36 (33%) affirm having obtained public financial support, the great majority of the managers do not recognise in the EU ecolabel a vector for obtaining subsidies from the Italian Public Administration. The reason why not all managers indicate support by the local public administration as a major benefit depends on the regional context in which they operate in. For example, 4 of the 12 managers (33%) that indicate of having obtained benefits from public bodies are located in Sardinia and joined the ecolabel in 2015, because of the publication of a specific regional act.

Table 6

**Benefits of the certification**

Benefit	Number of responses	Mean	Standard deviation	Differences by type (Mann-Whitney U-test)	Differences by region (Kruskal-Wallis $\chi^2$ )
Energy efficiency	36	3.56	1.340	80*	0.302
Water saving	35	3.20	1.389	110	0.556
Savings on the purchase of products	36	2.47	1.207	107.5	2.042
Benefits and/or subsidies by the Italian public authorities	36	2.22	1.514	98*	1.754
The employees are more motivated	36	2.72	1.323	96.5*	5.037*

*Note:* Levels of significance: \*  $p < 0.10$

Specific questions were suggested in order to investigate whether the ecolabel contributed to improved financial results of the accommodation establishment. Firstly, respondents reported great difficulty in quantifying the benefits of the ecolabel adhesion: only 3 out of 36 hotels (8.3%) affirm to be able to respond to this question. Secondly, even if a tourist seems to know this label, as 50% of hotels' and 35% of the non-hotel accommodation establishments' managers think, the certification does not necessarily lead to an increase in the number of guests. In fact, only 3 respondents note a major increase in the number of guests after the certification. All these perceptions drive the managers to report how their expectations before obtaining the label have been substantially disproved (73% and 86%, respectively for hotels and other accommodation).

**Discussion and conclusion**

The main results of this work show both strong and critical point in the adoption of the European Ecolabel by the Italian accommodation establishments. On the one hand, the main motives for certification are the sustainability awareness by the hospitality managers and the aim to improve the image of the property among guests, confirming one of the main factors in joining this kind of tools – the manager's disposition – as identified by Park, Kim, and McCleary (2014). Furthermore, the certification costs do not seem to create a barrier. On the other hand, some difficulties in evaluating and, above all, quantifying the benefits persist among the Italian hospitality managers. The respondents' opinions reveal a lack of balance between expectations

(the improvement of the corporate image) and related benefits (in terms of increase in the number of guests) that drives the managers to affirm how their expectations are not satisfied. In conclusion, even if Italy is the first country in Europe in terms of adhesion to the European Ecolabel (EU, 2016) with 194 certified accommodation establishments, after more than 10 years since its first introduction, they only represent the 0.12% of the 158,000 accommodation establishments in the country (ISTAT, 2016).

As all research projects, this study has some limitations. As already mentioned in the methodology section, even if it is possible to consider the sample as representative in regard to the division of properties by type (hotels and non-hotel accommodation establishments), there is a prevalent presence of facilities located in the North of Italy. Future studies, therefore, should concentrate their attention in order to enrich the number of the accommodation involved in order to sharpen the data analysis. Lastly, considering that different cultural groups may have diverse expectations and concepts of quality (Amstrong, Mok & Go, 1997), future research may investigate the differences in motivations, difficulties, costs and benefits of the European ecolabel in different EU countries and in other cultural contexts.

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Editor-in-chief:	tel.. (+359) 882 165 157
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