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FOREWORD

Conference on Information Technology for Practice 2017

Ladies and gentlemen,

welcome to the traditional IT4Practice 2017, a conference with international attendance. This year, we celebrate the 20th anniversary of this conference.

It was organized under the auspices of CIT (VŠB-TUO Information Technology Center), EUNIS-CZ (Association of European University Information Systems Czech Republic) and ČSSI (Czech Society for System Integration - Moravian-Silesian Section Ostrava).

In agreement with the name of the conference, participants come from academic staff, managers and ICI staff, IS designers at companies and institutions, ICT providers, and students. The conference was supported by IT Cluster (people for IT) too.

We are sending you complete set of selected research papers.

The topics of this year's conference are:

- Management of IT processes;
- Information security;
- Information Society and Education;
- IT Innovation.

The organizers created a platform for the exchange of knowledge and skills in the field of ICT innovations and the use of new our knowledge in practice.

We wish you to create new professional contacts and tighten the existing ones, which are useful for solving specific problems in your companies and institutions.

On behalf of organizers,

Milena Tvrdíková October 2017

C O N T E N T S

MANAGEMENT OF IT PROCESSES, PROJECT AND SERVICES

Digital Transformation in the Knowledge Management of Polish SMEs

Piotr Adamczewski[1]

Abstract. Business in the 21st century is redefined by a data-driven revolution. Small and medium enterprises (SMEs) play an essential role in the global economic growth. The share of the Polish SME sector in GNP has been at 48% for years now. This sector has been also among the most dynamically developing and computerising areas in the Polish economy. ICT (Information and Communication Technology) systems create the foundation of modern economic organizations in the times of digital transformation. This applies in particular to advanced ICT infrastructure, which is the condition sine qua non for the effective knowledge management. The objective of this article is to discuss organizational and technological aspects within the modern knowledge management using ICT called SMAC (Social, Mobility, Analytics, Cloud), being at present the canon of ICT support in this respect. The analysis has illustrated with findings of research carried out by the author in 2014-17 in selected SMEs from Mazowieckie and Wielkopolskie provinces.

Keywords: ICT, intelligent organization, SMAC, knowledge management, SME.

JEL Classification: A23

1 Introduction

The global economy evolves into a "knowledge-based economy", where market success of enterprises more and more depends on efficient knowledge management that is on acquisition, generation, distribution and application of nowledge within organizations. The strategically important nature of knowledge results firstly from the fact that it is harder to imitate and substitute when compared with material resources, and secondly from the fact that it is more flexible, i.e. more useful for the creation or improvement of various elements of the enterprise's offer. Knowledge is currently perceived as a strategic enterprise resource and as such it should be subject to constant identification, measurement, acquisition, development, utilization and protection. In other words, it should be appropriately managed. The operation of globalised and modern organizations requires the continuous

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adaptation of management methods and development strategies to new economic conditions.
This is particularly important in the process of digital transformation, which has been transforming all sectors for several years now. This applies in particular to the issues of knowledge management in economic organizations, which can be analysed in the area of organizational structures, business processes, personnel, organizational structure as well as ICT that supports management.

Similarly to other EU Member States, the largest share of GNP in Poland is generated by the sector of small and medium enterprises. The competitive potential of SMEs operating in Poland is high (very high price competitiveness, high competitiveness in terms of product and service quality, and improving innovation competitiveness). However, to fully utilise such potential, SMEs have to operate based on state-of-the-art ICT solutions. Due to differences between SMEs and large organizations and international corporations, a question arises as to the extent to which the SME sector can implement advanced ICT solutions effectively in the period of digital transformation? What factors determine decisions taken in this respect, and what implementation barriers occur?

This article is aimed at presenting the latest condition of digitalization and development tendencies in supporting the SME sector with SMAC solutions (Social, Mobility, Analytics, and Cloud*)*, which is a *sine qua non* condition of enterprises from this sector to operate in a modern way and to take part in the process of digital transformation. According to research by Cisco Global Cloud Index, half of the global population will have access to the Internet in 2018, and more than 53% of them will use tools for storing data in the cloud (Cisco, 2016). ICT implementation in every organization depends on numerous factors, mostly organizational, human, and technical, but also on the needs of the management, which can be more or less conscious. Unlike large organizations, where the implementation of advanced SMAC is perceived positively, it seems that an opposite approach can occur to this trend in the SME sector. Hence, the objective of the research has been defined to test the readiness of Polish SMEs to implement and use systems within the so-called 3rd ICT platform. In order to fulfil the objective, the following research hypotheses have been formulated:

- elements of SMAC solutions are used on an increasing scale in SMEs,
- SME management pay growing attention to the implementation of SMAC systems.

The analyses are illustrated with survey results and direct observations of the author from 2014-2017 in selected 120 SMEs from Mazowieckie and Wielkopolskie provinces, Poland, with reference to the general development trends in the studied area. The survey sample was made up of micro (9%), small (56%) and medium sized enterprises (35%). Surveyed companies represent a wide range of industries: retail and wholesale trade, discrete and process manufacturing, transport, HoReCa, utilities, finance, construction, telecommunication and ICT.

2 Intelligent organizations in the turbulent economy

The dynamics of market changes and the high level of turbulence in business environment make modern economic organizations face the challenge of continuous improvement in their operational methods and development. In practice, it implies the necessity to use modern ICT solutions in knowledge management, which enable to support business processes within the acquisition and reinforcement of business's competitive advantages. Within the evolution of the information society towards the knowledge society, it boils down to the treatment of modern organizations as intelligent organizations. A intelligent organization is one whose business philosophy is based on knowledge management (Waltz, 2003). This term became popular in the 1990s owing to the growing ICT development, the dynamically changing economic environment, and the increasing market competitiveness. An intelligent organization is one that learns and has the capacity to create, acquire, organise, and share knowledge and use it in order to raise the efficiency of its operation and increase competitiveness on the global market. The idea of such an organization is based on the systemic approach to organization, i.e. its treatment as a complex organism founded on existing structures and executed processes, focusing on the role of knowledge. In that approach, which is called 'the fifth discipline' by P. Senge, owing to knowledge and suitable tools all elements of an organization and its personnel can collaborate in order to achieve set objectives (Senge, 2002). Thanks to that, the whole organization operates as an intelligent and successful organism in the competitive environment. This explains the mutual relationships between methods of fulfilling targets, their understanding, methods of solving problems as well as internal and external communication.

The most important characteristics of a intelligent organization include, among other (Grösser, 2012), (Schwaninger, 2010):

- fast and flexible operation,
- the ability to monitor the environment,
- the capacity to diagnose early market signals and to react to changes in the environment, and
- the ability to implement new knowledge-based solutions and achieve economic benefits therefrom.

The growing volume of information used in a intelligent organization is accompanied by its increasing importance. Peter Drucker indicated already that traditional factors of production, such as growth, labour, and capital, are losing their importance in favour of a key resource, namely knowledge applied in the creative operation of an organization. It constitutes intangible resources that are related to human actions, whose use may be the basis for gaining a competitive advantage (Schwaninger, 2010). Knowledge has to be treated as information embedded in the context of an organization and a skill to use it effectively in the organizational activity. It means that knowledge resources are data about its customers, products, processes, environment, etc. in a formalised form (documents, databases) and in non-codified forms (knowledge of staff).

In the practical dimension, the effective collaboration of such elements means the necessity to use advanced ICT solutions. Technical, technological, and organizational innovations, which have appeared in recent years, are all utilised. They encompass almost all areas of a modern organization operation, starting from means of transport and equipment, through organization and material and raw material flow management, to the development of system structures that implement business processes, i.e. within logistics systems that are the essence of modern management based on e-logistics (Adamczewski, 2016b).

3 Knowledge management in theory

According to the above-mentioned definitions and interpretations, knowledge management is defined in many different ways. A large number of perspectives, where focus is on varied aspects, indicates that it may affect the operation of specific organizations in their numerous aspects and is subject to dynamic transformations. Such transformations result, *inter alia*, from the fast technological progress and the intensive search for the increasingly effective methods of gaining a competitive advantage on the market and acquiring new customers by organizations (Jashapara, 2006).

Knowledge management will be understood hereunder as the process of identifying, acquiring, collecting, processing, sharing, and using knowledge, aimed at improving a competitive position of an organization. Knowledge management is supported by four aspects: leadership, organizational culture, technology, and a measuring system (Waltz, 2003).

Information and its effective management have become one of the essential development factors of modern organizations in the information society. The basic role is played there by advanced ICT solutions. Its foundation are the concepts of the so-called third wave offered by A. Toffler. The dynamic growth of ICT and management pragmatics have made the time paradigm equally promising as cost paradigm in the economic activity of the information society era. The practical shortening of a time path in the cyberspace and disregarding geographic boundaries have resulted in the major acceleration of business processes in the global chain of supplies.

The concepts of knowledge management appeared in the early 1990s and gained significance with the ICT revolution. At the beginning of the 21st century, they underwent a fast metamorphosis. At present, they are divided into numerous schools and currents.

Classic approaches to knowledge management encompass (Schwaninger, 2010):

- a technocratic approach – it focuses on systems of processing information, distribution, reproduction, and knowledge resource protection, etc.,
- a behavioural approach – its focus is on changing the operating philosophy in an organization and on organizational behaviours:

strategies, practices, and creating social networks (both external and internal); it speaks about ‘intelligent organizations’ and ‘learning organizations’, and

- an economic approach – focused on the conversion of knowledge into funds and vice versa.

The present status in this respect can be put simply as certain eclecticism in the understanding of the whole mosaic of numerous approaches (mostly technocratic and behavioural). It is difficult to indicate a ‘pure’ project that would implement the assumptions of only one approach. As a result, it is difficult to compare projects and assess the efficiency of individual solutions. A technocratic approach was often promoted by ICT companies, while the behavioural approach was usually supported by consulting firms. The economic approach was created by consulting firms as well, but there is no certain data on its results. In general, there are no scientifically justified recommendations for specific solutions.

Knowledge management is a developing discipline with varied characteristics. The IT revolution is overturning the existing world of business and it continues, while its pace is still increasing. Organizations are facing new challenges; however, the present status of research does not allow to give explicit recommendations as to solving their problems; therefore, most investments in knowledge management are in fact experimental. In Poland, we are standing on a threshold of the epoch that will see fast changes in this respect.

4 Digital transformation environment

The present effect of the ICT evolution in the form of the so-called third ICT platform, has been treated since 2013 as the foundation of the 4th industrial revolution, being the natural development stage of the 3rd revolution of 1969 (its symbol being electronics with its transistor and automated production). The main distinguishing element of new changes has become the redefinition of the present course of business processes that contributes to new operating models of economic organizations facing new challenges to maintain their position and expand on the market further. The industrial revolution of the 4th stage is breaking out due to (Report, 2016):

- the introduction of the all-present digitalization,

- decision processes based on virtual simulations and data processing in real time, and
- machine-machine and machine-man communication.

The digital transformation means a change of the present approach to a customer and a comprehensive process where an organization moves to new methods of operation using the state-of-the-art SMAC digital technology, including social media, mobility, big-data – analytics, and cloud computing. However, it has to be kept in mind that the role of digital technologies in that process is to enable the necessary changes and open an organization to new opportunities. Therefore, they should be a tool rather than the aim of transformation. The centre of the process has to be the customer and his needs, as the main driver for manufacturers and service providers. The digital transformation is no longer the method of gaining a competitive advantage – it is becoming a factor that enables to stay on the market.

Today, it is difficult to find an economic sector that would be isolated from what is happening in the area of ICT solutions. Within several years, Airbnb, a company with no hotels at all, and in fact operating based on an algorithm of room rental, has become one of the main players on the global hotel market. A similar role is being played by Uber on the taxi service market. Both organizations have made innovations of a digital disruption type, which have changed the previous business order, providing customers with new advantages. In most cases, technological innovations and solutions that change business models and operating conditions in individual enterprises and whole sectors come from outside. Therefore, the careful monitoring of what is happening in ICT is the requirement not only for ICT companies, banks or telecommunication firms, but primarily for all organizations that want to maintain their leading position on the market.

Elements of the digital transformation include (Li, 2015), (Perera, 2015):

- SMAC technologies,
- IoT – Internet of Things,
- multi-channel models of product and service distribution, and
- automation and robotisation.

Such technologies determine changes in three areas of intelligent organizations that apply them through:

- developing relations with customers and counterparties owing to the deeper understanding of their needs, introducing numerous channels of communication, and enriching forms of self-service,
- improving operational processes within internal organizations and working environment as well as mechanisms of monitoring their efficiency, and
- modelling organizational operations within product manufacturing and services provided on the market.

Almost one third of management boards in leading global organizations expect that their revenues in the following years will be threatened by so-called digital disruptions, i.e. phenomena of a sudden appearance of new technologies and business models that will affect the value of products and services provided by such organizations (Report, 2016). It can be concluded that the world of business has become even more changeable, and primarily unforeseeable and complex. The concept of VUCA is often used to describe such phenomena (Marz, 2015), namely:

- Volatility – in particular the dynamics of changes and their catalysts, which are not governed by any predictable patterns,
- Uncertainty – no predictability that certain events will take place and the low awareness and understanding of situations that occur,
- Complexity – complexity and correlation with the lack of systematic knowledge that would allow to plan actions in a reliable manner, and
- Ambiguity – ambiguity and the lack of explicit interpretation of phenomena with the risk of interpreting conditions and cause-and effect relationships.

It means that in conditions of extreme competitiveness and the digital transformation, the previous methods of management are failing, as they have often been focused exclusively on providing stability and predictability. Advance ICT solutions for knowledge management provide assistance in this respect.

5 ICT ecosystem in a intelligent organization

Literature regarding this discipline presents two models of adapting ICT solutions in organizations (Duczkowska, 2013):

- a ‘linear’ model (‘a ladder’), and
- a relationship and conditional model (‘a transporter’).

A linear model provides for the gradual implementation of ICT in stages by business organizations. The sequence complies with e-business generations, where the following stages are listed (Adamczewski, 2016a):

- access to the Internet (e-mail and a browser),
- a company website,
- e-commerce – procurement and sale over the Internet,
- e-business – e-commerce with IT systems that optimise enterprise operations, and
- networking with other enterprises (electronic enterprise ecosystems).

The conditional model starts with the assumption that the implementation of ICT in an organization does not take place linearly but depends on the following two most important factors:

- forecast organization development; and
- expected utility of Internet technologies.

The basic premise of the second model means that the e-business implementation does not have to be linear. Specific solutions can be applied without a sequential order after approval of the management of the organization. The management decides to modify its structure, taking account expected benefits, the readiness and possibility of making changes in the enterprise, and external factors, such as pressure from customers or counterparties.

An intelligent organization, as an economic system that uses advanced ICT infrastructure in its internal organization and communication, including external communication, constitutes the essence of information society operation in business areas at present. In practice, it means that ICT supports basic organizational structures and the application of the now economy concept in the on-line mode with (Adamczewski, 2015):

- the level of technical infrastructure (hardware),
- the level of system-communication infrastructure,
- the level of application software, and
- the level of integrating business processes with external counterparties.

The dynamic development of ICT has led to the development of a new technological standard, namely SMAC systems, which enable to introduce new business models. They are based on four pillars:

1. Social – social networks are breaking barriers in information flow among people and are becoming platforms where the fast exchange of knowledge is becoming increasingly effective. Communication within social platforms is strongly replacing telephone or e-mail communication. This phenomenon is taking place in businesses as well, where the fast information exchange is of great importance. The use of social networks makes it possible to obtain a better customer interaction and, as a consequence, it becomes possible to react faster to problems and build a knowledge base according to preferences and behaviour of users.

2. Mobile – mobile devices, such as smartphones, tablets, and notebooks, have become a basic working tool of a modern worker. They have also enhanced the opportunities to reach customers who use mobile phones and have become accustomed to e-shopping and using different types of services and applications anytime and anywhere. The growing popularity of mobile shopping has also forced enterprises to develop their online marketing and to provide customers with mobile channels. In such conditions, the presentation of an offer on mobile devices is the first step in achieving and maintaining a high position on the market.

3. Analytics – understanding the behaviour and preferences of customers is one of the greatest advantages of using analytics. By using collected data that is analysed with advanced algorithms, entrepreneurs can deduce how to earn loyalty from their customers, improve marketing campaigns, enhance product development processes, and render services that meet the preferences and requirements of customers. By learning tastes of their users, entrepreneurs can present content according to their expectations. The ultimate aim in using analytics in business is, therefore, taking right decisions based on updated and segregated information.

4. Cloud – the technology of a computing cloud offers tools that enable to collect and process data on network services effectively, which contributes to the efficient organization management. By using tools available in a cloud, it is possible to reduce operating costs of ICT systems, break down geographic

barriers, and obtain access to data at any time and place. A cloud is a factor that puts other elements of the SMAC solution together.

There are numerous examples in the business practice proving that expectations and actual benefits from using ICT solutions do not tally. The cause of such an effect may be the shortage of the sufficient integration between implemented systems. A key to success in using the SMAC technology is to combine the four above-mentioned technologies, which communicate among themselves, and to enable a synergy effect. None of the four technologies alone can give a full effect. Only synergy generated by all SMAC elements working together makes it possible to create a competitive advantage. So far, organizations have invested in mobility, cloud, business analytics, and using social media in business by creating independent, usually unintegrated solutions. Their combination within the third ICT platform allows to create new revenue-generating services, deepen relationships with customers, and improve the efficiency of organizational operation (Adamczewski, 2016a).

By developing a computing cloud and mobility, it has been possible to move from closed communication systems to social platforms (Barry, 2015), (Mateos, 2011). As a consequence, the working system and business communication have changed deeply and permanently. Social channels have made it possible to create and provide access to content, the broader distribution of information, as well as the better cooperation and interaction with customers. Mobile technologies have provided easy access to information through the non-stop Internet connection. Data analyses are used to optimise the management of customer relationships and improve the efficiency of sales channels. Finally, a cloud is in many enterprises a foundation of their ICT systems, improving their flexibility and scalability, while reducing costs of data processing at the same time.

Organizations that want to maintain their position on a competitive market have to be ready to provide their customers with services that are fully customised. Owing to the SMAC development, IT is no longer only the support in business development, but rather a turning point that gives an advantage to organizations and enables them to stand out against their competitors. SMAC provides required information on time, which makes it possible to take good decisions and to collaborate effectively both inside and outside an organization, i.e. in the whole cooperation chain.

The unique ICT ecosystem of an intelligent organization is usually based on advanced ERP solutions (*Enterprise Resource Planning*). ERP systems in their traditional function as solutions that integrate an information infrastructure in an organization are no longer sufficient. Their basic functionality has been enriched with Customer Relationship Management (CRM), Supplier Relationship Management (SRM), Supply Chain Management (SCM), and Product Lifecycle Management (PLM). Owing to their properties, SMAC systems enable to raise the efficiency of information services in business processes and, finally, to achieve higher market competitiveness. A conclusion can be ventured that such solutions are no longer a way of gaining a competitive advantage for organizations, but have become a factor that determines their survival on the global market (Adamczewski 2016a).

According to IDC forecasts, in the next two years 80% of global organizations will initiate projects of digital transformation in their knowledge management, to be based on SMAC systems, including as many as 50% of outlays spent on the 3rd ICT platform solutions (Report, 2016). Research carried out by the author[1] shows that the popularity of IT support in management processes in SMEs can be presented as follows (percentage of analysed enterprises):

- finance and accounting – 87%,
- human resources – 75%,
- warehouse management – 63%
- production management – 21%,
- customer relationship management – 52%,
- office work support – 96% (including e-mail 98%), and
- procurement and sale process service – 64%.

The analysed enterprises use laptops and PCs in their day-to-day operations (99% of indications). On average, they hold about 15 computers. The vast majority use both land lines and smartphones. Tablets are used

[1] The research was conducted in 2014-17 on a selected sample of 120 enterprises from the SME sector in Mazowieckie and Wielkopolskie provinces.

in every third enterprise (36%), with 4 tablets per firm on average. The above-mentioned statistics are supplemented with the 48% ratio of using online messenger systems and taking advantage of the support provided by ICT freelancers at 59%. SMEs usually do not use multi-layer data processing protections. Instead, they choose only basic anti-virus software (90%). Every second enterprise (53%) protects its data with a standardised policy of passwords that are set and managed by the management. On the other hand, less than half SMEs (48%) encode their e-mails. Only one out of three firms uses data backup (35%), including as many as 88% having that process automated. Interestingly, backup is used to secure company data more often by entities that do not consider their ICT security to be of essential importance for their business.

The readiness of the studied entities to face the challenges of digital transformation is as follows:

- 22% of respondents answered positively, confirming the implementation of such tasks,
- 12% of respondents answered that such actions would be taken soon,
- 20% of responses indicated that such actions would be taken in the near future, and
- according to 46% of respondents such actions were not being conducted and there were no such plans.

As regards the use of SMAC solutions, the statistics of the analysed entities reflect the general global trend in this respect, i.e. (Choi, 2016), (Gajewski, 2016), (Report, 2016):

- a cloud is used in 18% organizations (38% of analysed population plans to start using it),
- mobility is utilised in 29% of organizations (with 15% of analysed population planning to launch it),
- analytics is applied by 9% of organizations (while 16% of studied population have plans to start it), and
- social media are declared by as many as 45% of organizations already, and their use in the near future is declared by 55% of respondents.

The development trends of Polish intelligent organizations in the digital transformation is supplemented with the following declared initiatives (Corcoran, 2016), (Gajewski, 2016):

- office digitalization – 70%,
- modernization of ICT infrastructure – 64%,
- consolidation in ICT and advanced analytics – 49%,
- new mobile applications for personnel – 49%,
- networking – 49%, and
- mobile self-service applications for customers – 30%.

The fact of placing a customer in the centre was confirmed by responses about catching up with the dynamically evolving needs of contemporary consumers. Moreover, half of the respondents indicated the necessity to follow the changing expectations of their customers, declaring it to be their top business priority. The continuous improvement of customer satisfaction level is possible mostly owing to investments in new ICT solutions. Only owing to them shopping can be comfortable, fast, and possible at any time and place, while customer service can be effective. It also means the new opportunities in acquiring knowledge about needs, behaviour, and opinions of customers. In general, the above-mentioned study results show that Polish modern business organizations are becoming more confident in using advanced solutions of SMAC systems, to meet the challenges of digital transformation (Brunswicker, 2015).

The growing demands of intelligent organizations within the ICT support for knowledge management result in general from their operation in real-time (RTE – *Real Time Enterprise*). Therefore, SMAC systems enable to raise the efficiency of management to a higher level by:

- reaching customers more effectively with mobile solutions,
- understanding customer needs better by using advanced analytics,
- communicating with customers more effectively via social media, and
- reducing data processing costs with cloud computing solutions.

6 Conclusion

Digital transformation requires not just the adoption of digital tools but a complete change of mindset throughout the organization. Employees need to approach problems differently, communicate and collaborate differently, and measure success differently. Ultimately, an organization's operations, revenue model, and organizational structure will change. And to add to the complexity, digital transformation will look different for every organization. Consequently, change management models are becoming an increasingly popular tool to help navigate and indeed drive the success of digital transformation projects.

An active sector of SMEs in Poland is a prerequisite of a properly functioning market economy. This sector encompasses various enterprises. The dynamic economic changes and the evolution of business relationships devaluate traditional sources of competitive advantages in the SME sector, such as capital, infrastructure, access to outlets, and the quality of offered products and services. Modern enterprises that want to compete on the market effectively have to give priority to flexibility of their organization and its ability to implement innovative business models and reorganise logistics processes. Examples of numerous Polish SMEs show that the vision of a business managed in a modern way has come into the dynamic phase of realization, while the effective knowledge management with advanced ICT solutions is growing to the role of paradigm. There is no doubt that reserves still present in the SME sector can be utilised, through supporting its operation with advanced ICT systems with the dominant role of SMAC solutions.

Statistics from the last years unequivocally confirm growing indicators of ICT solutions implementation in the sector of SMEs, which gives fair promise to Polish enterprises for their operations on global markets. Conducted research has confirmed research hypotheses. It shows that SMAC solutions are more and more common among small and medium enterprises while company management of the surveyed enterprises pays more and more attention to applying knowledge management systems. This stems from the conviction that in the times of digital transformation information technologies which support effective knowledge management not only allow to keep up with the rising competition but are an indispensable condition of market survival.

Nevertheless, it has to be remembered that the creation and development of such smart technologies has one basic aim for businesses, namely to accelerate the development pace and improve the quality of offered products and services, while reducing operating costs. Although it seems apparently simple, paradoxically innovation of Polish business organizations from the SME sector is burdened with the concern about the unknown. SMEs are afraid of investing in solutions that are not popular yet. Nevertheless, the strategic vision of the management in such organizations will determine the directions and pace of popularising modern and effective solutions in knowledge management, which may contribute to the improvement of their competitiveness on the global market.

According to the above analysis, the conditions of effective knowledge management in intelligent organizations have to be treated in a complementary way, so that ICT aspects, although very important, do not dominate the preparatory work or the operation of solutions in this respect. Equally important are so-called ‘soft’ conditions, which concern the strategy of organization’s development, its organizational culture, and qualifications and motivation of personnel. One thing seems certain already — the period of digital transformation poses new challenges for Polish intelligent organizations in the area of knowledge management. If they rise to them, they can compete on global markets more effectively.

Polish SMEs as intelligent organizations with strong technological orientation appear to be well prepared for the challenges of the knowledge-based economy, where the quickness of access to knowledge and possibility of its utilization constitutes the key factor of competitiveness. The best evidence for that is the fact that intelligent organizations achieve much better economic results than the remaining organizations. It appears that, under current economic conditions where knowledge constitutes an increasingly important factor of competitiveness, assimilation of features and principles of functioning or intelligent organizations is inevitable. An important factor for stimulation of enterprises to adapt the features of intelligent organizations is represented by the dissemination of knowledge about intelligent organizations and promotion of the examples of good practices of enterprises that already operate under the intelligent organization formula.

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Use of IT when Managing a Company

Ján Barto[1], Adam Levit[2], Jan Hana[3]

Abstract. In today's society the information technology (furthermore IT) is an important factor in successful management of companies. Great competition on the market requires access to correct information and flexible response to market changes in the IT area. Furthermore, investments by companies through financial management are important for projects that have potential to create new opportunities and increase the competitiveness of the company.

Keywords: information technology, strategy, competitiveness, financial management, information.

JEL Classification: M15, O32, L00

1 Introduction

In the current constantly changing business environment the success or failure of a company depends on the ability of its management to timely anticipate market opportunities, identify threats and, of course, solve possible problems (Janovská, 2012). Management of the companies across industries needs to reflect on general trends and evaluate business environment.

When positive as well as negative consequences of up-to-date development are identified timely they enhance the quality of business strategy and thus contribute to increasing the value of the company. The importance of strategic management emerged at the beginning of the 21st century as a result of the global economic crisis (Kutač, 2013). Those companies that had their strategic management already integrated in their business culture managed to get back on their feet much faster than their competition (Pitner & Ministr, 2015].

When making strategic, tactical and operational decisions, managers need to have sufficient and quality information (Danel, 2016). On the top

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of that they need system support so the information technology can process and evaluate the data and prepare the outputs adequately. It is therefore important for enterprises to cooperate with the academic sphere (Ministr & Pitner, 2014).

2 Information technology in management

Given the importance of strategic analyzes that can highlight potential opportunities and threats, the implementation of strategic analyzes should be an integral part of business activity of companies.

2.1 Application of IT in management

And that is probably why in the past the managers at various levels of decision-making have been asking for necessary system support, as mentioned in a number of articles, written by e.g. Houdeshel (1987), who wrote about the MIDS information system or Miniate (2012), who dealt with another example proving that the matter is still pressing and not only in the world of business or industry as the article focused on decision support system for management and technological planning of field hospitals.

The fact, that managers on various levels and in different spheres need information technology is supported by a research that can be found on www.cfo.sk (2013). It has also been discovered that up to 84% of the CFO respondents said they have been working more intensively with IT management since 2010. The reason for greater cooperation is due to the rapidly changing market and IT development.

Information technologies provide companies not only with new opportunities, but also improve their competitive advantage. Among the most important factors when using and applying IT in companies are speed and important information accessibility (for the company to be able to react promptly to any market changes) as well as investment into data analysis (the source of competitive advantage when the company transfers a lot of information pointing them towards new opportunities) and budget for current infrastructure maintenance.

2.2 Market and Business Intelligence Systems

At present, there are enough data sources, but the problem is primarily to organize them so that they become an input for strategic decision-making of the companies. Another problem is the number of well-known market and entity analyses that are often carried out in isolation and therefore the interpretation of their outputs is not in line with managers' expectations. They lack a crucial dimension - complexity - and therefore do not result in a combination of individual resources and practices to the desired synergistic effect.

Therefore, in line with increasing size and economic strength, research services companies have a wider and deeper understanding of the market, based on consultations and specific recommendations. However, this requires a systematic solution for continuous collection and analysis of information from multiple sources at the same time. This solution is provided by Market and Business Intelligence Systems (Crowley, 2015). They are based on knowledge of the market, business, competition, customers, consumers, and all the information is then evaluated in a context. They work with data from surveys, research, accounting, CRM databases, and so on.

When performing a state-of-the-art research, it has been found that there are many publications offering strategic management and strategic analysis, but usually in a form of a list of the most popular methods and analyses. For example, Berg (2015), who deal with strategic analysis, mostly tend to describe analyses rather than how to proceed with it. The main shortcoming of such publications is the small sophistication of individual strategic analyses and managerial methods, and very little practical quantification.

Top business managers are accustomed to processing highly aggregated and visual information. They do not have the time and personal capacity to read large texts. On the contrary, their main requirements in the decision-making process are clear, concise and, as far as possible, brief visual outputs.

3 Management support system

During the years 2015-2017 the research team from the Institute of Economics and Management Systems at the Faculty of Mining and Geology of VŠB-TU Ostrava (Kozel, 2015, Chuchrová, 2016, Kozel, 2017) aimed at creating system, model and software applications for the development of strategic and other supporting analyzes of industrial companies. The goal was to prepare a list of the most commonly used analyses, sort them into somewhat logical groups and categorize them.

3.1 Creation of the system

As previously said, many of these analyses have their outcome from available resources only in the verbal and very subjective form and that rather complicates the job of the managers. And for that reason researches everywhere, where possible, tried to design measurable numeric outcomes accompanied with graphics.

For these purposes the methods of operational research have been used together with complex statistical procedures in order to create analytic tool for industrial companies that could be used when implementing strategic and other consequent analyses. Designing this analytical tool has been done so it is possible to quantify all outcomes of individual analyses by question tables. These tables were then processed into visualized graphical outputs.

The frame operation of the model is shown in Figure 1.

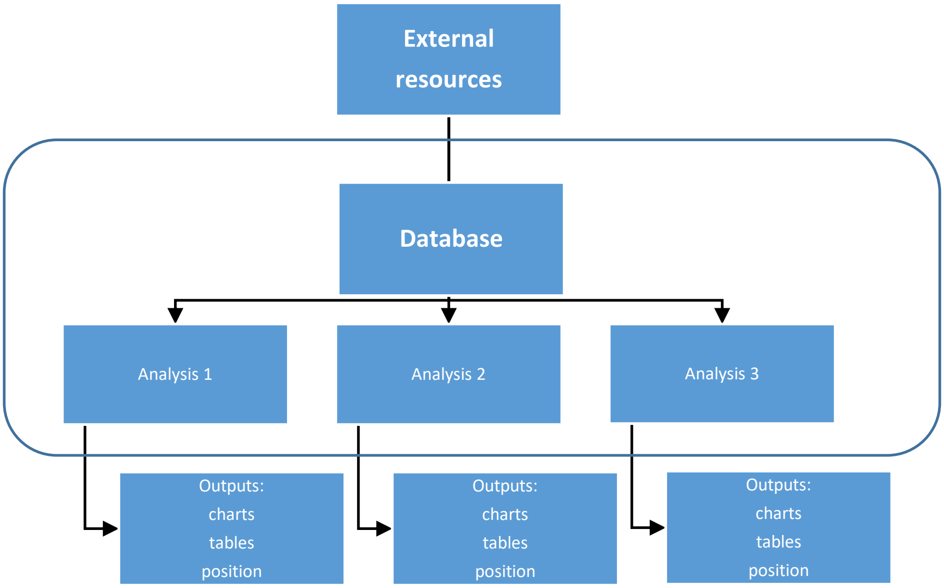

Figure 1 Frame operation of the model, Source: Chuchrová, 2017

The research team was looking for parameters that would allow clear specification and comparison of competition in the given industry, then standardize them and create a database of possible parametric indicators of the competition. The proposed system consists of input, source and output data.

3.2 Brief description of the system

Financial burden of the Market and Business Intelligence Systems, or other professional analytic alternative systems makes the companies look for other effective yet cheaper solutions. That was the reason why the research team when making the user-friendly software environment was looking for solutions suitable for everyone. And that is why the proposed system was created in MS Excel and programmed in VISUAL BASIC to produce a service that can be said to be available to all potential users.

Once the user starts the system, the homepage displays (Chuchrová, 2017). After pressing the button “Enter” the user gets to so-called initial table, where he defines the basic parameters of the evaluation. As soon as the user makes a decision on how to proceed, right before pressing the “Strategic analyses” button, he gets to the strategic analyses menu. In this menu he then chooses the area he wants to focus on in the next evaluation. From the list of analyses of the given business environment he chooses the analysis that will be used for the chosen evaluation. As soon as he goes through clicking on individual graphic elements of the analysis, the user gets to the input table where he is instructed on how to enter the parameters and so on.

As the system has been developing for more than three years, it now includes about fifty programmed partial analyses. In the analysis input screen, graphical outputs are generated after entering the parameters, which can be switched through the menu. The system works primarily with the following graphical outputs – above all position maps, portfolio charts and spider charts.

4 Conclusion

The proposed model is continuously tested on businesses in a real business environment, and is gradually complemented by further analysis to ensure that programmed analyzes match the needs of users, both in terms of content and user comfort.

It has been proved that the research team from the academic environment in cooperation with potential users can help to produce with relatively low expenses an analytic tool that can really help big industrial companies as well as small entities with lesser budget, whose needs are in the end quite similar as they also work with relatively large amount of data.

Acknowledgements

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A Management of Cloud Services in Social-Economic Systems

Olexander Beley[1,] Volodymyr Chaplyha[2]

Abstract. Building on the potential of integrated clouds, IT-professionals can turn from system administrators to intermediaries that coordinate access to additional services. The article looks at how they can create a flexible infrastructure and offer business units the choice of a whole suite of cloud services, rather than simply responding to specific individual inquiries on their part. The processes of making recommendations on the choice of partners and services, co-ordination of the used decisions, models and approaches to the construction of networks are considered. The technologies of implementation of the comprehensive directory of services based on the adoption of hybrid solutions within the framework of a well thought-out integrated network that includes models of security and management are offered. The introduction of a huge amount of cloud services can be a daunting task, which has led to the emergence of hybrid and integrated clouds. These clouds help manage the consumption of individual "components as services" and make integrated management decisions.

Keywords: integrated clouds, includes models, components as services, technologies of implementation.

JEL Classification: C63, D12.

1 Introduction

We live in a world of high speeds. Between the idea and its embodiment are not centuries or decades, but for years. New technologies overturn the world. These social and economic changes that are constantly taking place in society, experts have called the fourth industrial revolution.

It is considered that the first Industrial Revolution occurred after the introduction of mechanization in production. Symbol of the second was a conveyor assembly at Ford factories. The third was held under the slogan shift Centers of manufacturing value added in sales and design. Now, more

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resources need to have to come up and sell a new product than to make it (Foster, 2008).

"Industry 4.0" is characterized by the full penetration of the Internet and IT-technologies in all spheres of human life and socio-economic systems - from life to production. "Industry 4.0" refers to the use of cloud computing, the Internet of Things, and Big Data in the production, when all elements of the system are interconnected via the Internet and can independently find ways to reduce costs (Lee, 2014).

The director (or owner) of a modern enterprise with the help of only one smartphone can receive complete information on optimization of production processes. The enterprises themselves will create products tailored to the needs of the individual customer, but this does not happen due to the increase in cost of production processes. By connecting all the elements through the network, it becomes possible to find the optimal (low-cost) ways to execute orders. This will promote the rational use of natural and technical resources, maximally effective energy conservation, recycling all waste and obtaining new products, raw materials or energy from them. That is, we can confidently speak of a fundamentally new paradigm of management of socio-economic systems: "Repair instead of a new purchase, lease instead of ownership" (Drath, 2014).

For the first time at the state level, the "Industry 4.0" program was adopted in Germany in 2011. It was about the strategic program of economic development of the country. However, now China is the leader in robotizing production. In 2014, Chinese President Xi Jinping delivered a speech at the Chinese Academy of Sciences on the upcoming revolution of robots, which initially transforms China, and then the entire world.

One of the most important and most developed areas of "Industry 4.0" is cloud technologies. We use cloud technologies almost every day. This can be an online service for sending email, editing documents, watching movies or TV programs, listening to music, playing games, or storing images and other files. The first services of cloud technologies began to be used only for ten years, and now they are using hundreds (thousands) of socio-economic systems, ranging from small start-ups, government agencies, non-profit organizations and ending with global corporations.

In February 2016, Google merged its cloud services under the Google Cloud brand. From now on, Google services include: Docs, Gmail, Presentations and Tables, Google Maps for Work, Google Cloud Platform, Google Search for Work and Chromebooks. The company also re-branded Google Apps for Work: now the service is called G Suite (Aiken, 2011).

In July 2016, Google acquired the company Anvato, the creator of a software platform that provides the ability to encode, edit, publish and securely distribute video content, and launched on its basis a video editing service in the Google Cloud structure. On October 18, 2016, Google announced a new platform called Nomulus Open Source Infrastructure, which is available to everyone. The Nomulus platform allows you to process an unlimited number of TLD registries in a single instance that is shared using a horizontal scaling, and includes Extensible Provisioning Protocol (EPP), WHOIS, reporting and trademark protection features (Ben, 2016).

The research of specialists has shown that by the end of 2016, the volumes of the world market of public cloud services grew by almost 17% compared to the previous period, which in monetary terms is about 208 billion dollars (Christy, 2017). The previous year's figure was at $ 177 billion. The most positive dynamics can be seen in the IaaS segment, with revenue rising by almost 42% compared to 2015. Still, the market leader remains the SaaS segment, where revenues amount to approximately $ 38 billion from the overall figure. Analysts believe that in future, innovative technologies and the introduction of cloud services will allow socioeconomic systems to save at least 15% of the budget allocated to IT.

2 Types of cloud technologies and services that they provide

The concept of cloud technology combines many concepts: infrastructure, software, platform, data, workplace, etc. The main function of cloud technologies is to meet the needs of users in remote processing of data. Under this concept, thanks to the special user interface supported by the network software setup tools, virtual objects are formed in adaptive information communication networks. Such objects are virtual platforms with a situational component of a logical network infrastructure. Such a temporary open flexible architecture, which in its structure and the time of its existence corresponds to the personified needs of the user, is formed and used by cloud technologies (Trevor, 2012).

The main characteristics that determine the key differences in cloud services from others are: self-service as needed; universal access to the network; grouping resources; flexibility and so on (Hewitt, 2008). The combination of such features greatly diversifies the capabilities of users, allowing them to receive a variety of services. The openness and accessibility of services is increased by the fact that such services can be supported by various class-based devices: from personal computers to mobile phones. In turn, this is in line with the main principles of open education: freedom of choice, invariance of learning, independence in time, extra-territoriality, humanization, internationalization, economy, mobility, equality of access.

The current expansion of the software cloud (Software a Service - SaaS, Platform as a Service - PaaS, Infrastructure as a Service - IaaS) is not sufficiently flexible to meet a variety of consumer requirements regarding composition and service quality (Aiken, 2011). In the future, "clouds" will collect various services from different places and combine them together. It's hard to say that the three-tier cloud computing model will change, but Gartner analysts believe that cloud computing will ultimately lead to the Everything as a Service concept: Compute aaS, Storage aaS, Data aaS, Data base aaS, virtual desktop aaS.

According to the requirements and types of ontological description of SaaS (Software as a Service); Figure 1 shows three main levels of structure and software components that require a detailed ontological description in accordance with the above requirements.

Other services also require ontological description of the component and taxonomy, which will lead to the formation of a relevant "virtual cloud", which consists of various services of different providers of computing clouds. Standardization in the field of cloud computing can provide an opportunity to avoid uncertainty and confusion. Standardization will allow us to agree on a common terminology, to identify those technologies, the use of which is mandatory for the creation of joint decisions, to put suppliers in a certain framework, which is also important for security in this area (Takahashi, 2010).

The most serious work on the standardization of cloud computing has been done by the international IEEE organization in the list of standards and specifications used to create common cloud systems, as well as basic information and recommendations for interoperability and data transmission in cloud computing.

When it comes to cloud technologies, it often means public cloud, which has undeniable advantages: economy - the user pays only for real time, resources, services; no need to buy software licenses, organize and maintain their own servers, hire experienced administrators.

The following are the disadvantages of public clouds: the integrity of the processed data, vulnerability and privacy breach (Furht, 2010).

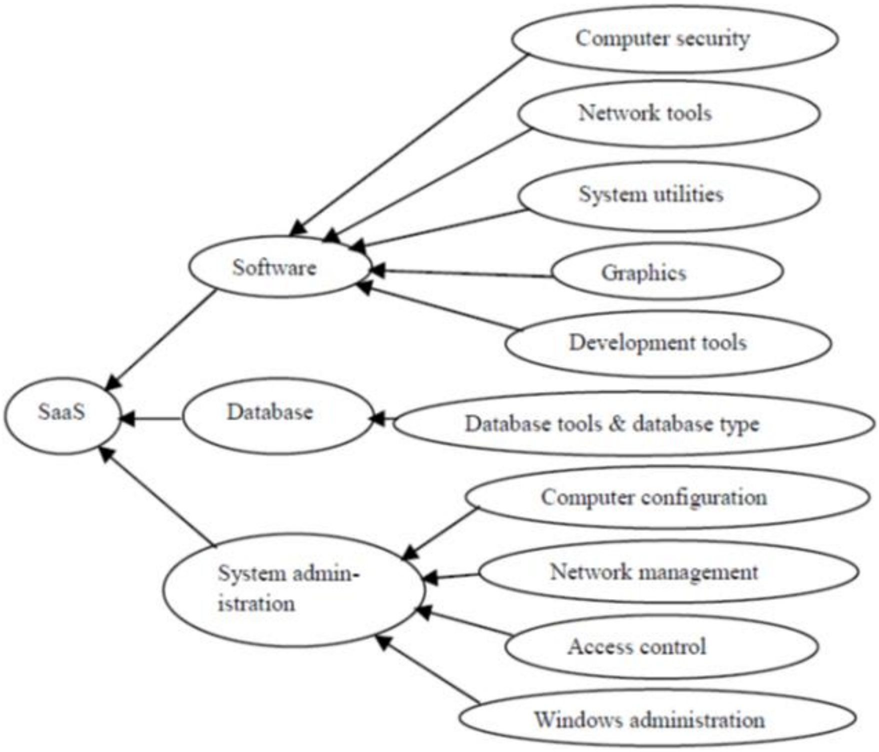

Figure 1 Three main level structure "Software as a Service", Source: own.

In a private cloud, all data and user usage remain inside the system. The problem is that only large companies can afford the organization of a private cloud, since the infrastructure can be quite expensive and require highly skilled administrators.

Hybrid clouds represent the introduction of cloud computing, in which one part of the system is placed in a public cloud (based on the date of the cloud provider's centers), and the second part is in a private cloud (on the servers of the company itself). A hybrid cloud is not an independent type of cloud computing, but only points to the close integration of public and private cloud systems.

Such integration is possible when making a backup system in a public cloud, or vice versa - when backing up data from public to local. Another option for using a hybrid cloud is to install applications on the internal servers of the company with the lease of additional capacity in a public cloud of a third-party vendor in case of increased load (Tvrdikova, 2016).

To move to the cloud, you need to rebuild the architecture of the computer network of the socio-economic system, as well as - the approach to business processes and management. The need for this restructuring is the driving force behind the new approach to information technology: "IT as a service".

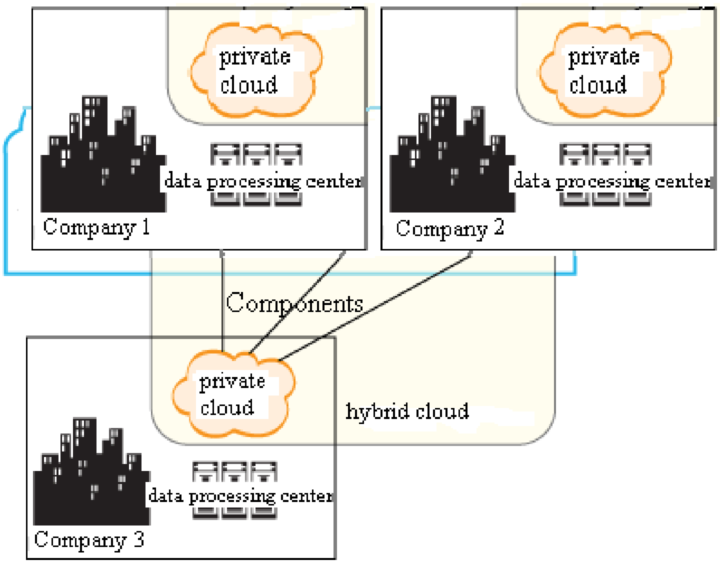

Figure 2 "IT as a service" provides a business-focused partnership, Source: own.

When using the "IT as service" approach between the IT department and the production units of the company, close partnerships are established. The IT department, in collaboration with the production units, provides business processes and decision making to achieve the most efficient and effective service to improve production performance and increase the profitability of the enterprise.

In the hybrid cloud, intelligent workloads serve as a means to eliminate constraints and isolation of used software. They allow the hybrid cloud to provide the same level of access to controls, security, control and compliance with regulatory requirements, both in physical and virtual systems.

3 The use of intelligent information systems in the management of commercial enterprises

We propose the process of making a management decision to implement in DSS Cloud (Cloud decision support systems) based on simulation, which will allow remote complex simulation "on demand". A manager from his working computer or tablet gets flexible access to a powerful database of math, software and hardware distributed in the form of services (services, works) through standard interfaces. All DSSs can be broken down by end-user type into three groups: DSS for managers, DSS for individual industries, and simulations for large enterprises.

DSS Cloud on the SaaS model, like all modern web applications, is built on the model of three-tier architecture (Figure 3) by allocating three logical

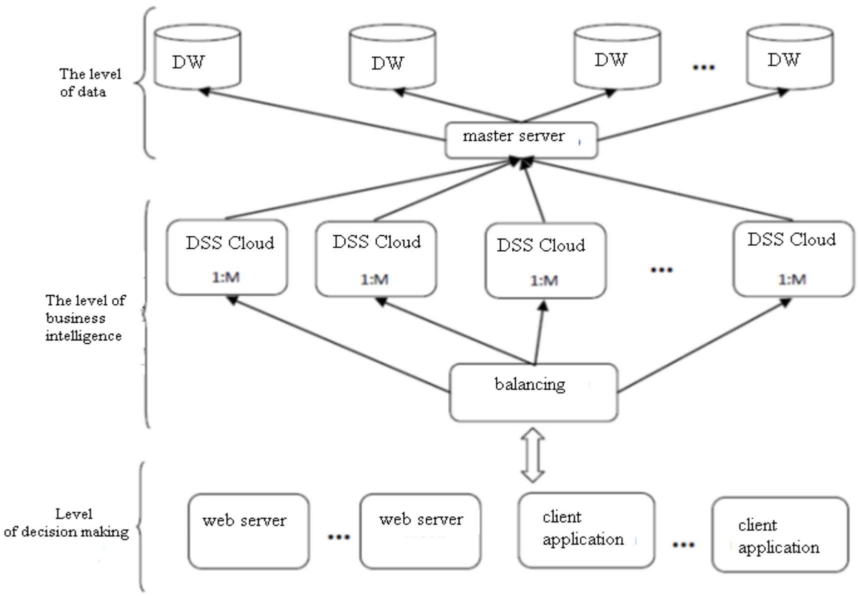

Figure 3 DSS Cloud's Decision Support Systems Architecture, Source: own.

levels of the application - the level of decision making, the level of business analysis and the level of data. Each layer of DSS Cloud is physically separated and occupies a separate part of the data center.

The core of the DSS Cloud program exists at the level of business analytics and horizontally scales to a multitude of virtual machines. The application is based on the principle of "Multi-Tenancy" and serves a large number of users (1: M).

The data layer is a DW, consisting of a DW server cluster and a master server that performs the distribution of data between DW nodes. In addition, the master server implements the standard interface to DW, invariant to its hardware and software features. Data in DW stores the following types - information about the management decision, scenarios (model) and simulation results, as well as user benefits that are used in particular for configuring the Web application interface (Ministr, 2014).

The presentation level forms both an accessible web interface and various additional client applications that use the functionality of DSS Cloud through standard interfaces. Standard interfaces between levels are implemented in the form of generally accepted Web services (SOAP) and REST-services (HTTP, XML).

Note that, despite the fact that SOA is often implemented in the form of web services (and REST services), the use of web services alone does not allow building service-oriented solutions, if not followed by SOA principles.

In the application of DSS Cloud according to individual decision-making steps, we can distinguish the following services: simulation service; distributed synchronization service; high performance simulation service; experiment planning service; optimization service; service of mathematical calculations; service analysis and statistical processing of results; graphic calculation service (2D, 3D, stereo-3D); service interaction with DB / DW.

To integrate services into a single cloud-based application, the enterprise service bus template ESB (Enterprise Service Bus) is used, which is a special way of building SOA solutions, in which the services included in the application are deployed around the service bus, which forms the system of their interaction. In addition, the ESB also performs the load balancing function. Customer access to DSS Cloud functions is via the SSB (Simulation Service Bus), which serves as the point of entry for cloud application (Ministr & Pitner, 2015].

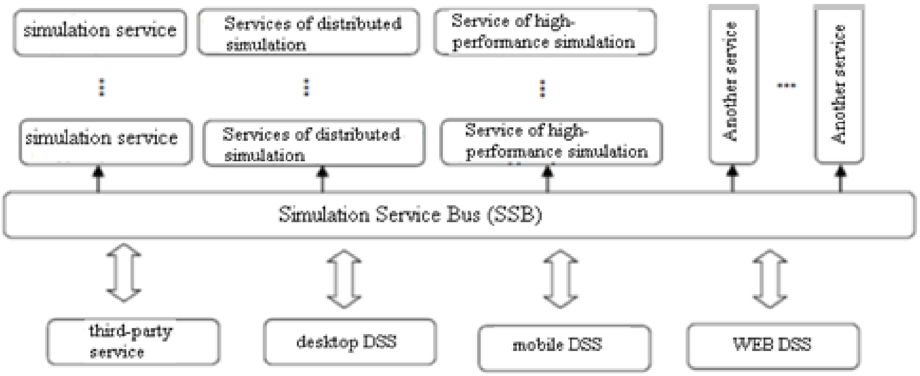

Figure 4 Service-oriented architecture of DSS Cloud, Source: own.

According to Figure 4, the service bus is a link between client applications and DSS Cloud business intelligence, and dispatch requests from different types of DSS to relevant simulation services or services for other stages of simulation research. SSB also facilitates the real-time data transfer (PMV) between cloud-based applications, management modeling, and decision-making.

SOA allows you to consider DSS Cloud as the only application with multiple instances of load balancing services.

Proceeding from the axiomatic cloud theory of Joe Wienman (Wienman, 2011), we propose some mathematical description of DSS Cloud, which is given below.

Under the cloud is the structure $(S, T, G, Q, \delta, q_0)$ that satisfies the five formal axioms: 1) community; 2) independence from location; 3) permanent connection; 4) communal services; 5) provision on request.

In our opinion, the cloud structure $(S, T, G, Q, \delta, q_0)$ contains the following elements:

1) space $S = (M, \lambda)$- metric space with metric λ: $M \times M \to R_0^+$;
2) time $T = (T_S, \Sigma, \tau, <)$ - space with degree and relation of strict order, where T_S is the infinity of time intervals, Σ is the σ-algebra on T_S, τ: $\sum \to R_0^+$is a measure on Σ, < and the ratio of strict order to T;
3) the network $G = (V, E)$ is a simple graph without hinges and multiple edges, where V is the set of vertices, E is the set of edges, $E \subseteq V \times V$ i $(u, v) \in E \Rightarrow (v, v) \notin E$ & $(v, u) \notin E$;

4) $Q = \{q_0,\ q_1,\ q_2, \dots\}$ is the set of managerial decisions, with each $q_i = R_{q_i}, A_{q_i}, L_{q_i}, P_{q_i}$, where $R_{q_i}: V \to R^r$ is a resource function, $A_{q_i}: E \to R^r$ is a function of resource allocation, $L_{q_i}: V \to M$ is the placement function, $P_{q_i}: E \to F$ is the price function, where F is the set of functions $F = \{f \mid f: R^r \times R_0^+ \times R_0^+ \to R\}$;
5) $\delta: T \to Q$ - display of the transition;
6) $q_0 \in Q$, де $q_0 = \delta(t_0)$.

In our case, space S is a metric infinity, elements of which are points on the Earth's surface, and metric is the network delay between the points. This space is used to determine the physical location of DSS Cloud components - datacenters and users. The point in $S \subseteq R^2$ is given by an ordered pair <*Latitude, Longitude*>.

The infinity of T_s in the definition of the space $T = (T_s, \Sigma, \tau, <)$ is the times in UTC with a second accuracy: {"Apr 23, 2012 13:05:00", "Apr 23, 2012 13:05:01", "04/24/2012 00:00", ...}. The algebra Σ is a nonempty infinity of subsets T_s, closed with respect to the combinations and additions. The map τ is a measure of the length of Lebesgue in space T.

The network graph $G = (V, E)$ defines the cloud topology: the vertices determine the available or requested resources, arcs - the possible ways of moving resources to meet demand. Each vertex is assigned a vector of resources with R^r, each dimension of which characterizes a separate resource, with a negative value indicating the need for resources.

The DSS Cloud topology is a two-component graph with two types of vertices - "Suppliers" and "Consumers" with resource vectors corresponding to R_0^- and R_0^+. From $(u, v) \epsilon\ E$ it follows that u is a precursor v, and v is the successor u. Denote by I_v (Inputs) an infinite set of all vertices of the precursors v, that is, all of u for which $(u, v) \epsilon\ E$, and O_u (Outputs) is an infinite set of all successor vertices u, that is, all v for which $(u, v) \epsilon\ E$. Accepting for a positive direction of movement of resources, the direction "from manufacturer to consumer," we will find that I_v is identical to "Suppliers", and O_u - "Consumers".

At each moment of time, the cloud structure is uniquely determined by its state$q \in Q$, which includes information about the supply and demand of resources at each vertex, distribution of resources (demand satisfaction), vertices location and price policy.

Each vertex corresponds to the top five <R1, R2, R3, R4, R5>, where R1 is the calculated computing power for simulation (in units of equivalents), R2 is the storage memory for the results (in gigabytes), R3 is the computing power of supercomputer modeling, R4 - computing power for distributed simulation, R5 - computing power for other services.

Thus, Figure 5 shows four DCs with available resources and 4 clients with resource requests: DC1 → Client A, DC2 → Client B, DC3 → C and DC4 Client → Client D.

In addition to resources, each vertex is matched to its physical location at the point M, which in the case of mobile clients may vary from time to time. The cost of using cloud resources for each arc is defined as $p \cdot \alpha \times \tau(t)$, where p is the price vector, α is the distribution of the arc resources, "·" is the scalar product of the vectors, τ (t) is the length of the determined interval measure τ.

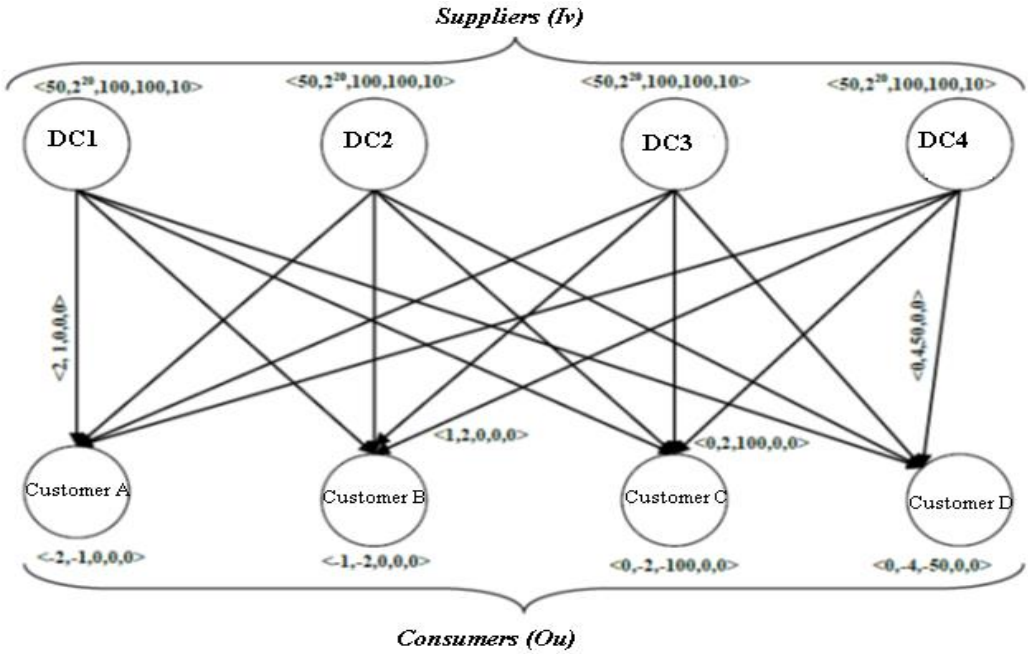

Figure 5 Network descriptor of the cloud structure of DSS, Source: own.

The task of cloud computing is to meet the demand for resources, and if each consumer can use resources from only one supplier, then the task of the cloud management decision support system is solved.

4 Conclusion

Given the situation in the market in Ukraine, one can safely say that there is simply no large amount to buy software and the various equipment in small and medium business. The solution to this problem is the use of cloud services. Working with clouds allows you to reduce the real cost of buying and maintaining cloud services. You need to pay only for what you really use. In the field of cloud solutions today there is a lot of delivery options. The manager of any enterprise can choose a convenient and economical option for themselves based on their capabilities. For example, you can rent cloud services when you pay monthly only for using solutions, and you as a client need only a workplace with access to the Internet. Working in the cloud is a high mobility, so you can work anywhere, if you have access to the internet. This option allows you to work remotely and with minimal expense. Data protection in the cloud is very high, the information is stored and transmitted in encrypted form and has several levels of encryption. More and more small and medium-sized companies are starting to use cloud solutions in their business, because it allows them to automate the process of their work and save money on the introduction of IT.

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Three Challenges of Digital Transformations for Vendors of ERP Systems for SMBs

Aleš Eliáš[1]

Abstract. Digital transformation is one of the major drivers for disruptions in business models used by vendors of ERP systems for SMBs. It brings new demands on flexibility, availability and security on their products and services. ERP system is not competitive advantage of a SMB anymore. Integrated ERP system is must have component of successful business and SMBs have increased expectations of added value that the ERP systems brings. Hence, vendors of ERP systems for SMBs have to adapt their business models and value proposition to fulfill this demand and so to succeed in the competition with other products.
In this article, I would like to summarize three challenges that have to be addressed by vendors of ERP systems for SMBs to adapt their products and services to the new digital world.

Keywords: digital transformation, postmodern ERP, intelligent ERP, SMB.

JEL Classification: L86

1. Introduction

Satya Nadella (CEO at Microsoft) said at Partner Conference in Toronto 2016: "Businesses of all sizes in every country will not just use digital technologies, but become digital companies themselves. Each company is attempting to digitally transform to achieve the same four outcomes – to engage customers, empower employees, optimize operations and transform products."

This announced new digital transformation has deep impact on very foundation of ERP systems for SMBs. Vendors of these systems has to adapt their product strategies to address the new demands of digitalized companies:

- ERP system has to be seamlessly integrated into the digital ecosystem of a company. ERP system is not a monolithic package working as a silo but one of the key components of the broader ecosystem. ERP system has to be **postmodern**.

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- ERP system has to be infused with **intelligence** to assist users with fulfilling their daily task quickly and effectively and to provide predictive notifications to avoid potential issues.
- ERP system had to deliver comprehensive solutions as part of **standard** package but has to be **flexible** to adapt to specific needs of a company

2. Postmodern ERP

"Postmodern ERP represents a fundamental shift away from a single vendor megasuite toward a more loosely coupled and federated ERP environment," said Carol Hardcastle, research vice president at Gartner. Vendors of ERPs for SMBs have to redesign their solution to reach this target.

Architecture

Monolithic ERP solutions has to be transformed to suits of solutions providing required services. Loosely coupled components of the suits have to be integrated by strong backbone layer that enables further integration with third party products and services. The integration backbone has to provide rich set of APIs to integrate postmodern ERP with market leading products providing specific services as well as to build ad hoc integration with any required system.

Workflows

Workflows in postmodern ERPs have to be built around person and encompass anything that the person needs to do in the context of their role. It has to deliver end-to-end journeys that seamlessly span across all system people work on daily basis. Vendors of ERPs for SMBs have to acquire good understanding of standard processes and specific systems relevant to various industries and offer solution packages that are supporting the end-to-end journeys. Standard workflows have to be built into the ERP systems out of box and augmented further by integrating with other system relevant for respective industry (e.g. office suites, specific logistics solutions, mobile apps, social networks etc.).

3. Intelligent ERPs

Traditional ERP systems are based on the concept of standardized business processes performed routinely by end users. User transactions are producing data that is afterwards analyzed with standardized tools to optimize daily operations or to support strategic decisions. The processes and tool are rigid and require huge number of routine steps to be performed on daily basis by ERP system users.

Intelligent ERPs should take over routine tasks in the end-to-end business process model that are currently performed by humans. This particular change is driven by an ongoing need to reduce operational cost by increased effectiveness of the organization. Intelligent ERP can release users from repetitive tasks and empower them for non-routine, analytical and creative tasks focused on customer service and satisfaction.

SMBs hold wealth of structured data locked in their ERPs. Additionally, in last five years organizations encountered explosion of unstructured data that they capture without a clear approach on how to properly use it. These two sources are valuable asset but organizations struggle with transforming data in meaningful information, decisions and actions.

Intelligent ERP has to provide solution that leverages AI capabilities to manage and analyze structured and unstructured big data and that delivers analytics solutions that can provide information with a user-friendly experience.

4. Standardized and flexible ERP

Vendors of ERPs for SMBs are encountering saturation of market of these systems as well as strong price competition from other players on the market that reduces margins in the ERP business. At the same time, overall complexity of expected solution is growing. This vicious combination of decreased margins and higher complexity requires ERP systems that fit this business environment.

Rapid implementation

ERP systems have to be delivered as packages enabled for rapid implementations. This first of all requires strong orientation and knowledge of respective industry that is built in to the provided solution. ERP system have to fit our-of-box all standard needs of potential customer; there is no room left for extensive customer tailored customizations.

EPR systems have to provide tools for self-service implementation that can decrease costs of implementation to acceptable level. This includes e.g. setup wizards, standardized data migration toolkits ready to consume data from major competitive products, built in process-oriented helps etc.

ERP systems have to be intuitive and easy to understand without extensive training. This requires redesigning of UI/UX to shift focus from data collection to intuitive workflows as well as using understandable terminology and providing context sensitive user assistance.

Upgradability

ERP systems have to keep up with rapid changes of technologies and market requirements. This requires regular updates of the solutions similar to mobile applications or even operating systems.

Foundations of ERP systems have to be redesigned to enable effective upgradability of the product and also every enhancement of and ERP has to be designed with consideration of future upgrade process.

Flexibility

ERP systems have to be offered as standardized packages. But at the same time they have to offer options how to tailor the product to specific need of a customer without braking upgradability and long term maintainability.

To achieve this ERP systems have to be based on platform that provides this kind of flexibility:

- Customization of UI
- Adoption or extension of internal workflows
- Integration with third party products via standardized APIs

5. Conclusion

New digital transformation brings major challenges to vendors of ERP systems. To address them the vendors have to rethink and redesign the very foundation of their business and products to deliver complex but affordable solutions that will support their customers in the new digital world.

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The Necessary Conditions for the Implementation of the USOS System at the Cracow University of Economics

Jan Madej[1], Paweł Konkol[2]

Abstract. The aim of this article is the presentation of requirements that Cracow University of Economics has to meet to ensure successful implementation of the USOS system (University Study-Oriented System). Although these prerequisites refers mainly to organizational aspects, it is not an easy process to comply with them. Hence, the important initial step of the USOS implementation is the prior requirements recognition with the acceptance by the University Authorities.

Keywords: information systems, IT project management, university management, integrated information systems

JEL Classification: C 80

1 Introduction

Cracow University of Economics (CUE) is currently running the process of implementation of IT system for the management of study activities (USOS - University Study-Oriented System). The choice to implement USOS has been preceded by the analysis of the University's requirements and IT systems available on the market. The new unit of the University, Department of Development and Maintenance of IT Systems (DRUSI), has been established to coordinate implementation process. Both authors work for that Department and have participated in its activities since the very beginning.

DRUSI staff prepared analysis of documentation concerning previous tender offers referring to the implementation of IT integrated system at Cracow University of Economics, got acquainted with market offers of IT solutions for higher education, made contacts and had many discussions and correspondence exchange with representatives of companies and IT departments of other universities. DRUSI organized also many meetings and

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presentations to gain detailed information on solutions offered for higher education institutions (HEIs).

As the result, the recommendation report has been produced listing USOS advantages and prerequisites for its implementation.

The aim of this article is to present these preconditions and requirements that have to be complied with by a university to make USOS implementation possible. Although these prerequisites refers mainly to organizational aspects, it is not an easy process to follow. Hence, the important initial step of the USOS implementation has been the prior requirements recognition with the following acceptance by the CUE authorities. The necessity of this acceptance should be underlined, taking into account the fact that this is not the first attempt CUE takes to implement IT integrated system. The first one was taken from 2012 to 2015 without achieving all the goals that had been planned. The next tender in 2015, focused on further full realization of the plan, was not resolved. As the consequence, the University has been obliged to take another attempt of the implementation of integrated system based on its own resources or external company.

2 University demands and decision about the system

2.1 Demands of the University

Starting point of DRUSI activities has been the description of basic University requirements concerning purchase and implementation of IT systems. The list of the main demands includes these system's modules which have not been provided in the frame of the last implementation project (the tender from 2015 referred to them), i.e. the modules listed in the Terms of Reference of 2015 tender (*Dostawa i wdrożenie …*, 2015). In general, this means that the complete integrated system implementation at CUE misses still three modules:

- *Studies* – which should cover overall course of study. In particular, the module should enable: definition of teaching offer, recruitment of external candidates, thesis repository service, diploma and supplement printing, incoming and outgoing mobility service, allocation and reporting of teaching activity, posting of study fees, students' proposal service, management of study groups, diplomas issuing, scholarships service, student surveys, integration with library system, registry of study documents, service for Disabled Office, graduates professional career tracking;

- *Research* – should provide service for all processes related to academic achievements of staff and units. This includes service of research project, academic activity and promotion process, academic awards, domestic and foreign research mobility, payments for Polish and foreign publications, membership fees, collecting information about scientific and didactic achievements of staff and departments, promotion procedures, habilitation procedures, title of professor conferring, sabbatical leaves, academic scholarships, honorary degrees, international cooperation, interim staff assessment;
- *Delegations* – providing service for local and foreign staff mobility, in particular installment calculation, mobility costs planning, clearing procedures, individual budget plan controlling, filtering of staff mobility data (reports, statistics etc).

In addition, these modules should be integrated, in the field of data exchange, with the ERP system (Egeria system of the Comarch company) which is used by CUE. This was also one of the criteria included in the analysis of all systems.

2.2 System selection

DRUSI has chosen following systems out of the solutions for university management available on the market:

- *Uczelnia 10 studies handling system* of the Partners in Progress Company[1];
- *Bazus* system of SIMPLE S.A.[2];
- *USOS system* with additional applications and services of the MUCI consortium[3].

The analysis of these systems led to the recommendation for the system selection, listing its advantages and conditions for its implementation (*Rekomendacja…*, 2016).

[1] https://pcgacademia.pl/images/docs/University_10_Student_Information_System.pdf
[2] http://www.bazus.pl/
[3] https://www.usos.edu.pl/about-usos

DRUSI recommendation was as follows:

- Implementation of USOS system, taking advantage of its subsystems depending on the University needs;
- Individual development (customization) of applications, which are not included in the USOS subsystems (research module and staff mobility module).

This recommendation resulted from the review of the University needs and capabilities and functionalities or features of the solutions concerned.

The table below presents the set of the main features of the selected systems in the context of the University needs.

Table 1 Comparison of systems: USOS, Uczelnia 10, Bazus, Source: own.

Feature of the system	**USOS**	**Uczelnia 10**	**Bazus**
Number of implementations of study module	48	59	44
Study module (compliance with CUE requirements)	yes	yes	yes
Staff mobility module	under development	no	no
Previous integration with Egeria system	few integrations between systems	no	no
Access to technical documentation (code, database) documentation)	yes	no/limited	no/limited
Possibility to expand system by CUE	yes	no	no
Possibility of implementation without tender	yes	no	no
Estimation on implementation costs (2 years period)	0,3 mln EUR	0,75 mln EUR	0,82 mln EUR
Estimation on maintenance during next 2 years	250 tys. EUR	75 tys. EUR	50 tys. EUR
Estimation on system development during next 2 years	included in the maintenance costs	200 tys. mln EUR	200 tys. EUR

The main advantages for of the USOS solutions were listed as follows:

- large and increasing number of the USOS implementations;
- popularity among users: students (over 50% students of Polish public universities), administrative and scientific staff;
- comprehensive character of the system providing the reach set of affiliated applications (over 20 services) and large number of functionalities for the cooperation with external services and open systems (Register of Secondary-School Graduation Certificates, Open System for Antiplagiarism);
- affiliation to nation-wide unique project which integrates HEIs facilitating better cooperation between academic communities, enhancement for joint projects and even stronger lobbying at the ministerial level;
- independence from external company in the field of implementation and maintenance;
- lower costs of purchase, implementation and maintenance;
- purchase of the system without the necessity of tender, providing financial and time savings;
- flexibility of the implementation in the field of time, pace and scope;
- access to the source code of the system and structures, schemas or relations of database;
- access to detailed technical documentations of the system
- possibility of adding new module (provided having technical staff with appropriate skills);
- access to various external support (from MUCI consortium or other universities);
- system compatibility with legal regulations, consistent interpretation of rules and fast modification of the system without additional costs.

DRUSI recommendation has been analyzed and accepted by the University authorities. However, since the very beginning, the process of implementation encountered organizational difficulties referring to the requirements stated in the recommendation document.

3 Necessary conditions for implementation

Recommendation stressed that the main USOS implementation difficulty is the fact that all tasks (analytical, implementation, coding, integration with other system, development and maintenance) have to be accomplished by the University itself which requires in particular:

- highly skilled and well paid IT staff;
- integration (by University itself) between new solutions and Egeria system in the frame of cooperation with Comarch Company;
- adaptation of some processes (organizational solutions) to the system requirements which may be opposed by certain University departments.

Hence, efficient and successful implementation of USOS system should be based on several conditions listed below. The list is the result of meetings and discussions with IT representatives from other universities and analysis of USOS documentation (Czerniak, Mincer-Daszkiewicz, 2017). Implementation as the whole should be prepared very carefully, taking into account the fact that in general many implementation of IT projects fail in the field of finance, time and scope or functionalities. One of the reason refers rather to week points in the project management process than IT technology itself (*The challenge…*, 2004). In this context, British National Audit Office points at the lack of clear link between the project and the organization's key strategic priorities or too little attention to breaking development and implementation into manageable steps (*Delivering successful…*, 2006). It should be added that in case of IT integrated systems of management and their impact on organizations sometimes similar effects, seen from different angles, are reported as positive or negative, depending on the character of the organization (Soja, 2006). One of the common example may be personnel reduction which is treated as the positive or negative effect, depending to whom a survey addresses its questions.

The main implementation requirements include:

- leadership of the implementation;
- coordinators in various university departments;
- relevant IT staff;
- adaptation of university rules and legal documents;
- bearing of necessary costs.

The main characteristics of these requirements involve following aspects:

Responsibilities of the leader:

- active involvement in the process of implementation;
- support for the implementation team;
- enforcement of necessary organizational adaptations (revision of regulations and internal university rules).

The leader should have a high position in the CUE hierarchy with respect among academic community of the University (if possible, coming from present or past authorities at the University or Faculty level).

Nomination of coordinators of implementation in various departments and units. It should involve persons with a deep understating of processes at the Faculty or department level. They will focus on:

- cooperation with implementation team in the adaptation of processes for the new system;
- cooperation in configuration, customization and migration of data to the new system;
- transfer of knowledge and skills concerning new system among staff of their respective units.

It should be emphasized that coordinators do not have to be IT professionals with a specific technical knowledge.

IT staff with relevant knowledge and skills. It means new staff employment in DRUSI and close cooperation with IT Center of CUE.

According to the assumptions, implementation requires 5 IT full time equivalent position (analyst/implementation specialist – 2,5 full time equivalent, programmer – 2 full time equivalent, database administrator – 0,5 full time equivalent) and assistance provided by CUE IT Center in such tasks as servers installation, configuration and maintenance or installation and maintenance of workstations. As the result, the list of DRUSI employees should be extended by one programmer, one IT specialist (to work on the system analysis and implementation), one database administrator (0,5 full time equivalent).

Adaptation of university rules and legal documents is a process, which should run alongside the progress of implementation. In the implementation of a particular module the analysis of processes and relevant documentation should be undertaken (with participation of coordinators) with the following comparison with functionalities provided by the new system. It should result, if necessary, with recommendation of adaptations and new solutions to implement.

Implementation of the new system provides an opportunity for the analysis of current information processes (and organizational solutions) and their optimization through eliminating redundancy or inconsistencies. Possible objections within departments should not be the explanation for concessions or abandonments in the system implementation. The role of the leader and coordinators should be to take actions which will facilitate adaptation of processes to the USOS requirements.

Bearing necessary costs mostly means expenses concerning membership in the MUCI Association, which is responsible for the USOS development, expenses related to IT infrastructure and data software, USOS annual fee, salary costs of IT professionals etc. However, it should be emphasized, that the costs of USOS implementation significantly differ from these concerning the purchase of a system on the market. This is because USOS own implementation relates mostly to salary costs of IT professional team which, after implementation process, will continue to maintain and develop new system together with other IT solution at the University. Expenses concerning these salaries should be seen as the investment in the IT human capital of CUE.

At present, implementation is in progress (since Januray 2017). Tasks are completed in accordance with the project schedule. However, from the very beginning there some difficulties concerning following aspects:

- nomination of the project leader;
- employment of IT professionals.

Bearing in mind significant responsibility of the implementation leader many CUE representatives refused to accept this position. Eventually, it was the Vice-Rector for Communication and Cooperation who has accepted the challenge and presented strong involvement in the whole process. As the representative of the University Rector’s body she has the appropriate authority for this position.

Problems with finding right staff for DRUSI department mainly was the consequence of the salary level offered by the University. It is hard for CUE, being the public institution, to compete with private ones on IT professional wages.

Nevertheless, after the long search, University managed to find little less experienced but well promising staff together with programmers from IT students community.

The next requirements – adaptations of University regulations and providing financial sources for implementation costs – are met on a regular basis. Although it cannot be stated that there are not any problems, the difficulties are still at the acceptable level.

On the other hand, looking at the progress of the implementation, close future may bring serious problems caused by the necessity of adaptations in CUE regulations and rules, since the legislative process at the University takes usually much time.

In the authors opinions, the most easily has been the *nomination of coordinators* for implementation process which are responsible for cooperation with DRUSI. Previous cooperation with them has been very satisfying, though the scope of it is quite narrow. It will be definitely expanded in future and the level of the difficulty will also increase.

4 Summary

Selection and implementation of information system in every organization is not an easy task to perform. The situation at Cracow University of Economics is further complicated due to the fact that the previous implementation failed so the time and effort of many persons devoted to it has been – in their opinion – wasted. It has definitely decreased confidence in external companies offering services and solutions of this kind. These both factors – together with the necessity of system implementation and obligation to finish the previous project – are not good background for the present attempt to implement new IT system.

Recommendation to implement USOS has been preceded by the review of solutions available on the market, ended up with USOS being the system with the longest list of advantages.

However, it should be mentioned that the method of USOS implementation is different than in case of other two systems mentioned above. The main difference is that the university itself holds the sole responsibility of the process, in particular when completing implementation tasks only with its own resources. Hence, this is very important to meet the requirements which may decide on success or failure of the implementation.

IT department with appropriate position in the University hierarchy, having support from the leader and assistance of coordinators to facilitate necessary adaptations in the organization of information processes, these are the requirements that have to be met during USOS implementation.

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Critical Success Factors of ICT-based Organizational Creativity Support

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Abstract. This study provides valuable information on the concept of organizational creativity and the role of ICT in its growth. It also investigates critical success factors to development of ICT-based organizational creativity. Based on the above, the paper then presents a survey among 232 polish organizations to demonstrate the chances and the possibilities of ICT applying in organizational creativity as well as the factors that determine the development of ICT-based organizational creativity support. The study makes useful contribution to our understanding of the ICT-based organizational creativity. The outcomes will hopefully help the organizations to understand the consequences of ICT using as well as to identify the factors on which they should give particular attention while developing organizational creativity.

Keywords: organizational creativity, ICT, organizations

JEL Clasification: D23, O19

1. Introduction

The need for creative thinking, activities and creative management of the organization has been known for a long time (Drucker, 2014; Proctor, 2010). However, the role of creativity has significantly increased recently. Some people even herald the arrival of new era of socio-economic development – the era of creativity, characterized by new management models, encouraging whole organizations and individuals to creativity and innovativeness (Walton, 2010). Creativity is becoming a key direction of organization management (Elsbach and Hargadon, 2006; Shin and Zhou, 2007; McLean, 2009). Several important reasons contributed to this situation. Here are some of them: (1) organizational creativity is regarded as an important resource or organizational capability (Andriopoulos, 2001) which are the key to effectiveness of organizations, striving to achieve competitive advantage and to hold their position in the turbulent environment (Wang and Cheng, 2010); (2) thanks to creativity, organizations develop new situations, addend value and consumer's satisfaction (McLean, 2009); (3) creativity is indispensible while creating new

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behaviors and interpretations in unexpected situations (Bechky and Okhuysen, 2011); (4) creativity is becoming a key strategic tool, enabling handling adverse economic conditions arising e.g. from various crises and economic downturns (Nissley, 2010); (5) creativity is a means by which organizations and their actors can create a significant sustainable value for their various stakeholders (George, 2007); (6) creativity in new technology industries, as well as in traditional, mature organizations, seems to play more significant role in achieving success than effective production systems (Styhre and Sundgren, 2010).

Recently, it is stressed that ICT can play an important role in the development of organizational creativity. However, there is still little research focused on the exploration of the issue of ICT-based organizational creativity support. In particular, there is a lack of empirical studies that illustrate how ICT tools can be used in organizational creativity support and what determines their use. The main objective of this study is to identify a possible use of ICT to support organizational creativity. The implementation of the so-formulated objective of the research required the use of different research methods. The most important are: literature analysis, critical reasoning, deductive thinking and survey method with a questionnaire. The logic of the argument in this paper is carried out as follows: firstly, the essence of organizational creativity and the role of ICT in supporting it are discussed. Then, selected results of the study, which was conducted in 232 organizations on the use of ICT in organizational creativity support, are presented. In the final part, the paper summarizes the results of the research and identifies directions for further work on the subject of ICT-based organizational creativity support.

2. ICT in supporting organizational creativity

According to the report published by the US National Academy of Science (Mitchell et al., 2003), ICT unquestionably influence our economic, social and private life. They not only improve business processes, products and services, but also facilitate transformations and the new value creation for organizations and society at large. The authors of the report emphasize that ICT support creative practices in art, design, science, engineering, education and business through enabling development of original creative production types. ICT play a key role in developing new markets, products and services, as well as in competition and in the emerging of new creative sectors (art, computer games, music, publishing). It is worth stressing that ICT have an immense impact on other sectors and on the creation of new jobs, occupations and specializations. ICT are considered to have become a binder for different fields of study, science, business and culture, that triggers creative practices in these domains.

Studies conducted by different authors (Dewett, 2003; Shneiderman, 2007; Woodman et al., 1993) indicate certain relationships between ICT and organizational creativity. The following issues deserve special attention (Olszak and Kisielnicki, 2016):

- improved information flow and communication between employees,
- enhanced codification of organizational knowledge,
- expanded limits to employees' knowledge and abilities.

Electronic media are claimed to intensify and improve communication between employees in organizations. Databases, workflow systems, intranet portals, electronic mail and videoconferences enable employees to exchange opinions and suggestions, to work together on documents, as well as to contact different experts, while also facilitating communication within virtual teams, thereby improving their productivity and creativity. Many a time, ICT have been proved (Hayen et al., 2007; Kim, 2006; Laudon and Laudon, 2003; Pissarra and Jesuino, 2005; Turban et al., 2002) to be suitable for supporting such activities as brainstorming, categorization of ideas, analysing alterative solutions, sharing knowledge, evaluating ideas, making decisions, as well as planning and group decision support. Today, communication and collaborative group work can be effectively supported using a variety of web technologies. These include: WebDemo, Sametime, eRoom, Microsoft NetMeeting, Interwise, Groove, PlaceWare, WebEx, GroupSystems, Google Groups, MSN, Yahoo and others. These technologies enable development of (Saldanha, 2012): (1) www platforms (open innovations, integrated team support platforms), (2) e-learning platforms for teaching foreign languages at schools, (3) web 2.0, social software that facilitates access to specialist knowledge, exchange and dissemination of knowledge, as well as new knowledge generation.

To be able to understand the weightiness of ICT in knowledge coding, it is worth remembering the imperfections of human memory, that manifest themselves through the limited ability of memorizing large volumes of information. ICT enable the storage of an immense stock of information in different databases, data warehouses and knowledge bases that are referred to as organizational memory. In particular, much attention is given to data warehouses that integrate historical data and knowledge, both internal and sourced from the organization's environment. Here, many authors emphasize the role of OLAP and data mining techniques that are used to analyse information and discover new knowledge, as well as data visualization techniques that make learning and understanding newly discovered knowledge easier. The tools used for this purpose include conceptual graphs, diagrams, visual metaphors and knowledge maps (Eppler and Burkhard, 2008), as well as image processing systems (Cooper, 2000).

Studies confirm (Shneiderman, 2007) that access to a variety of knowledge repositories and knowledge discovery techniques facilitates the process of overcoming mental barriers and contributes to knowledge expansion. Greene (2002) stresses that organizational creativity support software tools enable exploration and better understanding of problem domains, learning, discovering new ideas (classifying and storing them), collaboration and visualizing interdependencies between processes (phenomena). Heweet et al. (2005), Indurkhya (2013) and Nakakoji (2006) argue that ICT facilitate brainstorming, merging ideas and ranking them. Proctor (2010), on the other hand, claims that ICT accelerate the process of moving through the creative process stages and problem solving. Furthermore, they stimulate thinking and creating mind maps. ICT enable employees to reach new sources of knowledge (both within the organization and outside it). Such external repositories as databases, Open Access bases and social media provide extremely valuable knowledge. Exploring them using ICT enables one to break barriers to knowledge.

Arif et al. (2010) argue that ICT may not only support operationalization of different business activities (through providing guidelines, prompts and suggestion methods) but also enable language translations and enhance user's confidence in the system through offering a friendly human-computer dialogue. Similarly, Ulrich and Mengiste (2014) emphasize the role of ICT in human-computer interaction, as well as in supporting business plans and in development of personalised services for users.

Lubart (2005), Klijn and Tomic (2010), on the other hand, appreciate the role of ICT in supporting "what-if" analyses, visualization processes, dissemination of creative effects and visualization of ideas. Shneiderman (2007) adds, that ICT may offer work progress measurement and alert generation tools, support development of libraries of ideas, thesauri, maps of ideas and mind maps.

Saldanha (2012), whose focus is on innovation, describes a wide range of areas that can be supported by ICT. These include in particular: knowledge management, group collaboration, information processing including process coordination and uncertainty reduction, as well as supporting creativity, which includes creative thinking.

3. Research method

The main aim of this research is to explore the issue of the ICT-based organizational creativity support in selected organizations, in particular to: investigate ICT tools to support organizational creativity, identify the determinants and barriers to the development of organizational creativity support as well as to know the success factors of ICT-based organizational creativity support.

The idea of this study is an attempt to answer the following questions: (1) what ICT tools are used to support organizational creativity in organizations?; (2) what ICT functions are important for supporting organizational creativity?; (3) what information resources are applied in ICT-based organizational creativity support?; (4) what benefits are achieved by ICT-based organizational support, and (5) what are the critical success factors for ICT-based supporting organizational creativity?

The survey method based on a questionnaire was used to accomplish the research objectives. The questionnaire consisted of 26 questions. All the questions took the form of closed affirmative sentences and they were mostly single-choice questions. All the questions (except those in demographics) used a five-point Likert scale. The collected data was processed using SPSS. The invitation to survey was sent to 345 companies which are related to the services sector (71.1%) and manufacturing (28.9%). They represented the following industries: ICT, telecommunications, consumer electronics, finance, automotive, chemical and tourism. The majority of the surveyed companies are small and medium-sized enterprises – 67.2% (employing 10 to 49 workers). The rest were micro enterprises – 19.4% (up to 9 workers) and large enterprises

13.4% (employing more than 250 workers). The respondents were mostly managers (47%), operational staff (32.3%), employees of R&D department (12.1%), ICT specialists (7.8%) and other employees (e.g. project managers – 0.9%).

The research was conducted at the turn of September and October 2015 using on-line tools – SurveyMonkey. 278 companies began the study. 232 companies presented fully complete data. Relatively high return ability was recorded – 67.5%. It resulted, among others, from the three-time call to participate in the study sent to each company.

4. Findings and discussion

It should be emphasized that the results of analysis of the collected empirical material presented in this paper show only a small portion of the study.

At the outset, it is worth noting that almost half of the respondents (47.8%) associate the term *"organizational creativity"* with innovation. 41.8% of the surveyed companies identified this term with new and useful ideas about management practices and competitive strategies. Over 30% of respondents believe that organizational creativity is the ability to change (36.6%), knowledge discovery (34.5%) and ability to create new and useful ideas for products and services (30.2%). To a lesser extent, creativity is identified with organizational expertise (27.6%), learning organization (19.4%) and creative analytics (19%).

The analysis of the extensive research material shows that ICT is not considered by organizations as a foreground tool for supporting the organizational creativity. Primarily, the organizations pointed to the role of such elements in supporting organizational creativity as: cooperation within a group (76.3%), freedom of action (70.7%), management support (69.8%), clearly defined goals of organizational creativity development (68.6%), and motivation (67.3%). Further, the attention was paid to the ability to access a variety of information resources and expertise (64.6%), as well as the use of adequate ICT tools and infrastructure (64%). The study illustrates that ICT is used to support creativity, especially in the traditional areas of an organization, such as: manufacturing (71.2%), services (66.8%), marketing and HR (62.9%) and finance (60 , 3%) and logistics (54.3%).

The conducted analyses show that ICT (in the context of organizational creativity support) is primarily used to quickly access various databases (79.3%) and information resources, as well as analyse information (64.9%). Less frequently it is used in: problem search, knowledge discovery, identifying creative needs, computer simulations, teamwork, information visualization, knowledge mapping, knowledge coding and hierarchization of knowledge (Table 1).

Table 1 ICT functions in organizational creativity support in studied organizations, Source: own.

Indications	Definitely yes	Rather yes	Neither yes nor no	Rather no	Definitely no
Quick access to various databases and knowledge repositories	28,0	51.3	12.5	6.0	2.2
Finding problems	25.9	36.6	27.2	8.2	2.2
Identification of creative needs	19.8	42.2	22.8	12.9	2.2
Knowledge coding	17.7	40.9	25.4	12.9	3.0
Discovering new knowledge	19.4	42.7	24.1	10.3	3.4
Knowledge generalization	15.5	37.9	32.3	10.8	3.4
Hierarchization and decomposition of knowledge	17.7	40.5	28.9	10.3	2.6
Knowledge mapping	16.8	43.5	23.3	12.9	3.4
Information analysis/filtering/ aggregating	19.5	45.4	22.5	10.9	1.7
Computer simulations	21.6	40.1	25.0	10.3	3.0
Information visualization	19.8	40.5	28.0	9.5	2.2
Teamwork	20.7	40.9	28.4	7.8	2.2
Information dissemination/ communication	24.1	42.2	23.7	8.2	1.7
Other (transferring knowledge) N=1	-	100.0	-	-	-

The respondents when asked which specialized information resources they use in their work stated that it is mostly internal documentation (77.3%), internal database (63.3%), social networking portals (58.2%), knowledge portals (56.1%), specialist studies, books (55.2%), patent databases (50%). Less frequently, they use library databases (43.5%) and government databases (38.3%).

From the study emerges a picture of organizations that use rather basic ICT features and tools in organizational creativity support (Table 2).

Table 2 ICT tools used in organizational creativity support, Source: own.

Indications	Definitely yes	Rather yes	Neither yes nor no	Rather no	Definitely no
Search engines (e.g. Google, Yahoo)	39,7	37.9	16.8	5.6	0.0
Spreadsheets	39.2	28.9	23.3	6.5	2.2
Data mining and Business Intelligence	23.3	34.9	24.6	12.9	4.3
Big data	13.8	31.0	34.1	17.2	3.9
Data warehouses	19.8	31.5	30.2	14.7	3.9
Databases	30.3	28.9	26.5	12.6	1.7
Decision support systems	16.8	32.8	32.3	12.5	5.6
Expert systems	22.0	30.6	27.6	14.2	5.6
Customer relationship management systems	19.5	39.3	27.3	9.2	4.7
Teamwork systems	23.3	30.2	32.8	9.5	4.3
CAD, CAM systems	14.7	32.8	25.9	19.8	6.9
Computer simulations	20.7	31.5	31.0	12.5	4.3
Data visualization systems	24.6	28.0	30.6	13.8	3.0
Electronic mail	41.8	28.4	21.6	7.8	0.4
Intranets	25.4	36.6	26.3	9.1	2.6
Extranet	18.6	34.7	32.9	9.9	3.9
Discussion forums, social networking portals	16.8	44.4	25.9	8.6	4.3
Other (environment analysis) N=1	-	100.00	-	-	-

The organizations frequently use: search engines (77.6%), electronic mail (70.2%), spreadsheets (68.1%), forums (61.2%). These are tools which primarily help search for information, access different data repositories, facilitate communication and preparation of simple analysis. Less often, ICT is used to conduct sophisticated analyses (e.g. on the behaviour of customers) and data mining. It turns out, which is perhaps a little surprising, that the main barrier to the use of more advanced ICT tools is primarily a lack of time to explore ICT tools (50.9%). It was also stressed that ICT tools are too complex, and that organizations neither have sufficient knowledge and skills to use ICT tools, nor they fully trust in their effectiveness. Interesting analyses were obtained by examining the relationship between ICT and organizational creativity enhancement. They show that ICT contributes to faster access to various information resources (63.8%), improvement of communication

(62.5%), and facilitates information analysis (60.8%). To a lesser extent, it enables the acquisition of new knowledge and improves knowledge coding.

Carrying out a more detailed analysis concerning the relationship between ICT and the enhancement of organizational creativity required the development of organizational creativity enhancement index (aggregate). The index was worked out based on the previously identified factors. The developed index shows that in the vast majority of the surveyed organizations, ICT has a large (45.3%) or very large impact (43.5%) on creativity enhancement. Small impact indicated only 2.2% of respondents, while no one pointed out the absence of such effects. The conducted analysis showed, among others, that there is a link between the organizational creativity enhancement and the use of various ICT functions. This analysis was performed according to Spearman's rank correlation test (Table 3).

Table 3 The relationship between ICT functions and organizational creativity enhancement – Spearman's rank correlation coefficients, Source: own.

ICT functions used in organizational creativity support	**Spearman's coefficient**	**ICT function impact on the level of organizational creativity enhancement**
Quick access to various knowledge databases and repositories	Correlation coefficient	0.460
	Significance (two-tailed)	0.000
Finding problems	Correlation coefficient	0.516
	Significance (two-tailed)	0.000
Identifying creative needs	Correlation coefficient	0.530
	Significance (two-tailed)	0.000
Knowledge coding	Correlation coefficient	0.635
	Significance (two-tailed)	0.000
Discovering new knowledge	Correlation coefficient	0.590
	Significance (two-tailed)	0.000
Knowledge generalizing	Correlation coefficient	0.558

	Significance (two-tailed)	0.000
Knowledge hierarchization and decomposition	Correlation coefficient	0.553
	Significance (two-tailed)	0.000
Knowledge mapping	Correlation coefficient	0.530
	Significance (two-tailed)	0.000
Information analysis/filtration/aggregation	Correlation coefficient	0.584
	Significance (two-tailed)	0.000
Computer simulations	Correlation coefficient	0.606
	Significance (two-tailed)	0.000
Information visualization	Correlation coefficient	0.566
	Significance (two-tailed)	0.000
Teamwork	Correlation coefficient	0.560
	Significance (two-tailed)	0.000
Providing information/communication	Correlation coefficient	0.605
	Significance (two-tailed)	0.000

All correlations were found to be statistically significant and positive. The strongest correlation was observed for knowledge coding and computer simulation, while the weakest for quick access to various databases and repositories of knowledge, as well as for problem finding. However, all the correlations are of moderate force. The analyses of the relationship between the use of various ICT tools and organizational creativity enhancement were also carried out based on the obtained results. The analysis of such dependence was conducted in a similar manner as in the previous instance, i.e. on the basis of Spearman's rank correlation test (Table 4).

Table 4 The impact of ICT tools on organizational creativity enhancement – Spearman's rank correlation coefficients, Source: own.

Tools used in organizational creativity support	**Spearman's coefficient**	**Impact of ICT tools on the level of organizational creativity enhancement**
Search engines (e.g. Google, Yahoo)	Correlation coefficient	0.462
	Significance (two-tailed)	0.000
Spreadsheets	Correlation coefficient	0.516
	Significance (two-tailed)	0.000
Data mining and Business Intelligence	Correlation coefficient	0.473
	Significance (two-tailed)	0.000
Big data	Correlation coefficient	0.437
	Significance (two-tailed)	0.000
Data warehouses	Correlation coefficient	0.576
	Significance (two-tailed)	0.000
Databases	Correlation coefficient	0.591
	Significance (two-tailed)	0.000
Decision support systems	Correlation coefficient	0.497
	Significance (two-tailed)	0.000
Expert systems	Correlation coefficient	0.566
	Significance (two-tailed)	0.000
Customer relationship management systems	Correlation coefficient	0.528
	Significance (two-tailed)	0.000
Teamwork systems	Correlation coefficient	0.581
	Significance (two-tailed)	0.000
CAD, CAM systems	Correlation coefficient	0.481
	Significance (two-tailed)	0.000
Computer simulations	Correlation coefficient	0.507
	Significance (two-tailed)	0.000
Data visualization systems	Correlation coefficient	0.551
	Significance (two-tailed)	0.000
Electronic mail	Correlation coefficient	0.476
	Significance (two-tailed)	0.000
Intranet	Correlation coefficient	0.523
	Significance (two-tailed)	0.000
Extranet	Correlation coefficient	0.492

	Significance (two-tailed)	0.000
Discussion forums, social networking portals	Correlation coefficient	0.481
	Significance (two-tailed)	0.000

Also in this case, all the correlations were found to be statistically significant and positive. The strongest correlation was observed for databases and teamwork systems, while the weakest for Big Data and search engines. All correlations are of moderate force.

The conducted study also illustrated that the most important factors in the development of computer-aided organizational creativity include: clearly defined problems/needs and creative processes (77.2%), as well as effective communication (68.9%). Motivation to share knowledge and ideas, and budget were subsequently mentioned. It turns out that having adequate tools and ICT infrastructure is a critical success factor in the organizational creativity support for 62% of the organizations.

The analysis of the collected empirical material also permits to state that the most serious barrier to the development of computer-aided organizational creativity is the lack of clearly defined problems/needs and creative processes (85%). About 60% of organizations pointed to such elements as: lack of desire and motivation to share knowledge and ideas, lack of adequate skills in the use of ICT and information analysis, as well as the lack of support from managers and poor data quality.

5. Conclusion

Referring to the presented, in the theoretical part of this paper, ICT possibilities in organizational creativity support, it should be stated that the analysed organizations do not fully utilize their capabilities. As demonstrated earlier, they apply rather classical and relatively simple ICT tools. They are mainly interested in quick access to various databases and information resources, and their simple analysis. Indeed, as shown by the analyses, these are the features that are statistically significant for organizational creativity enhancement, although the strength of this correlation is weak. To a lesser extent, the organizations use tools targeted at discovering new knowledge, computer simulations, carrying out teamwork, knowledge mapping and problem searching – albeit according to studies, these are precisely the features that bear the greatest impact on the organizational creativity enhancement. The study illustrates that ICT is used to support creativity rather in the classic areas of organization's operations, such as: production, service, marketing and HR, as well as finance and logistics.

It turns out that among the reasons which cause that organizations do not reach for more advanced ICT tools was mainly the time factor as well as insufficient knowledge about the benefits of ICT, and low skills in ICT use.

At the same time, the obtained results confirmed that the development of computer-aided organizational creativity depends largely on organizational and cultural factors, to a lesser extent on technological factors, including ICT. ICT is not considered as a foreground tool for supporting organizational creativity by organizations. The respondents emphasized the importance of such elements in supporting organizational creativity as: teamwork, freedom of action, support from management, clearly defined objectives in the development of organizational creativity and motivation. Further, the following were mentioned: ability to access various information and expert resources, as well as the use of appropriate ICT tools and infrastructure. More detailed analysis on these aspects and their impact on the development of computer-aided organizational creativity will be discussed by the author in the subsequent planned papers.

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Estimation of Stability of Dynamical Systems

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Abstract. In this paper presented the fractional-continuous method for assessing the stability of a dynamic systems in which it is only necessary to calculate the coefficients of this fraction. The advantages of the fractional-continuous method are shown in the examples. Continuous fractions can also be used in the theory of disasters.

Keywords: continuous fractions, stability, secular value, principal macroeconomic model, dynamic systems.

JEL Classification: C62, M15

1. Introduction

The modern infocommunication network has a complex structure and a large number of components and functional connections. To implement its management functions, a management information system is created. Finding the stability parameters of these complex systems is a unique problem, despite the fact that numerous techniques for assessing the stability of complex systems have already been developed. In particular, in the analysis of a linear stationary dynamic system for stability, the rule of Raus-Hurwitz is widely used, which requires the performance of the calculation of determinant. In contrast, this method describes a fractional-continuous method for assessing the stability of a system in which it is only necessary to calculate the coefficients of this fraction. The advantages of the fractional-continuous method are presented in the examples. Continuous fractions can be used in the theory of disasters.

Generally, in dynamic systems, not only continuous and relatively expected behavior, but also rapid and stepwise changes are possible. The steps occur in the points of extremum of the functions, describing the systems. One of the aspects of extremum problems is closely connected with modern definition of structural stability of the functions of automatic regulation. To make the mathematic model useful, it should be a stable one. In case the system

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demonstrates rapid changes, the process should be described with application of the catastrophe theory (Arnold, 2004), (Nedelko, 2010), (Bełej, Kulesza, 2013), (Poston, Stewart, 2014).

In the system of automatic regulation, the following requirement is one of the most important, i.e. in case of any real perturbation on the system, a regulated value in transition process should not continuously deviate from the determined value, it should be stable (Doroshenkoetal, 2008).

It is known that a stationary linear system, where a signal of a limited value is supplied to its income, is stable only when all zeroes of a characteristic polynomial $\det(A-\lambda I)$ are inside the circle $|\lambda|=1$ of a complex area λ.

Under certain situations, the procedure of determination of secular values is rather complicated. Hereafter we will use a criterion of the model stability without solving of the very characteristic equation. The authors of the article consider that the criterion is the most ration one.

2. Tasksetting

Calculation of secular values (zeroes of characteristic polynomial) of A matrix is made by solving of a certain polynomial equation. The mentioned polynomial will be stable (as well as the studied system) when all its roots have negative present parts. The question can be answered without solving of a characteristic equation, but by means of infinity of steps, provided by the Routh-Hurwitz rule. However, the rule is very lengthy. The article's authors define a very original method, based on the fundamentals of continuous fractions (Siavavko, Pasichnyk and Rybitskaia, 1995).

2.1. Main material

Let the examined polynomial look like

$$P(x)=a_0x^{2n}+a_1x^{2n-1}+a_2x^{2n-2}+...+a_{2n-1}x+a_{2n}\,, \qquad (1)$$

or

$$P(x)=a_0x^{2n+1}+a_1x^{2n}+a_2x^{2n-1}+...+a_{2n}x+a_{2n+1}. \qquad (2)$$

Thus, using coefficients of P polynomial, the authors make rational functions according to the two polynomials

$$R(x)=\frac{a_1x^{2n-1}+a_3x^{2n-3}+\ldots+a_{2n-1}x}{a_0x^{2n}+a_2x^{2n-2}+\ldots+a_{2n}}, \quad (3)$$

or

$$R(x)=\frac{a_1x^{2n}+a_3x^{2n-2}+\ldots+a_{2n+1}}{a_0x^{2n+1}+a_2x^{2n-1}+\ldots+a_{2n}x}. \qquad (4)$$

Functions (3), (4) are called test functions of stability. Applying a standard algorithm, they can be revealed by continuous fractions of corresponding form

$$R(x)=\frac{1}{b_1x+}\,\frac{1}{b_2x+}\cdots\frac{1}{+b_{2n}x}, \qquad (5)$$

or

$$R(x)=\frac{1}{b_1x+}\,\frac{1}{b_2x+}\cdots\frac{1}{+b_{2n+1}x}, \qquad (6)$$

where symbol $\frac{1}{a+}\,\frac{1}{b}$ is considered as

$$\frac{1}{a+}\,\frac{1}{b}=\frac{1}{a+\frac{1}{b}}.$$

There is the following assertion.

Polynomials (1) or (2) are stable only in the case when all parameters are bi>0in correlations (5) or (6) respectively.

Example 1. It is known (Matveeva, 2007) that principal macroeconomic model with consideration of impact on the change of products outcome is revealed by the following system of differential equations:

$$DK=\gamma(vY-K), \qquad (7_1)$$

$$DC=\alpha((1-s)Y+A-C), \qquad (7_2)$$

$$DY=\lambda(C+DK-Y)+\mu(S^0-S), \qquad (7_3)$$

$$S^0=b(C+DK)+c, \qquad (7_4)$$

$$DS=Y-C-DK, \qquad (7_5)$$

Where D is a differentiation operator d/dt; $S^0$and S are an optimal and present level of reserves respectively; α, s, ν, λ, γ, b, c, μ – positive constants, $s< 1$. Here Y – is a net income or output, C – is actual consumption, K – is a volume of fixed capital. In (7_2), parameter αdefines speed (reaction speed) of the system. Value S contains reserves of both consumption and capital commodities. For example, they can include building materials, not used in building of constructions, or machines, which are unfit for buyers.

Balance values C, Y, K, S i $S^0$are determined in the following way:

$$C^* = Y^* = \frac{A}{s}, \tag{8}$$

$$K^* = \frac{\nu A}{s}, \tag{9}$$

$$S^* = S^{0*} = \frac{bA}{s} + c. \tag{10}$$

Excluding the value S^0out of (7_2) - (7_5), (8) - (10), we obtain the system

$DY = FY$,

$$Y = \begin{pmatrix} C - C^* \\ K - K^* \\ Y - Y^* \\ S - S^* \end{pmatrix},$$

$$F = \begin{pmatrix} -\alpha & 0 & \alpha(1-s) & 0 \\ 0 & -\gamma & \gamma\nu & 0 \\ \lambda + \mu b & -(\nu\lambda + \mu b \nu) & \mu b\gamma\nu - \lambda(1-\gamma\nu) & -\mu \\ -1 & \gamma & 1-\gamma\nu & 0 \end{pmatrix}.$$

Characteristic roots of the F operator are roots of the polynomial

$$x^4 + a_1 x^3 + a_2 x^2 + a_3 x + a_4, \tag{11}$$

where

$$a_1 = \alpha + \gamma + \lambda - \gamma\lambda\nu - \mu b\gamma\nu,$$

$$a_2 = \alpha\gamma + \gamma\lambda + \alpha s\lambda - \alpha\gamma\lambda\nu + \mu(1 - \alpha b - \gamma\nu + \alpha s b - \alpha b\gamma\nu),$$

$$a_3 = \alpha\gamma\lambda s + \mu(\nu + \alpha s - \alpha\gamma b - \alpha\gamma\nu + \alpha\gamma bs),$$

$$a_4 = \mu\alpha\gamma s.$$

Required and appropriate conditions of the polynomial (11) stability are defined by the conditions of Routh-Hurwitz: under a_0>0 for the polynomial

$$\sum_{i=0}^{n} a_i x^{n-i}.$$

The conditions are presented by means of positivity of determinants

$$a_1 > 0, \quad \begin{vmatrix} a_1 & a_3 \\ a_0 & a_2 \end{vmatrix} > 0, \quad \begin{vmatrix} a_1 & a_3 & a_5 \\ a_0 & a_2 & a_4 \\ & a_1 & a_3 \end{vmatrix} > 0, \quad \ldots \quad \begin{vmatrix} a_1 & a_3 & a_5 & a_7 & \ldots & 0 \\ a_0 & a_2 & a_4 & a_6 & \ldots & 0 \\ 0 & a_1 & a_3 & a_5 & \ldots & 0 \\ 0 & a_0 & a_2 & a_4 & \ldots & 0 \\ . & . & . & . & \ldots & 0 \\ 0 & 0 & . & . & \ldots & a_n \end{vmatrix} > 0.$$

The condition is very labor-consuming.

Let us study stability of polynomial (11) with application of the fractional method, determining $\alpha = 0{,}6$, $\gamma = 0{,}4$, $\lambda = 4{,}0$, $s = 0{,}25$, $\nu = 2{,}0$, $\mu = 0{,}4$ and $b = 0{,}5$. Thus $a_1 = 1{,}640$; $a_2 = 0{,}414$; $a_3 = 0{,}232$; $a_4 = 0{,}024$.

Finally, in our case

$$P(x) = x^4 + 1{,}640x^3 + 0{,}414x^2 + 0{,}232x + 0{,}024 \qquad (12)$$

and

$$R(x) = \frac{1{,}640x^3 + 0{,}232x}{x^4 + 0{,}414x^2 + 0{,}024} = \cfrac{1}{\cfrac{x^4 + 0{,}414x^2 + 0{,}024}{1{,}640x^3 + 0{,}232x}} = \cfrac{1}{0{,}610x + \cfrac{0{,}273x^2 + 0{,}024}{1{,}640x^3 + 0{,}232x}} =$$

$$= \cfrac{1}{0{,}610x + \cfrac{1}{\cfrac{1{,}640x^3 + 0{,}232x}{0{,}273x^2 + 0{,}024}}} = \cfrac{1}{0{,}610x + \cfrac{1}{5{,}959x + \cfrac{1}{\cfrac{0{,}273x^2 + 0{,}024}{0{,}089x}}}} =$$

$$=\cfrac{1}{0{,}610x+\cfrac{1}{5{,}959x+\cfrac{1}{3{,}067x+\cfrac{1}{3{,}708x}}}}.$$

Considering the fact that all parameters 0,610; 5,959; 3,067 and 3,708 of the record are positive, the polynomial (12) is stable and, thus, the studied model is also stable.

Example 2.

Under what parameters of *a, b, c, d*is cubic polynomial

$$P(x)=ax^3+bx^2+cx+d \tag{13}$$

stable?

To answer the question, the authors of the article make test function according to (4)

$$R(x)=\frac{bx^2+d}{ax^3+cx}$$

Having done the transformation (6), the function is presented in the following way

$$R(x)=\cfrac{1}{\cfrac{ax^3+cx}{bx^2+d}}=\cfrac{1}{\cfrac{a}{b}x+\cfrac{\cfrac{bc-ad}{b}x}{bx^2+d}}=\cfrac{1}{\cfrac{a}{b}x+\cfrac{1}{\cfrac{bx^2+d}{\cfrac{bc-ad}{b}x}}}=$$

$$=\cfrac{1}{\cfrac{a}{b}x+\cfrac{1}{\cfrac{b^2}{bc-ad}x+\cfrac{d}{\cfrac{bc-ad}{b}x}}}=\cfrac{1}{\cfrac{a}{b}x+\cfrac{1}{\cfrac{b^2}{bc-ad}x+\cfrac{1}{\cfrac{bc-ad}{bd}x}}}.$$

To make polynomial (13) stable, it is necessary to satisfy the following conditions

$$\frac{a}{b} > 0, \quad \frac{b^2}{bc-ad} > 0, \quad \frac{bc-ad}{bd} > 0,$$

i.e. it is required that $ab>0$, $bd>0$, $bc-ad>0$.

3. Conclusion

Application of continuous fractions supplies a simpler estimation of dynamic systems stability, and defines weaknesses in the theory of enterprises management. The theory of continuous fractions provides approximate solutions in bifurcation points (Pasichnyk, 2006).

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Top Ten Principles for Effective Time Management of Project Managers

Zora Říhová[1]

Abstract. The paper aims to highlight the need of respecting the time management as an integral part of the success of the work of the project manager. Time is a non-renewable resource that can be neither bought nor stopped. Although many project managers are aware of the time parameter, only few people are able to manage their time effectively. In this paper we will focus on the ten most important aspects of time management in the work of the project manager in addition to the theoretical foundations of this discipline.

Keywords: time management, project manager, principles for effective time management.

JEL Classification: M15

1 Introduction

Time is a non-renewable resource, can be neither stopped nor replaced, cannot be saved or bought. On the other hand, there is plenty of time, just to discover it - it's available and depends on how we manage it – thus how time is managed (time management). It is necessary that time does not deprive us of our personal energy. Then the time is spent efficiently or, on the other hand, even lost. For project manager (PM) role, it is one of the basic aspects of project success. PMs, of course, are aware of the time parameter, yet few are able to manage their time effectively. This paper highlights ten of the most important aspects of project manager time management. The paper adds a further insight into the work of the project manager and complements the previous articles on the aspects of the project manager's work in the areas of legal (Říhová 2015), psychological (Říhová 2016), systemic thinking (Říhová 2013) and management problems in project management (Říhová 2010).

2 Theoretical Foundations of Time Management

Time Management generally includes a set of procedures and recommendations on what to do, when to do it, and how to do it, in order to utilize the time to make as many activities and as efficiently as possible.

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The first principles and recommendations emerged at the turn of the 18th and 19th centuries. According to Godefroy and Clark (1996), 43% of people complain about lack of time and only 27% for lack of money.

Dr.DeWoot's study of senior managers' time utilization showed that 49% of their time was spent on the tasks that could have been done by their assistants; 5% of their time spent on the tasks that their secretaries could do; 43% of their time spent on tasks that could be delegated to their deputies; and only 3% of their time spent on tasks that best matched their level and expertise. Thus, 97% of the time was not used efficiently (including endless consultations on unresolved issues).

Problems of time management are dealt with in the books (David Allen 2008), (Tracy, 2001) or (Bennett, A. 2010).

An interesting modern concept was published in the (Ferris 2010) book "A Four-hour Working Week" , based on the idea of eliminating work for work with the motto: "slave → save → rest" where at least 50% of the work can be eliminated by applying several rules and tricks: especially Pareto's principle, Parkinson's laws outsourcing or selective ignorance.

According to Stephen Covey (2010), the following generations of time management can be traced:

1) The first generation of time management deals with the question of "what to do" (create task lists).
2) The second generation of time management - "what + when" - is the most common time management method, adding the time when the task should be done to the task list.
3) The third generation of time management - "what + when + how" - also adds instructions on how to accomplish the task to the task list and timeline. It involves teamwork, delegation, and priorities.

All three generations aim to improve discipline. They consider man as a machine that can do almost anything at a given time when it's well-timed and planned.

4) In the fourth generation, emotions are added - "what + when + how + emotion", when it focuses on the ideas of man, his vision, the future, and strategy. Man is not approached so hard in his plans, but his human side is taken into account. It aims to wake up the motivation, the feelings of growth or the interests common with the company. In essence, it is about forcing someone to come up with some results, ideas

and motivations - to make a profit for himself and for the company. It also adds intuition and an effort to devise solutions already before the event occurs.

Time management as part of information management deals with a range of activities: goal setting, planning, delegation, analyzing spent time, monitoring, and prioritization.

3 Time Management at Work of Project Manager

Time management at work of PM has many specific features compared to general time management instructions. PM, while managing the project, has to respect the contract, timetable, project content and customer. The PM monitors its time, time of the project and the time of the members of the project team (often also members of the customer team). The project time is given by schedule. The time of PM and team members is fulfilled accordingly and will appear in the project costs. This may have retrospective effect on project time. The reasons for failure / non-compliance with the project time may be due to internal conditions (lack of suitable consultants, illness, ...) and external (failure to observe the terms by sub-contractors, unpreparedness on the part of the customer, ...). Failure to meet time is one of the most common reasons for the failure of the project. Time Management is mostly not taught as a subject of its own (though thematic courses can be attended) and so it is difficult to realize how well or poorly we manage with time.

Given that PMs mostly draw on personal experience, top ten principles for effective time management of PMs are presented further on. Obviously, also the precise content and scope of the project is a clear prerequisite for success is, however, it is not the subject of this paper.

3.1 Top Ten Principles for Effective Time Management of Project Managers

The following points stress the necessity to realize the use of time and to realize the causes of weaknesses of utilizing time. Some points may seem simple, but they are mostly just those where most time is wasted. The communication with the team and the customer is quite fundamental. See Figure 1.

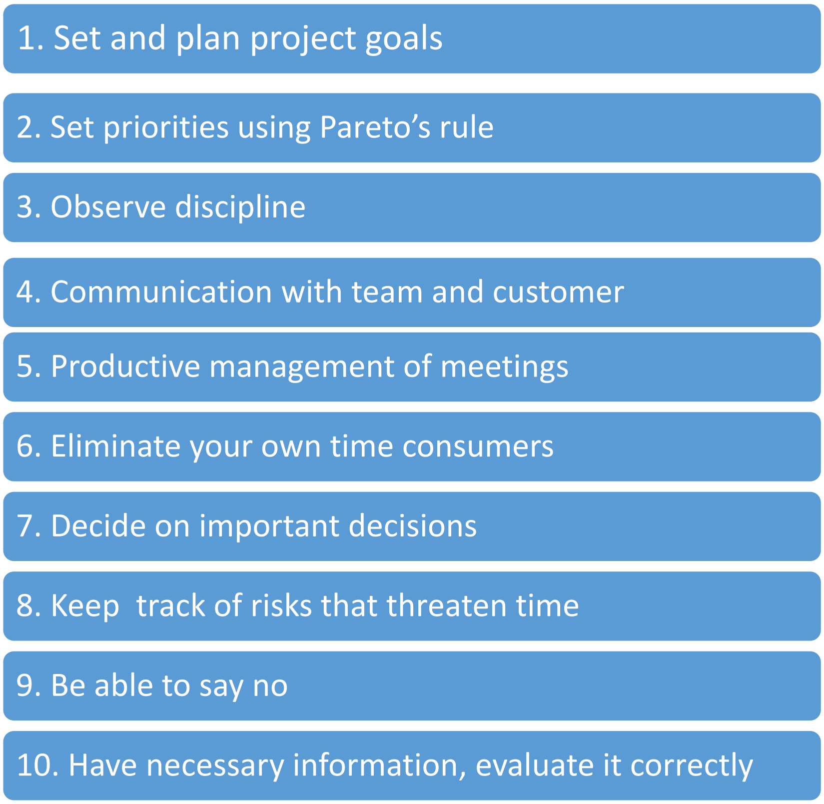

Figure 1 Top Ten Principles for Effective Time Management of Project Managers, Source: author

1) Set and plan your project goals and how to get there. Set achievable goals. Have a clear objective and sub-goal of the project. It is advisable to write down goals - it is not enough to have them in one's head. Goals must be clear, concrete and measurable. The terms (deadlines) should be set not only for the whole project but also for the individual stages - this is usually specified already in the contract or in the schedule of the project management plan. However, PM does not always know a specific contract with the customer. If, for any reason, it is not possible to meet the target date, it is necessary to define and justify the new term in time. Perhaps the original term was chosen incorrectly with respect to the target. The goal should still be correct / real. It also helps to visualize the goal, thus the clear idea that the project has succeeded. The problem of changing time often involves the need to change the procedure for a contract or shorten tasks on a critical path.

2) Set priorities - use Pareto's rule (20% of activities take 80% of time). It is necessary to create a list of activities that will be transformed into

an action plan, where priorities will be determined (what is more and less important) and ordering (link-up, possibilities of parallel processing). Check off the completed tasks and place the remaining ones in the new list - update the lists daily or at least weekly – plan the time according to the project's difficulty. Plan what to do in what order. Schedule 60% of the working day (and thus create a reserve for sudden unplanned activities or create a reserve for out of work time and think of a rest). Learn how to plan activities so that they do not deprive of energy, but add it and end the day with a feeling of "I'm done." An urgent problem should not put aside an important planned activity.

3) Observe discipline rather than some special motivation. It is necessary to follow the timetable, which is agreed by both parties
4) Communication within the team and with the customer. This is a very crucial point when we save a lot of time if the problems are discussed in time. PM must have time for team members - time for interviews and establishing contacts. Identify the skills and knowledge, experience, skills of team members, and other resources that can influence project progress (timely identification and problem solving). Find out how to make full use of team members - how they will help, cooperate, support. Know what they are trying to do / help. This can actually influence the "critical path" of the project.
5) Productive management of meetings - setting the length of the meeting, setting the program and selecting the participants. Facilitating meeting, readiness of participants, keeping time and program. Common mistakes are: No agenda set, Begun late, No conclusion reached. Not suitable participants, concrete tasks for particular people not specified.
6) Eliminate your own time consumers. Recognize your advantages in terms of time planning (organizing, know how, overwhelming delays, using internal biological clocks, ...).
7) Deciding on important decisions, awareness of obstacles (interpersonal relationships, motivation, ...).
8) Keep track of risks that threaten time. Identify the risks / obstacles that need to be overcome. Find limitations that may compromise your goal fulfilment speed. It is possible to apply the Pareto’s rule and to select the most important activities, at the same time it is necessary to update the list of risks / restrictions daily / weekly.
9) Being able to say no - not to exaggerate the sense of responsibility, not to accept a task for which there is no time or human resources or money, to be able to delegate tasks - others can process the task faster and better.
10) Have the necessary information and evaluate it correctly.

Certain tools, procedures, circumstances can help to maintain timelines. The most important ones are listed in the following.

3.2. What saves time and PM can influence:

1) document templates (records, transfer / acceptance protocols, reports for the Steering Committee, project progress report, for larger projects it is worthwhile to write diary / weekly about the activities carried out) and project management aids (planning SW, ...);
2) prepared agenda at meetings (duration of the meeting, program, length of individual points, prepared participants);
3) active communication with both the team and the customer (avoiding the big problems and the loss of valuable time, and/or problems are solved better and faster);
4) delegation of tasks;
5) an overview of the workload of individual team members;
6) linking tasks to customers - keeping track of forwarding and acceptance;
7) solve problems while they are small - do not postpone decisions;
8) to prevent interference in the scheduled day (calls, mails, ...) that disturb and deprive of concentration;
9) an organized workplace provides prerequisite for efficient work.

4 Conclusion

Time management is an important factor for success in project management It is a discipline that PM usually learns by personal experience and not much is devoted to courses of this subject specialized for PMs.
Awareness of time management, the ability to organize time and activities, will also help to better manage your own goals and self-management, provide a new look at resources and change management, and, moreover, stress control. Of course, this includes managing external causes, controlling time and priorities. A very important aspect is communication, both within the team and with the customer. In the record of time on the project, we can still encounter different ways of recording actual time spent (e.g. overtime) and time reported. We can end the paper with a quote (Allen,2008): *The more you are busy, the less time you have to learn to use it better.*

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CART-SEM Approach to TAM

Adam Sagan[1], Mariusz Grabowski[2]

Abstract. The paper presents the results of research concerning the structure of attitudes toward a Moodle-based e-learning system in a higher education institution. The study utilizes TAM model and is one of uncommon TAM-based assessments of Moodle platform presented in the IT/IS literature. Because of potential sample heterogeneity the CART-SEM approach has been used in model estimation. It allows for considering the background covariates in parameter estimation. The TAM model was based on four constructs (perceived easy of use, perceived usefulness, attitude toward using and behavior and system use). The background variables involve gender, type of study, level of study and year of study.

Keywords: TAM model, Moodle, CART-SEM approach.

JEL Classification: C52, I23, L86

1 Technology Acceptance Model

Technology Acceptance Model (TAM) (Figure 1) (Davis, 1989; Davis, Bagozzi and Warshaw, 1989) and its derivatives e.g. UTAUT (Unified Theory of Acceptance and Use of Technology) (Venkatesh et al., 2003) belong to the most frequently used theoretical frameworks aimed at explaining the behavior of users with regard to IT/IS artifacts and their acceptance.

Its theoretical foundations are acquired form the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) and the Theory of Planned Behavior (TPB) (Ajzen, 1985). In the light of these theories on general, and TPB in particular, the behavioral intention is shaped by three mutually conditioning factors: an attitude toward the behavior, a subjective norm, and a perceived behavioral control. In TAM (figure 1) Actual System Use is directly determined by Behavioral Intention to Use. This intention, however, is formed directly by the Attitude Toward Using and Perceived Usefulness and indirectly through Perceived Ease of Use. Perceived Ease of Use and Perceived Usefulness may be influenced by additional external variables.

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The original TAM (Figure 1) was often modified in the literature. These modifications involved adding different external variables and/or constructs. However, the most frequent modification of original tam was its simplifying by grouping two constructs: Behavioral Intention to Use and Actual System Use into one: Behavior and System Use.

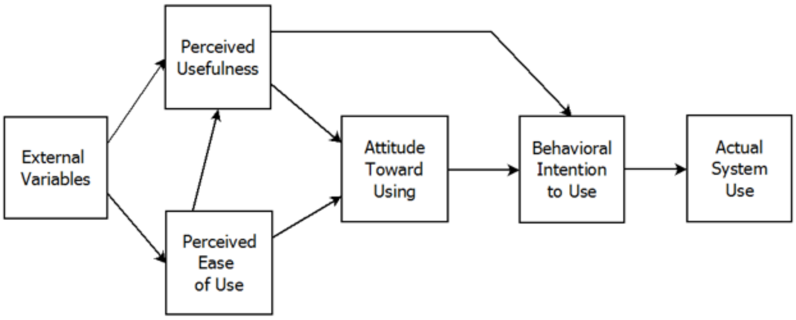

Figure 1. Technology Acceptance Model. Source: (Davis, Bagozzi and Warshaw 1989, p. 985).

Such simplified TAM will be utilized in this study (Figure 2).

2 CART-SEM approach in model building

The CART-SEM approach combines the advantages of exploratory classification tree methods and the structural equation modeling. The purpose of this approach is to search for covariates that may define the subpopulations, and have the most significant influence on the parameters differences of the SEM model. It is a very flexible approach, because the models of linear regression, path models, confirmatory factor analysis, latent growth curves and autoregressive models are treated as a special case of the general SEM model. All models however, assume a homogeneous population. For heterogeneous populations, consisting with multiple segments, which is a common case in social research, these models do not adequately describe the reality (regression or path parameters appear to be statistically insignificant due to the existence of differentiated subpopulations).

The purpose of the CART-SEM approach is to divide the population into segments that most differentiate the groups, based on the size of the SEM model parameters estimated in each of the classification tree leaves (Brandmaier, Oertzen, McArdle and Lindenberger, 2013, Brandmaier, Oertzen, McArdle and Lindenberger, 2015). The CART-SEM approach allows for the division of the set of observations not only for the homogeneity of the classes from the point of view of the predefined dependent variable but from the perspective of the parameters of the SEM model also.

The process of model building consists of two stages. In the first stage, the SEM base model is developed for the whole sample, which is the model in the "root" of the classification tree (this is so called template model). In the second step, given the set of covariates and its interactions, the "temporary" subdivision of the sample is made for the subgroups, within which the SEM models are constructed and compared to the baseline model. The covariate variables can be metric, ordinal or nominal. The comparison is based on differences in the log-likelihood ratios of both models (-2LL). The classification tree algorithm selects the best covariates for each tree split.

3 Application of CART-SEM in TAM for Moodle platform

The study was conducted among the students majoring in IT/IS (business information systems) at Cracow University of Economics (CUE), Krakow, Poland, where e-learning is utilized in a mixed learning fashion, as it supports regular studies. All students from all types, levels and years of studies were asked to fill noncompulsory questionnaire (Table 2). As a result, 204 nonrandom responses were obtained which constitute 25.2% of the total enrolled students (809). The distribution of responses in relationship to the total number of students is presented in Table 1.

Table 1. Distribution of responses within the student groups Source: own

Full Time				**Part Time**			
Graduate		**Postgraduate**		**Graduate**		**Postgraduate**	
Total	**Survey**	**Total**	**Survey**	**Total**	**Survey**	**Total**	**Survey**
474	124	68	35	160	31	107	14
RR:	26.2%	**RR:**	51.5%	**RR:**	19.4%	**RR:**	13.1%

There are significant differences in response rates (RR) across full time and part time students. This is especially evident at postgraduate level. It should be, however, admitted that despite of the evident differences, the smallest response rates within the student groups are fully acceptable, which gives as the right to assume legitimacy of the obtained results.

To get insight into the structure of users, four external variables (covariates) aimed at defining the segments have been added to the model. As portrayed in Figure 2, they are used for looking for post-split the entire model rather than influence the specific variables. The covariates include: gender, type of studies (i.e. full-time or part-time), level of studies (i.e. undergraduate or graduate), year of studies (i.e. 1-3 for undergraduate or 1-2 for graduate).

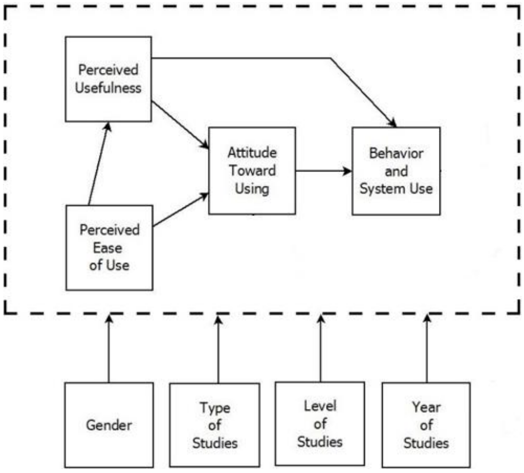

Figure 2. The model used in research. Source: own.

The constructs and indicators (measured on 5-point Likert scale) used in the survey of 204 selected respondents -- users of e-learning system in Cracow university of Economics are presented in Table 2.

Table 2. Variables used in the study. Source: own.

Variables	Constructs and items
PEOU	**Perceived Ease of Use**
PEOU1	e-Platform is easy to use
PEOU2	e-Platform is an easy tool for achieving learning objectives
PEOU3	e-Platform is easy to master the material
PEOU4	e-Platform is easy to understand
PEOU5	e-Platform CUE is readily available
PU	**Perceived Usefulness**
PU1	e-Platform allows to learn more effectively
PU2	e-Platform allows to learn in a faster way
PU3	e-Platform allows greater control over the learning process
PU4	e-Platform allows to save learning time
PU5	e-Platform allows for significant advancement of knowledge
A	**Attitude Toward Using**

A1	e-Platform is an attractive method of learning
A2	e-Platform is an improvement for the educational process
A3	e-Platform satisfies my needs for e-learning
A4	I like to use e-Platform
BU	**Behavior and System Use**
BU1	I use e-Platform to prepare for the exam session
BU2	I am using e-Platform on daily basis
BU3	I am using e-Platform whenever I have a problem to solve
BU4	I am using e-Platform because I can do it at any time

The CART-SEM analysis starts with the base model calculated on entire sample. The model is estimated using standardized factor scores that represent four constructs. In the estimation, the library *lavaan* of R package is used. The results of base model are presented in table 3.

Table 3. Parameters of base model. Source: own based on *lavaan* output of R package.

```
Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)
  BU ~
    A                 0.479    0.075    6.423    0.000
    PU                0.291    0.072    4.017    0.000
  A ~
    PEOU              0.600    0.070    8.608    0.000
    PU                0.364    0.057    6.404    0.000
  PU ~
    PEOU              0.884    0.059   14.865    0.000

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)
   .BU                0.503    0.050   10.100    0.000
   .A                 0.325    0.032   10.100    0.000
   .PU                0.494    0.049   10.100    0.000
```

The results show significant and positive direction of relationships between all of constructs. Behavior and system use is strongly explained by attitude toward using of Moodle platform, and the perceived easiness of use has positive impact on the attitude toward Moodle platform. The model goodness of fit is acceptable. The Chi-square statistic is 0.644 with 1 degree of freedom and insignificant p-level value = 0.42. Root Mean Square Error of Approximation shows also acceptable error ((RMSEA = 0.00). The comparative fit indices CFI and TLI indicate good level of 1.00 and 1.04 respectively.

In the second stage, the CART-SEM model is applied for subgroups defined by additional covariates. In the estimation, the library *semtree* of R package is used. The incremental quality of the models in subsequent spits is given by the log-likelihood ratios. The most important covariates for post-split models were type of study (101 = regular students, 102 = part-time students) and year of study (1st, 2nd, 3rd). The stop rule was given by minimum number of cases is the final nodes (N_{min} = 10). The tree diagram of CART-SEM model is depicted on figure 3.

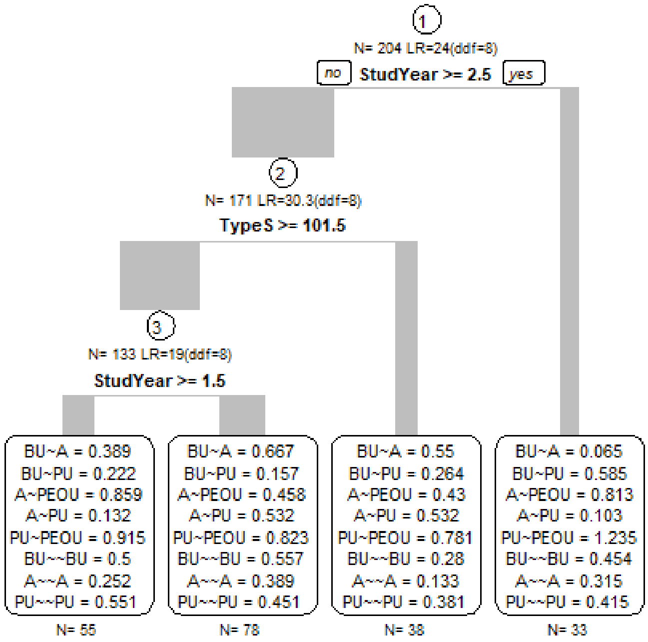

Figure 3. The CART-SEM model used in research. Source: own based on *semtree* output of R package.

Given the stopping rule and alpha level of significance (0.05) the algorithm proposed 4 segments, defined by 2 most important covariates (the importance of gender and study level is neglected).

The first segment (N=55) consists with 1st year, regular students ("freshmen"). In comparison to total sample, the relationship between perceived ease of use and attitudes are relatively stronger but impact of attitudes on behavior and system use is weaker. So, this group of students are learning the system and forming the positive attitudes toward the Moodle platform.

The second segment (N=78) is formed by 2nd year, regular students. They reveal strong relation between perceived usefulness and attitude toward the system and substantially weaker relationship between perceived usefulness and behavior and system use. Thus, the representatives of the segments learn to perceive the usefulness of the Moodle system, skipping the importance of easiness of use.

The third segment (N=38) is defined by 1st and 2nd year of part-time students. For extramural students, the relationships between constructs seem to be moderate and mostly weaker in comparison to the base model. However, the relation between attitude and perceived usefulness on behavior and system use indicates the importance of practical aspects of Moodle system.

The fourth segment (N=33) consists with 3rd year students. The specific relationships for this segment is based on the strong influence of perceived ease of use on usefulness and perceived usefulness on behavior and system use.

4 Conclusions

The estimation and analysis of TAM models rarely involve the heterogeneity of the populations. The classic approach is based on single – group SEM models that concentrate on causal relationships between constructs. The hybrid approach uses exploratory classification tree method on background variables and structural equation confirmatory model on construct level. It allows for incorporating the hidden heterogeneity of population in the process of model building.

The model results show the diverse relationships between TAM constructs depending on combinations on important institutional background variable. The study type and study year appear to be most important variables for students' heterogeneity that have strong impact on the size of path coefficients in TAM-SEM part of the models. Along with the expectations, the regular and freshmen students seem to be more sensitive to learning effects with respect to Moodle platform, whereas the part-time and older students reveal the practicability and usefulness of the system.

Acknowledgements

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Web Content Management Systems and their use in Practice

Darina Tothova[1], Dana Orszaghova[2], Radomira Hornyak Greganova[3]

Abstract. Web content management systems became an important tool for creating web sites for different organisations. They allow the design of the web site to be separated from content. If the possibilities of system are understood, it significantly changes not only in the minimal dependence of an external supplier, but also in the regular updating of important parts of the site in the sense of - the information is inserted by the creator at the time the information originates, when the responsible person gets in it. Financial savings are also not negligible, since the correct adjustment of the processes in the organization requires the supplier to change the design, not the content, when updating it. These are direct - visible costs, as few organizations are able to pay for a change, e.g. up to 1 hour or less, however, content management system provides it.

Keywords: web content management system, content management system, university portal.

JEL Classification: O10

1 Introduction

Content Management System (CMS) is software that is supporting creation, actualisation and publishing of digital information on the web sites. The advantage of CMS is that the user does not have to know programming, the knowledge of common IT user is sufficient. The content can be edited online and the changes are applicable immediately. CMS is appropriate for the creation of various web sites, as well as, the creation of e-shops, blogs, discussions and social media.

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2 History

As stated in Jedlickova (2015), since 1996, a few enthusiasts have begun to write their own source texts for web site creation and their management. In 1998, the first editorial system TYPO3 was created (Dalhouse, 2008). After the turn of the millennium, the popularity of open-source development grew. Free-licensed software was provided for unrestricted use and customisation. From 2000 to 2004, various proprietary solutions have been developed and since 2004 there are development-supported open-source CMS. The "pioneers" of such CMSs include, for example, Mambo and Drupal. Content management systems may not only manage content on the web, it is the management of any electronic content, but if it is web-based, it is called a web content management system. Since today it is mostly web content, the differences between CMS and WCMS do not exist anymore.

Content management systems can be divided into multiple groups: Portal editing systems, e-learning editing systems, blog systems, online shops, groupware systems, various forum systems, wiki systems, various photo gallery sites, and video galleries.

There are plenty of free-licensed CMS on the web that can be found e.g. at URL: http://opensourcecms.com. There are found 178 CMS.

Several enthusiasts at Slovak University of Agriculture in Nitra, created their own LMS within various projects, moreover, in 2001 a group of IT specialists from the Faculty of Economics and Management, following a visit to the Slovak Agricultural and Food Chamber (SAFCH), decided to help the SAFCH with their experience not only with network infrastructure, but we have suggested that we will help them to make their site more up-to-date and user-friendly. To achieve that, we wanted to create the web site that they can manage themselves. We have outlined the key information that needed to be kept up to date and we have developed a system to manage that. We have selected various entries for the key information, in particular minutes of meetings, regulations, guidelines and a photo gallery.

At that time, the term CMS was still not mentioned. The website of SAFCH has been functioning for several years, occasionally they wanted a new template from us, but otherwise they were able to help themselves.

3 CMS in commercial non-informational organisations

Students conducted a survey, what are the most widely used CMS in non-informational organisations. In the first place was WordPress, on the second Joomla!, Drupal ranked third. The most popular criterion for companies was simple usage with regard to installation and creating a web site. WordPress is very simple in the basic installation, it is necessary to install plug-ins (extensions, modules). The safety has to be on the first place. Plug-in from Michael Torbert, called SecurityScan, will perform a basic security check (Vojkovsky, 2017). Plug-in checks the security of passwords, database, or access rights to files.

4 CMS at the universities

The team of solvers of the Portal of Universities investigated how it looks with CMS at the universities in Slovakia. There were considered university-wide CMS, but also CMS used at faculties. The result is shown in the Table 1.

Table 1: CMS used at the universities

CMS	University-wide solution	Only Faculties, not university - wide
Contao	1	
DotNetNuke / DNN PlatforI	1	
Drupal	4	4
Frontpage	1	
Joomla!	4	7
Plone	1	1
Typo3	2	
WebGui		1
WordPress	4	2
Custom made	15	11

Surprisingly, 15 universities resolve their CMS on contract via a supplier. These are different CMS systems from different suppliers.

According to Galovicova et al. (2017) 53.6% of all university websites were created by commercial companies.

5 Portal of Universities

The main goal of the Portal of Universities (Portal VS) is to develop systematically and professionally guaranteed information relating to universities, integration and interconnection of key university-related systems, gathering information in a short space of time, access to central databases and numerals, and, in the case of a central electronic application, a solution enabling a transparent environment and a uniform way of applying for university studies.

The Portal of Universities as a project was designed in 2005 and was resolved within the EUNIS-SK working group in 2006. The original information system was delivered in 2007 and subsequently upgraded with other modules, development of the administration, etc. Since 2012, it is part of the data centre of the Ministry of Education, Science, Research and Sports of the Slovak Republic.

The main goal of the Portal of Universities by 2020 is to become source providing general but also personalised information, applications and services for the general public, focusing in particular on higher education institutions (universities).

Target groups of the Portal of Universities are:

- Secondary schools - university graduates, educational counsellors.
- Universities - students, teachers, other employees.
- Graduates - access to information on educational activities in the Slovak Republic, statistics, and evaluations.Taras
- Companies – employers.
- The wider public – candidates interested mainly in further education managed by universities, people interested in events at university, conferences, seminars, etc.

The following systems are closely linked to the Portal of Universities:

- Electronisation of applying to the university.
- Central Register of Students.

- Central Register of Employees.
- Information system for administering grant schemes (Fabus et al., 2010).
- Development, analysis and linking of the on-line mobility concept.

Connecting key university systems to the Portal of Universities are:

- An academic information system.
- An economic information system.
- Library information system.
- University Web (Internet Information System) (TDKIV, 2017).

At present, it is very important to eliminate the insertion of the same, respectively very similar data several times to different systems. It causes not only unnecessary loss of time, but also, in particular, unreliability of information, because it can lead to various mistakes or inaccuracies when inserting them. This, among other things, is about simplifying the credibility and truthfulness of information, especially on websites.

Achieving the goals of the Portal of Universities provides in point "Developing systematically organized and professionally guaranteed information related to the universities" persons responsible for the content (assigned by the rector of the university) - the whole-school administrators who can insert and modify data for the entire university and its components and faculty administrators who can insert and edit the data behind the faculty.

Getting information in a short time from one place is especially important for prospective students. The Portal of Universities allows it to them.

All universities have unified access to central databases and codes, thereby was next goal fulfilled.

The goal "Integrating and linking key systems concerning universities", which is related to the goal "Inserting information once only", is the most difficult to fulfilling. To reach this goal, the solving team decided to visit universities and present opportunities for integration personally.

In particular, it is possible to transfer the data from “their” academic information system to the Portal of Universities using exchange formats. This has been done for several years at the Slovak University of Agriculture, where the administrator, when filling in the data on the portal, sees the transmitted data written in grey colour lettering without modification and only adds data that do not contain their academic information system (Figure 1).

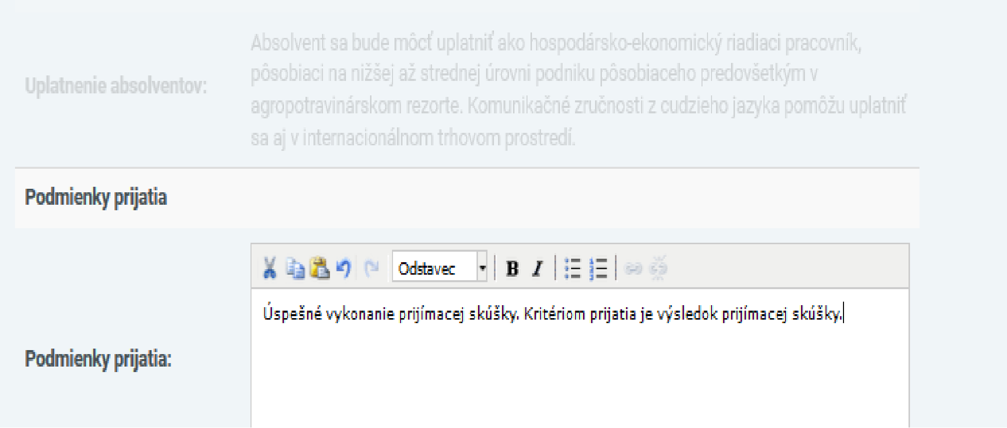

Figure 1 Inserting information only once - sample, Source: Author

The research team has chosen 3 CMS, among the all CMS used in universities, to present all of what can be done with the data taken from the Portal of Universities, and that they can be displayed differently, during visits the universities.

This is an interconnection of the Academic IS - The Portal of Universities - CMS (university website, faculty website).

The demos are done in:

CMS Contao (Figure 2),

WordPress (Figure 3),

Joomla! (Figure 4).

Similarly, it is possible to connect university, or faculty CMS with other Portal modules, conferences and seminars, and e-course information, teacher evaluation.

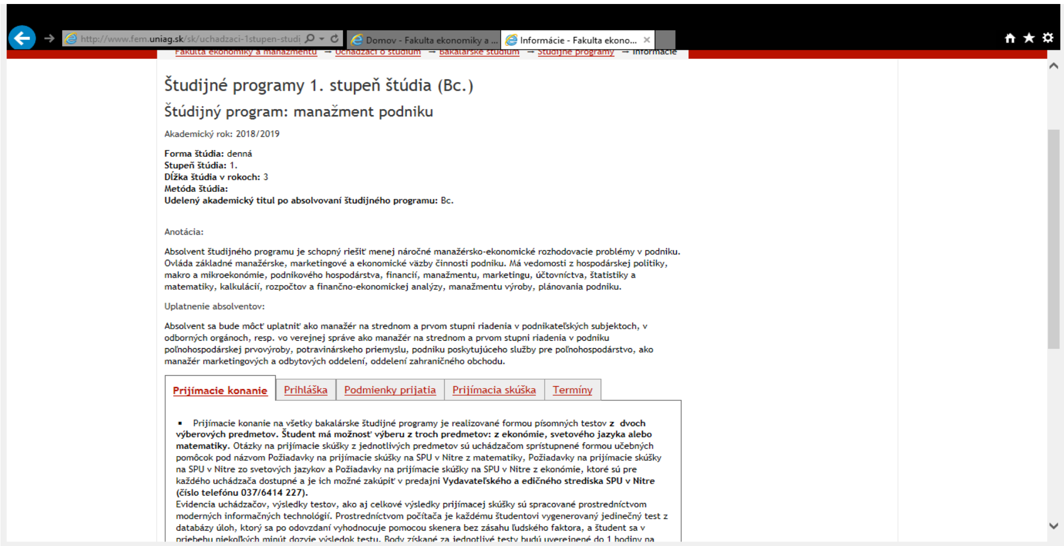

Figure 2 Study programme information shown in Contao, Source: Author

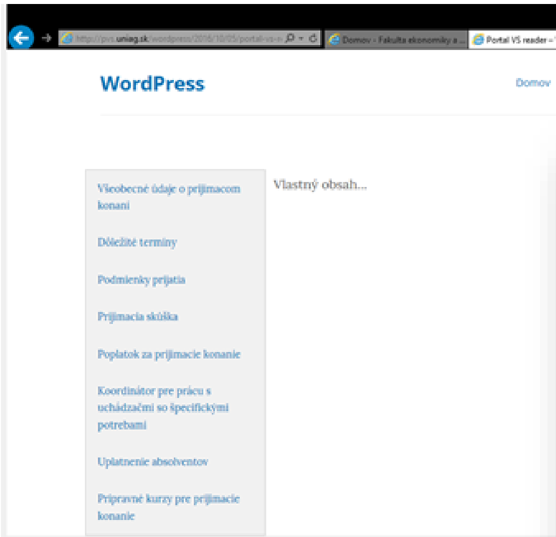

Figure 3 Study programme information shown in WordPress, Source: Author

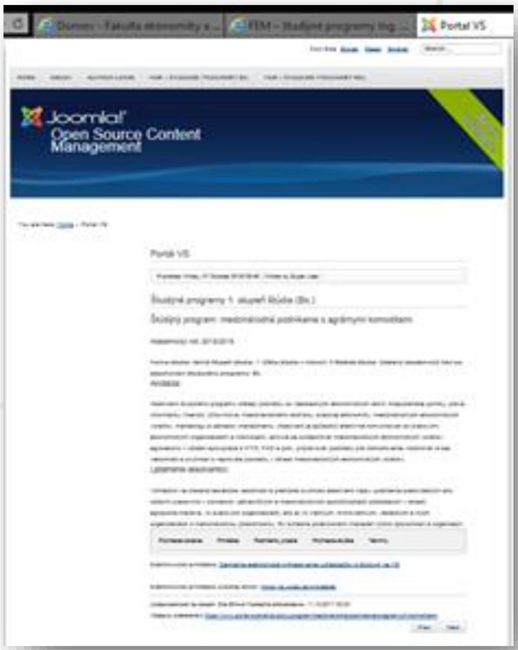

Figure 4 Study programme information shown in Joomla! Source: Author

5.1 Central Electronic Application (CEP)

The main goal of central electronic application to the universities as a service for applicants for studies is to allow send applications from a single one environment to the several universities.

Characteristics

- A uniform way of applying for university studies.
- Transparent environment.
- The ability to search for information from one location.
- The applicant enters data about himself only once, also in the case of reporting to more universities.
- Possibility to use the data of the candidate from the previous year.
- The possibility of submitting an application to several universities without requiring repeated entries of identical data.
- SMS notification to the applicant.

Integration with academic information systems (AIS) of higher education institutions is very important. All suppliers of academic information systems declared a link to the central application (CEP). Integrated AISs are:

- Zilinsky akademicky IS (own AIS)
- MAIS
- UIS IS4U
- AIS2

Even so, all universities do not receive applications from CEP. This is also an important question of the visits being carried out, where the emphasis is placed on the candidate and the equal rights of all the choices made in the decision-making for a particular university. In addition, the university must be interested in every candidate.

Conclusion

The Portal of Universities is a gateway to information for applicants, but also for university students and the general public. It also creates a gateway to national projects and other ISs, such as KEGA, CREPČ, and Electronisation of applying to the university. It benefits for universities that provide information about their universities, publish events organized at their universities and e-courses. The continuation of its operation has a great importance as the Portal is being built since 2006, there is a lot of information, university can exchange information with their IS using exchange formats, as for example Faculty of Economics and Management of the University of Economics in Nitra (information for applicants - years and conferences and seminars - innovations are being prepared) - this is only a one-time insertion of information and the possibility of their multiple presentation!

Within the Portal of Universities, a custom CMS is used. It is built on web technologies using HTML, CSS, and JavaScript programming languages. The interface is programmed using jQuery libraries and designed to make the user aware of the intuitive application. The web application runs on the Apache web server on the operating system Linux Ubuntu LTS and is programmed using PHP, Python and Bash. It uses PHP framework Nette and ORM framework Doctrine2 for mapping relational database objects with DIBI.

The key problem of effective develop of communication, coordination and control in the knowledge society is fast and effective providing of guaranteed information, the possibility of speedy and flexible searching, as well as providing and exchanging of valid experiences and knowledge. To ensure these processes in the required quality and range is possible only by informative and transfer technologies. These require achievement of the basic conditions of technological equipment and informational literacy of people. Accurate information at the right place and in right time is unthinkable presumption for effective management. In order to have them at disposal we need quality informational system, which ensures that our decisions will be always based on the real base (Krivonakova, 2012). Properly-built CMS, and its integration with other systems using standardized data exchange formats allows for data sharing. Data sharing resolves the difficulty and error rate of multi-input insertion of these data into different systems.

The article shows the importance of CMS with the presentation of one of them, on which the Portal of Universities is built. The importance of integrating different CMSs using exchange formats is highlighted.

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Changes in the Evaluation of Quality of Integrated ERP Systems - Causes and Effects of these Changes

Milena Tvrdikova[1]

Abstract. The variability of the internal and external environments brings about numerous requirements for the exchange or modification of a part of company IT. This results in the requirements for a stable system performance at a high degree of adaptability.

There is a change in thinking in relation to innovating, operating, managing and financing of company information systems. The large increase in the volume of data coming into companies from both internal and external sources, changes the approaches and methods offered in the field of data processing also.

IT vendors offer integrated enterprise resource planning systems (ERPs) and their operation in the form of services to replace on-premise solutions. The transformation of ICT into the services sector is reflected in the changes in the business environment.

The use of modern ICT, automation and robotics as part of the solution of many processes produces huge volumes of structured and unstructured data daily. There are significantly increasing demands on the security of information systems and populations around the world. The lifestyle of the society is changing, too.

The aim of the paper is to analyse the current ERP market situation and to identify the appropriate criteria for the selection of ERP vendors in the ICT transformation into the services sector for interested user companies in relation to changes in society, increasing volume of data, methods of their processing and the quality of analytical tools offered.

Keywords: IS innovation, data volume increase, ICT as a service, management changes.

JEL Classification: L86 M15

1. Introduction

Trends in Information and Communication Technologies (ICT) are primarily influenced by technological innovations that lead to increased microprocessor speeds, computer memory capacity, and computer network speeds. Integration trends contribute to reducing the size of devices and increasing their functionality. Intelligence move from end devices to networks. Entrepreneurs

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also automatically require the mobility and personalization of application devices. Technological innovation is followed by the development of new applications.

In this decade, developments in ICT have also brought about significant changes in company management methods, organizational arrangements, and demands placed on decision-making support tools. This is a transition to process management of companies using ICT – the effort to uniquely and efficiently connect ICT with the business model, corporate culture and business processes. Companies aim to increase the speed of response to major events, reduce costs, and increase the quality offered to customers. There is also a change in the relationship between business and IT. Service-based platforms are required. There is a division of responsibilities for the benefits and costs of ICT between business and ICT managers. The number of scalable ICT services is increasing. The number of requirements for the use of Cloud Computing (CC) when innovating the company information system (IS) is growing.

To ensure the necessary flexibility in management, managers require a comprehensive information system, which has to be dynamic and contain the necessary functionalities to different extents in different time periods. Solutions using CC increase a company's flexibility, have a positive impact on its production and competitiveness. CC service vendors can cover the entire information technology infrastructure of a company, from HW, SW, running of applications, to data storage, organization structure and security. The ICT is being transformed into the services sector.

IT vendors offer integrated ERPs and their operation in the form of services to replace on-premise solutions. The transformation of ICT into the service sector is reflected in changes in the business environment, requirements for the quality of data processing and the transformation of the data into relevant information.

Automation and robotics as part of the solution of many processes produces huge volumes of structured and unstructured data on a daily basis, both in the corporate environment and beyond. The lifestyle of the society is changing, too. There are significantly increasing demands on the security of IS and populations around the world. Growth in data volumes and prognosis for the future show Figure 1.

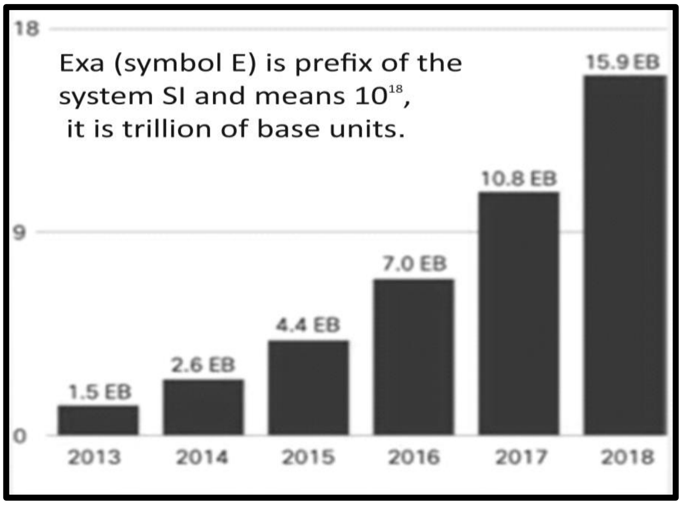

Figure 1. Growth in data volumes, Source: 2014, own

The aim of the paper is to analyse the current situation in the ERP market, identify the appropriate criteria for the selection of ERP vendors in the ICT transformation into the services sector for interested user companies in relation to changes in society, increasing volume of data, methods of their processing and the quality of analytical tools offered.

2. Theoretical background

2.1. Principles of CC technologies

There are many definitions of CC technologies by different authors and official sources; therefore, a selection of only a few is provided below. The reason for this is that the range of views on these technologies is expanding with the expanding number of ICT services. “A cloud is defined as the combination of the infrastructure of a datacentre with the ability to provision hardware and software.” says Sosinsky (2014).

The definition of the US National Institute of Standards and Technology, which defines the CC as a “model of a service that allows immediate, easy and on-demand network access to a shared offer of configurable computing resources that can be provided at minimal administrative costs and need of coordination with the provider of these resources”. This definition allows us to derive the basic characteristics of cloud computing – a self-service system, broad accessibility, numerous resources and flexibility (Mell and Grance, 2011).

Gartner, Inc. (Gartner, Inc. US research and consulting company in the field of IS/ICT technologies). It defines CC as: a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies. (Gartner, Inc., 2016). It describes the basic characteristics of CC as follows:

- *Self-service system* – automatically sends customer responses to the service provider. Service level and IT outputs (availability, response, performance vs cost), implementation solutions and the technology used.
- *Scalability* – Scalability is a feature of the basic infrastructure of software platforms. *Customizability* – it is linked not only to size but also to an economic model that allows scalability in both directions adding or removing the required amount of resources as needed.
- *Sharing* – using IT resources with maximum efficiency, i.e. sharing basic infrastructure and software among service users, which will make better use of available resources and reduce costs.
- *Frequency of use* – if a service provider adapts an accounting model based on the use of a service, different pricing plans and models can be created. The assumed payment plans are then based on the frequency of use of the service (on hourly rate, the amount of data transferred, etc.), not on the price of the device.
- *Use of internet technologies* – based on Internet technologies, formats and protocols.

2.2. Role of integrated IS in companies

For effective management of corporate and external resources, most companies today use the ERP systems. The ERP systems integrate most business processes. The ERPs have a modular structure and their content and scope differ as required by individual companies. Company management and process owners in each area of company activity are always co-creators of these systems. ERP includes a wide range of software products supporting day-to-day business operations and decision-making. ERP systems allow seamless integration of processes between functional areas with workflow processes, standardization of business processes, improved order management, accurate inventory overview and more efficient supply chain management (Aier, Bucher and Winter, 2011). ERPs are traditionally used by large industrial companies; today, the ERP market has changed and ERPs are also used in small and medium-sized companies (Hedman and Johansson, 2011). The trend of providing ERP in new forms such as open source ERP (Atem de Carvalho and Johansson, 2012) and cloud ERP will become even stronger (Johansson et al., 2015). At present, the trend in the companies of ICT vendors and customers is the transition of their IS to cloud computing as one of the possible forms of ICT services is extremely strong.

2.3. Changes in supplier requirements

Attention is paid to new solutions that significantly improve traditional approaches. Traditional approaches include specific tailor-made solutions, heuristics (heuristic solutions are often approximate, based on informed experience, intuition, experience, or simply on sound judgment) and data mining. Attention is paid to: processing a much larger amount of data, using new analytical approaches (such as deep neuronal nets and natural language processing). These solutions place significantly greater demands on the computing infrastructure and specialised skills of the vendor. In February 2017, Gartner, Inc. published a new type of Magic Quadrant (MQ). (9)

Figure 2. Magic Quadrant for Data Science Platforms (Gartner, Inc.)

"Magic Quadrant for Data Science Platforms" focuses on the possibilities of expert data processing in newly created IS solutions. It evaluates 16 vendors that can be the best choice when dealing with new designs. The choice depends on the requirements and expectations of a particular company. The analysis was performed by Linden et al (2016).
The analysis has shown that vendors turn their attention to:

In order for vendors to be included in the "Magic Quadrant for Data Science Platforms", they must also meet revenue requirements and identify reference customers that constitute a major cross-sectoral and cross-geographic traction. Only then do they qualify as suitable companies. Based on these criteria, 16 vendors qualified to be included in this MQ were identified.

3. Prerequisites for the effective use of ICT services in company IS.

3.1. User companies and organizations

In order for a company to make the transition to flexible IT, it should gradually and conceptually change the overall IT architecture, rather than be limited only to the IS features being currently changed. The investment in building the concept of a flexible IT architecture have no direct financial return, but they lead to a significantly faster and cheaper integration of new components and implementation of changes in company IS.

With the innovation of the company IS, the IT staffing structure changes, but the total number of ICT workers in the enterprise will not decrease. The pace of ICT development brings new demands and changes the requirements for the skills of IT specialists. The close link between ICT and business forces IT staff to focus on the relationship between business and ICT. Employees of the user's ICT department will have to be able to better demonstrate the importance of high-quality ICT for business and offer new possibilities for the use of ICT in business.

Customers are becoming increasingly perceptive to the need for risk management in early implementation of upgraded IS. They know that many innovations end up failing. They often realize that they lack the necessary knowledge and ability to prevent such situations. In this respect they are very pragmatic and seek to maximise the transfer of risks resulting from quick launch of the innovated IS to the vendor.

3.2. ICT providers – solutions vendors

The number and nature of the above requirements leads to the decision of IT companies to use shared CC services to develop, deploy and integrate the overall solution for the innovation of their customers' IS. Such solutions can support business processes of multiple customers efficiently, with a minimum of customization.

Vendors are expected to adapt the solution to the customer's information strategy. However, vendors want to make the most of the scale offered by the standardised solution. They have to decide what they will offer the users, whether customized standard solutions or tailor-made specific solution. They have to consider whether they are able to provide the necessary level of security for different applications and company data, and whether there is consistency between the specific business and regulatory framework conditions.

The pace of changes in the real world and in the ICTs (environment variability) creates an increasing number of requirements for vendors to comply with.

4. Proposal of a set of measures to achieve the desired effect in the creation and implementation of the transition strategy.

4.1. Innovation of a company IS

A prerequisite for the success of a company IS innovation is the development of a new global corporate strategy, based on the company's current conditions and possibilities. It will form the basis of the requirements for an effective information strategy that respects the opportunity to use modern ICT solutions. Managers thus get the data for a strategic decision on which automated ERP operations are more convenient to be bought and operated as an ICT service and how to properly begin the transition to new technologies and to develop rules for the transformation of data and application. They must prepare a Cloud Readiness Assessment. It is based on a detailed analysis and sound selection of applications and processes for migration. If they are also interested in specific solutions to expert analyses and data processing, they have to decide which one to choose and in form they want to get and pay for them.

The supplier cannot deal with the transition to the services sector without coordination with the managers of the vendor. Implementation of the decision is always accompanied by risks which can reduce the expected effect of the decision.

In the case of a new supply agreement, the clients must inform the vendor of:

- real developments in the organization’s environment and major internal changes in the organization’s behaviour.
- Level of participation of the relevant employees in the new solution.
- Requirements for quality of methodology, quality of information, quality of knowledge.

Cloud has an impact on safety, compliance with standards and rules, the law and IT infrastructure. However, it also requires major changes in company management. The nature of the applications mentioned above shows that it is no longer a conventional service in the sense of past computing centres or network administrators. These are IT features which are an integral part of the strategic, management, business, operational and other processes in the company. IT management must therefore be an integral part of the company’s management, and the opinions that IT should not meddle in corporate management are wrong.

4.2. Transition of companies to operating ICT as a service

User companies and organizations

The decision to transform part or whole company IS into CC has a significant impact on the situation in the user company. Companies need to develop key skills supporting the use of ICT – how to use ICTs to gain a competitive advantage, create new products or services, find new customers, speed up the company’s response to external events and reduce the costs of business processes.

Must prepare requirements for volume, quality and price of services. To specify the procedure for selecting the optimal vendor and the rules of systematic controls of ICT service delivery. Also, determining the rules for the controlling of IT services and measuring the effect of ICT on the quality of company processes.

Therefore, the CIO of the company and his team must have a steady supply of all the information about the top-level negotiations on company strategy, changes in marketing and in business.

A number of decisions on the use of ICT are made within the competence of the persons responsible for business processes and interfere with strategic management. This changes the skillset required from managers and many company employees. Managers who understand the possibilities offered by ICT to business and how they can be used to attract new customers are today indispensable members of the top management. When using CC applications is changing mainly the of the specialisation of programmers, administrators and other technology-oriented employees.

The number of employees responsible for the links between business and ICT services is growing. Their work description includes defining ICT requirements, preparing, formulating and checking contractual relationships, (e.g. SLA), and service delivery control. However, these employees will not work directly in the ICT department.

ICT providers – solutions vendors

There is also a change in the vendor company. Managers of the user companies emphasize the requirements for shortening the delivery times, budget reductions and complexity of mutually integrated systems. They consider them the input parameters for vendors, which have the same importance as demands on the functionality or performance of the desired information system.

There are growing demands for the mobility of solutions. Display and control devices today involve a range of mobile devices that people want to use in management. Given the possibility to run applications virtually anywhere, it is necessary that the mutual integration of these devices is defined by standard interfaces.

At the design and delivery stage, pressure is often placed on vendors to use innovative approaches such as agile system development, prototyping, or extreme programming. This is due to requirements to accelerate delivery and also to make managers more aware of developments in ICT.

Variability of environment – the pace of changes in the real world and in the ICTs creates an increasing number of requirements for vendors to comply with. The possibility of real-time data analysis is one of the most important elements of the new generation of ICT infrastructure. Analytical tools integrated into network equipment allow recording the events on the network, monitoring its performance and detecting any anomalies. This results in a much more effective protection against possible attacks, as well as the possibility to optimize the network in real time.

Analytical tools for real-time big data analysis are also required. They open way to business intelligence applications and transmission network management.

The number and nature of the above requirements leads to the decision of IT companies to use shared CC services to develop, deploy and integrate the overall solution for the innovation of their customers' IS. These solutions can support business processes of multiple customers efficiently, with a minimum of customization.

The vendor, however, also takes a considerable risk, because the decision to transform part or whole company IS into CC is part of a company-specific information strategy.

The vendor cannot deal with the transition to CC without coordination with company managers, who are informed about the possibilities of current ICT in relation to the entire business strategy of their company, the availability of its human and financial resources.

4.3. Criteria suitable for selecting an ERP vendor

The number of criteria for the selection of the right solution grows at the same pace as the offer of new IT. Some of the criteria are mandatory, required by most users. Others are mandatory only for some users, due to the specific needs of their business.

General requirements

- **User interface:** Does the solution have a logically coherent "look and feel" and an intuitive user interface?
- **Flexibility, scalability and openness: How can the solution integrate open source libraries? How can users create custom features? How does the solution work with laptops?**

- **Performance and scalability: How to manage desktop, server, and CC deployments? How to use configurations with multiple and multi-row features?**
- **Work with data**

  Access to data: how well the solution supports access to and integration of data from various sources (on-premise and in CC) and of various types (such as text, transaction, image, audio, time series, location data and position data, streaming (technology for the continuous transmission of audio-visual material between source and end user).

  Data preparation for modelling: the solution must contain a sufficient number of coding or non-coded functions, such as data transformation and filtering.

  Data survey and visualization: the solution will allow you to do a number of analytical steps, including interactive visualization.

  Further advanced analysis**:** integration of further analysis methods into the development environment (including statistics, optimization, simulation and text and image analysis).

Specific requirements for analytical data processing

- **Machine learning:** What tools does the solution offer for machine learning, are they delivered pre-packaged or are they easily available in the solution?
- **Automation:** Does the solution allow automation of function generation and hyper-parameter tuning (must be pre-fixed in machine learning)?
- **Cohesion:** How intuitive, consistent, and integrated is the solution for the support of all data analytics? The solution must provide metadata and integration capabilities for previous requirements so that data processing teams are more productive throughout data processing and in linking the analyses required. This meta-capability involves ensuring that data input/output formats are standardized wherever possible so that components have a consistent “look and feel” and terminology is consistent across the solution.

Requirements related to project activity

- **Solution and project management:** What management capabilities does the solution provide (such as security, computing resources administration, management, reuse, and project version management, line count and reproducibility control)?
- **Model management:** What features does the solution provide for monitoring and calibrating hundreds or thousands of models? This includes model testing capabilities.
- **Cooperation:** How can users with different skills work together on the same workflows and projects? How can projects be archived, commented on, and reused?
- **Preliminary solutions:** Are ready-made solutions (such as cross selling, social network analysis, fraud detection, recommender systems, purchasing tendencies, failure forecasting and anomaly detection) that can be integrated and imported through libraries?
- **Delivery:** To what extent does the solution support the capability to create APIs or containers (such as code, predictive modelling mark-up language (PMML) and pre-package apps that can be used for faster deployment in business scenarios?

The pace of changes in the real world and in the ICTs (environment variability) creates an increasing number of requirements for vendors to comply with. The possibility of real-time data analysis is one of the most important elements of the new generation of ICT infrastructure.

5. Conclusion and the directions of further research into the issue.

There is an interdependence between the companies' ability to use ICT and the ability to use them to promote their global strategies to achieve their goals. It is clear that not only the constant development of ICT is important, but the technologies themselves. It is necessary to improve the quality of the data and information they produce, that is, to transform them into knowledge effectively. Equally important is the ability to apply and use knowledge and ICT infrastructure across the company.

It is becoming increasingly clear that the ability to respond to ICT trends is crucial to the development of the whole economy. That is why it is necessary to raise managers' awareness of the current possibilities of ICT in supporting their decision-making and achievement of business goals, and to look for ways to support the deployment of new information and communication technologies into integrated information systems of companies and institutions.

It is advisable to continue by working on the design of the methodical approach in order to develop an effective solution in response to the growth of data volume, methods of their processing and the quality of the analytical tools offered. It is also possible to continue by studying and analysing the impact of changes in ICT on the methods of business management in companies and their organizational arrangements.

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E-services as a Key Element of the e-Government Priorities of State Administration in Bulgaria

Stefan Varbanov[1], Mariana Petrova[2]

Abstract. The share of administrative services in Bulgaria, available electronically is about 64%, with 80% on average for the European Union, but here the active normative acts are in huge numbers-over 3300. Two-thirds of them, however, are connected with the central administrations.
The main focus of the State e-Government Agencies placed in eight priorities as the focus is on users of administrative services, introduction of the principle of single data collection and pooling procedures. The Agency will offer system and will monitor the implementation of e-procurement, and a new system to replace the current electronic signature.
Initially there are going to be provided upgrades to key primary registers as Civil status and USCRASP systems, address register, trade register, together with others, that will be consolidated – land and cadastre, registration of motor vehicles and the basic systems of the NRA and the National Customs Agency.
The second part of the plan, as to the year 2020 is envisaged to have 480 new priority e-services.
The article reflects the results of the authors in relation with the provision of e-services in Bulgaria, as well as the problem with the whole appearance of the regulations of the State administration.

Keywords: e-government, e-services, e-administration.

JEL Classification: M1

1. Introduction

E-governance is a policy priority for the Bulgarian government. It is one of the ways to get out of the economic crisis, to reduce corruption, to reduce administration costs and increase its transparency. (Petrova, 2016).

The scope of information, provided data and services must comply with all legal requirements of the Republic of Bulgaria (Agents Act, Concept of e-governance in Bulgaria 2015-2020, Roadmap for the implementation of the

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Strategy for development of e-government in Bulgaria 2014-2020, Strategy for development of e-government in Bulgaria 2014-2020, etc.

The main problems in the area of public administration in Bulgaria are: the irrational use of resources, duplication of data, multiple input of identical information, the lack of automated data exchange between different systems, even within the same administration (Petrova, 2016).

The aim here is to align and simplify the relevant procedures without substantially alter their nature and optimizing the outcome. It is expected to develop new methods for automated electronic exchange of information while ensuring the protection of the data and the inability to be subject to unlawful actions by unauthorized entities, including within the same host or store of the administration. (Nenkov, N.V., Petrova M.M. and Dyachenko, Y., 2016)

The use of such funds in the State administration is time for optimization and enhancement of its efficiency in complex modern conditions (Nenkov and Varbanov, 2016)

The first challenge for the development of eGovernment in Bulgaria is e-government thinking only as the provision of administrative services electronically via the Internet. However, this is only part of the overall picture. The right questions relate, first, to what is happening within an administration, what are the working processes. And, second, how administrations interact with each other, share information, share resources.

The construction of e-government and electronic administrative services is a process that requires a great deal of administrative potential. (Petrova, 2016).

The components associated with the provision of e-services by central and municipal authorities include the single access gateway (E-Gov), e-authentication, e-authorization, e-payment, e-service and e-validation modules and a common service access and inter-link system.

2. Information System RMC 593

By Decision No 338 of 23 June 2017, the Council of Ministers took measures to reduce the administrative burden on citizens and businesses by removing the requirement for certain official paper documents to be submitted.

In the appendix to item 1, letter "a" of the RMC, the respective certification services are defined. For issuing certificates from the list of services, administrations use registers from registers, and the data they contain is retrieved by the administrations electronically.

The possibility to provide these services is realized through the RegiX interface, which provides an opportunity to implement an interface for automated submission and service of standardized administrative service requests electronically. With the developed components necessary to connect the information systems of the administrations, it is possible for the users of the information to automatically retrieve data from basic registers such as the National Population Database, the BULSTAT Register, the Property Register, the Trade Register, the Register of Obligations to the Customs Administration, Registry of Registered Personal Data Administrators, Registry of Bulgarian Identity Documents, Single Registry of Foreigners, Registry of Secondary Schools and Nurseries, Register of diplomas and certificates of completion of primary and secondary education and acquired professional qualification degree, Register of Insolvencies, Register of payers and others.

The RMC 593 Information System of the Ministry of Finance operates on the basis of Council of Ministers Decision No 593 of July 20, 2016 on the Terms and Procedure for Payments to Budget Treasurers under Contracts. Instruction outline was prepared. No УК-2 / 29.07.2016 of the Minister of Finance on the application of the Council of Ministers Decree No. 593/2016. Through the services provided by the Council of Ministers, the Council of Ministers 595 aims at supporting the budget spending units - ministries, agencies, municipalities, etc. by automated electronic means of information on the existence or absence of obligations collected by NRA and the Customs Agency for contractors. The CMS 593 covers the process of notifying NRA and the Customs Agency of the need to take action when a person's obligation is established; confirmation by the NRA and the Customs Agency that the payment may be made when the contractors do not have or have any overdue public liabilities, but they are secured under the Tax-Insurance Procedure Code / Customs Law; sending and service of documents already issued with a view to imposing precautionary measures and enforcement on the amount due for payment when contractors have overdue public liabilities and are not secured. The automatic checks and actions carried out by IS RMC 593 are set out in Item 3 of the Instruction of the Minister of Finance.

The first supporting documents, which should be dropped on paper after 31.12.2017. are:

- Certificate for BULSTAT registered in the Registry, issued by the Registry Agency;
- Certificate for the entries, remarks or deletions of a legal person's account in the Property Register, issued by the Registry Agency;
- Certificate for the entries, remarks or deletions per individual account of the Property Register, issued by the Registry Agency;
- Certificate of current status from the Commercial Register, issued by the Registry Agency;
- Certificate of presence or non-existence of public state receivables collected by the customs authorities, issued by the Customs Agency;
- Certificate of marital status, issued by the municipal administration;
- Certificate of marital status, spouse, children, issued by the municipal administration;
- Certificate of marriage, issued by the municipal administration;
- Certificate of the existence or absence of obligations, issued by the National Revenue Agency;
- Certificate YP-7 for the size and type of pension (s) and supplement (s) issued by the National Social Security Institute;
- Certificate YP-8 for income from pension (s) and supplement (s) issued by the National Social Security Institute;
- Certificate of Recognition of Acquired Higher Education Abroad, issued by the National Center for Information and Documentation.

The twelve paper-based certification regimes have an impact on over 1 million services per year and are associated with many other administrative services. Until the reform is fully completed, the digital and paper processes in the administration will exist in parallel.

3. Electronic administrative services at the Customs Agency

The Customs Agency successfully develops e-services not only at the national level but also at the European level.

The new Customs Code of the Union is aimed at meeting the Lisbon Strategy goals. This code requires the application of the legal principle that all customs and commercial transactions are processed electronically and that in each Member State the information and communication systems for customs operations offer the same facilities to economic operators through national and pan-European e-services.

- An example of this is the development of BCA IAM, which provides the following services and capabilities:
- Providing a national service that is integrated with electronic customs systems will ensure direct harmonized access for traders to centralized systems at European Union level;
- Ensuring systematics in the process of identification, authorization, authentication and access of users (external and internal) to customs information systems;
- Develop a national system for trader identification and access as a component of the EU-wide common system for direct access to traders;
- Maintenance of authorization and user authentication in the EU-level trading sector through exchange with federated authorization systems of the Member States;
- Creation of a unified module for authentication and identification to AM Information Systems for internal and external users in the form of providing services.

The integration approach of the Customs' Agencu future systems with BCA IAM will centralize and unify user management and access to information systems, with the systems themselves not managing digital identities (users), user authentication, and access management. Instead, the systems will be a Service Provider and will trust the BCA IAM for user management and will use it as a trusted IdentityProvider.

After the implementation of the BCA IAM, access to AM information systems for internal and external users will only take place through the single entry point (Internal Users Access Portal or e-Portal for External Users). Once identified, the user has access to all applications they have rights to and which correspond to the QAA level of credentials used by the user during the authentication process without having to re-authenticate.

4. Diskusion

The established opportunity for implementation of internal electronic administrative services is a prerequisite for achieving one of the main goals of e-government - a complex administrative service for citizens and businesses. As of September 2017, there are 62 core registers administered by 22 central administrations - ministries and executive agencies. There are 512 service e-services / directory inquiries.

The development of a unified architecture framework for eGovernment is the most important task of the State e-Government Agency in 2018 as it will set a working model for eGovernment in Bulgaria. All ICT projects should be in line with it, with all administrations using single modules for e-authentication, e-authorization, e-payment, e-service and more. Budgetary control by the SGA will be supported by a new IS in the agency, which will allow preliminary, ongoing and ex-post control of all ICT projects in the administration

By the end of next year, all major country registers (a total of 62) will have to exchange data on their own on the RegiX platform, as each registry owner has the obligation to maintain a correct and accurate database of all updates. Currently only 8 registers are ready to exchange data electronically through it, with about 100,000 transactions per month, more than 97,000 executed by the Ministry of Finance.

One of the main measures of the Se-GA is related to the intensified transformation of the certification services into internal e-administrative services. Although electronic regulations for some registers and administrative services require changes to a number of laws and subnormal acts, administrations will have to start collecting electronically or on paper the information available to the citizen or firm and delivering the final result.

This will also be done by expanding the possibilities for e-exchange of messages between the administration's flow management systems. The launch of a cloud platform for the provision of municipal services on the model of 50 EAS, developed for Sofia Municipality on a European project, is forthcoming. This model is already used by the municipalities of Bourgas, Radomir and Gabrovo, and they expect this to happen by the end of 2018 and for most of the other municipalities in the country.

By 31 December 2017, amendments to 49 laws and 70 secondary legislation should be made. Eight of the certificates issued to date can be dropped as soon as the regulatory changes have been made, and for the removal of four other documents, it is necessary first to digitize the processes behind them. These are the data certificates in the BULSTAT register, for civil marriage, for registered circumstances, deletions and notes in the Property Register in a physical and, fourthly, legal entity register.

5. Conclusion

EGovernment is not a tool for the self-embedding of information and communication technologies in various branches of government.

It is above all an instrument for reforming administrative processes in the interests of their end users - the people, the business, but also the administrations themselves.

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INFORMATION SECURITY

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Comparison and Analysis of Major Cryptocurrencies

Jaroslav Brada,[1] Jiří Sedláček[2]

Abstract. Major cryptocurrencies have been selected according to market capitalization. In August 2017 there were 11 of them with market capitalization over 1 billion USD. These crypto-currencies are compared and analyzed from both technical and market point of view. Technical aspects include hash algorithm, timestamping schema (POW, POS, others), degree of privacy, currency supply and other features (like dApps). Market aspects include comparison and changes of market share, market position and daily yields of cryptocurrencies.

Keywords: cryptocurrency, market capitalization, timestamping, blockchain, mining, hard fork

JEL Classification: E44, E51, F31

There are a lot of publications about cryptocurrencies, but most of them are mainly about Bitcoin (see e.g. Li, X. and Wang, 2017 or Raymaekers, 2015) or deal with some other aspects. Therefore the goals of this paper are:

- Selection of major cryptocurrencies based on simple unbiased criteria.
- Comparative analysis of some technical and market aspects of selected cryptocurrencies.
- Quantitative analysis of selected cryptocurrencies based on available historical data.

1 Selection of cryptocurrencies for analysis

Number of cryptocurrencies is enormous. Today, there are about 800 to 900 cryptocurrencies with some market capitalization and trading value (according to Coinmarketcap.com, 2017a). Many other (now defunct) cryptocurrencies have existed in the past and new cryptocurrency are created all the time. Of course, only dozens of them are really significant. Therefore, for further comparison and analysis we have selected only cryptocurrencies with market

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capitalization over 1 billion USD. As August 22, 2017 there are eleven such cryptocurrencies (see Table 1).

Table 1 Selected currencies, Source: Coincmarketcap.com, 2017a.

No.	Name	Market Cap (USD, 201-08-22)
1	Bitcoin	64,687,388,441
2	Ethereum	29,164,617,583
3	Bitcoin Cash	11,307,226,996
4	Ripple	7,637,479,802
5	Litecoin	2,441,719,783
6	IOTA	2,303,168,824
7	NEM	2,213,757,000
8	Dash	2,185,055,908
9	NEO	1,737,150,000
10	Monero	1,328,131,757
11	Ethereum Classic	1,327,107,829

2 Description and comparison of some characteristics of selected cryptocurrencies

Bitcoin is the first decentralized worldwide cryptocurrency and digital payment system, created by an unknown programmer or programmers, under the nickname Satoshi Nakamoto and released as open-source software in January 2009 (The Bitcoin Foundation, 2017). It is considered direct or indirect "mother and father" of all other cryptocurrencies for several reasons, including:

- For more than two years it was the only cryptocurrency on the market: Namecoin, the first fork of Bitcoin, was created in April 2011. Later, we can see flood of many other cryptocurrencies.
- But until 2015, Bitcoin market share was over 90% or at least 80%. After 2015, other cryptocurrencies are increasing their market share: at first, slowly: in first months of year 2017 Bitcoin's market share was still above 70%. In recent month, growth of other

currencies have increased significantly. As of August 2017 and beginning of September, Bitcoin is still number one, but its market share is somewhere between 50% and 60% (Coinmarketcap.com, 2017a) and day to day changes are sometimes quite large.

- The majority of cryptocurrencies are basically clones of Bitcoin (or some other cryptocurrency) and they differ in some parameter values only (e.g. currency supply, different block time etc.). These cryptocurrencies with little innovation are sometimes called *altcoins*. Only very limited number of cryptocurrencies bring some really new features (some of them are described later).

Bitcoin Cash is a hard fork of Bitcoin. It came to existence on August 1, 2017, as an impact of voting result from July 20, 2017. In this vote 97% of miners were for accepting some changes (improvements) presented in the Bitcoin Improvement Proposal 91: BIP 91 (Crosbie, 2017). Because Bitcoin Cash is so new cryptocurrency, we must wait at least several months to see stabilized results of a fork on both currencies. Currently Bitcoin Cash is 3rd or 4th largest cryptocurrency: not surprising result considering the long time position of Bitcoin.

Ethereum is currently second largest cryptocurrency based on market capitalization (Coinmarketcap.com, 2017a). Initial release of the project was on July 30, 2015 and Ethereum has experienced very significant growth in recent month. Nowadays, its market capitalization is somewhere between 2/5 and almost 1/2 of Bitcoin: one result of strong recent growth is very large volatility.

Ethereum is one of a few cryptocurrencies, which are not just clone or slight modification of Bitcoin. In fact, we can express it in opposite way. Primarily, Ethereum is an open-source, public distributed computing platform with strong smart contract (scripting) functionality (also called dApps) and decentralized Turing-complete virtual machine, the Ethereum Virtual Machine (EVM). Secondly, it is also a cryptocurrency (Ethereum, 2017).

Ethereum Classic is a hard fork of Ethereum (as a result of vulnerability found in Ethereum and disagreement on some proposals). However, Ethereum Classic is much less significant than Ethereum (based on market capitalization): usually holding 10th or 11th position, some days even quite bellow 1 billion USD criteria (Coinmarketcap.com, 2017a).

Ripple is now 3rd or 4th largest cryptocurrency based on market capitalization (Coinmarketcap.com, 2017a). Again, it is better to speak not only about currency, but about the whole Ripple infrastructure: a real-time gross settlement system currency exchange and remittance network (Ripple, 2017). There is also backend institution with the same name: Ripple. But the network is decentralized and can operate without Ripple (as institution). Prominent feature is use of shared, public database instead of blockchain. From practical point it is interesting, that Ripple network is already used by some large banks and other money service businesses (for different transactions, not just for cryptocurrency). Ripple is also considered as a bridge currency (used to facilitate currency exchange, especially for rarely traded currency pairs).

Litecoin now holds 5th position (Coinmarketcap.com, 2017a) and is one of the oldest cryptocurrency after Bitcoin (created 2011). It is also very similar, but has some technical improvements over Bitcoin (Litecoin, 2017). It has larger circulation supply (both current and planned final).

Dash (created in 2014 as XCoin, later renamed to Darkcoin and finally to Dash) has similar feature as Bitcoin but also some advanced capabilities like instant transactions (InstantSend), private transactions (PrivateSend) and decentralized governance (DGBB). During 2017 Dash gained significant increase in market capitalization (Coinmarketcap.com, 2017b; Dash, 2017).

Monero was created also in 2014 (as BitMonero) with strong focus on privacy, also on decentralization and scalability. The whole design is very different from Bitcoin (Latapie, 2015).

NEM was created in 2015 and has some new features in blockchain technology (NEM 2017). *IOTA* was created in 2016, prominent feature is the use of directed acyclic graph (DAG) instead of a blockchain. It also use different type of cryptographic function than most other systems. On August 22 it was No. 6, later it is still in top ten, but most of the time quite lower (Coinmarketcap.com, 2017b).

2.1 Hash algorithm, timestamping, currency supply

Hash algorithm: Bitcoin (and many others) use SHA-256d, generally purpose cryptographic hash function (part of SHA-2 family) used by many application (beside cryptocurrencies) designed by NSA and approved by NIST. Currencies IOTA, NEM use SHA-3 instead (also approved by NIST).

Litecoin use scrypt (also some other currencies not mentioned here). *Scrypt* was published by IETF as RFC for generally usage, but currently is not so widespread like SHA-2 or SHA-3. Algorithm intentionally use a large amount of memory to prevent easy large-scale custom hardware attacks (which is relatively easy on SHA-2 or SHA-3).

Ethereum and Ethereum Classic use *Ethash*, custom made hash function (some people may see as a disadvantage).

Timestamping: Bitcoin (and therefore also many others) use POW system (prof-of-work system), which is also used quite often for other purposes outside cryptocurrencies. Some other currencies not mentioned here use proof-of-stake (POS) instead or even different system. Dash use combination of POW and POS.

Currency supply: in Bitcoin only limited number of new currency units is created per block (at a given time slot). Currently it is 12.5 bitcoins per block (approx. every ten minutes), this number decrease to one half (so called halving) every four year. In other words, less and less new units of currency is issued over time. The total limit is 21 million of bitcoins. Most currencies adapted similar schema, they only differ in parameters, e.g. for Litecoin the final total limits is 84 million. From 11 cryptocurrencies in our comparison, only Ripple, NEM, IOTA and NEO are called as "not mineable". That means all planned supply is issued at the beginning and/or some amount is inherent part of transaction.

3 Cryptocurrencies like "national" currency?

Cryptocurrencies are (from the economic point of view) receivables for non-existent legal entities (or non-existent commodities). Therefore, we examine whether they could be considered like a homogeneous (perfectly substitute-able) items (receivables).

As indicator of that the correlation between daily yields has been selected, since in a homogeneous currency, the correlation between individual currencies should be equal to one. Since the time series for each currency are very different in length, the calculation (see Table 2) is divided into two sub-tables. The first sub-table considers all currencies in a short period, the second one contains a long period scheme, but only for some currencies plus supplemental calculation of standard deviation.

Table 2 Correlation of daily logarithmic yield, Source: own.*

	Btc	Eth	Bcc	Xrp	Ltc	Iota	Nem	Dash	Neo	Etc	Xmr
01-Bitcoin	1,00										
02-Ethereum	0,25	1,00									
03-Bitc.Cash	-0,13	0,05	1,00								
04-Ripple	0,03	0,73	-0,07	1,00							
05-Litecoin	0,28	0,64	0,04	0,64	1,00						
06-IOTA	0,46	0,40	-0,20	0,10	0,05	1,00					
07-NEM	0,02	0,24	0,29	-0,01	0,01	0,15	1,00				
08-Dash	0,18	0,30	0,14	-0,01	0,02	0,42	0,33	1,00			
09-NEO	0,33	0,22	-0,18	-0,03	0,00	0,26	0,29	0,05	1,00		
10-Eth.Class.	0,19	0,83	0,02	0,77	0,69	0,27	0,33	0,34	0,15	1,00	
11-Monero	-0,29	-0,14	-0,12	0,24	0,21	-0,36	-0,07	-0,25	-0,15	0,00	1,00

Period: from 24. 7. 2017 for 21. 8. 2017 (all currencies)

	Btc	Eth	Xrp	Ltc	Nem	Dash	Neo	Etc	Xmr
01-Bitcoin	1,000								
02-Ethereum	0,332	1,000							
04-Ripple	0,145	0,092	1,000						
05-Litecoin	0,379	0,191	0,195	1,000					
07-NEM	0,338	0,265	0,113	0,202	1,000				
08-Dash	0,394	0,361	0,010	0,247	0,318	1,000			
09-NEO	0,230	0,197	0,042	0,253	0,173	0,212	1,000		
10-Eth.Clas.	0,315	0,531	0,014	0,370	0,268	0,340	0,311	1,000	
11-Monero	0,046	0,055	-0,058	0,020	0,043	0,029	0,030	-0,045	1,000

	Btc	Eth	Xrp	Ltc	Nem	Dash	Neo	Etc	Xmr
daily std of yield	0,038	0,067	0,101	0,065	0,082	0,066	0,129	0,070	0,070
anualised	13,862	24,481	36,729	23,704	29,896	24,005	47,094	25,448	25,549

Period: from 1. 10. 2016 for 21. 8. 2017 (selected currencies: where data available)
*Source: own (calculations), data from Coinmarketcap.com, (2017b)
daily yield calculated as t-day = ln(close price day t/close price day t-1)

4 *Conclusions and interpretation*

Uncorrelated daily returns cryptocurrencies measured via daily logarithmic yield closing prices traded currencies in USD indicated that:

- Cryptocurrencies cannot be considered like substitutes, i.e. every daily calculated cryptocurrency yield moves separately and indepe-ndently on each other, i.e. cryptocurrencies cannot be considered like “national” currency (e.g. USD, CZK).

- Daily volatility (daily standard deviation) of daily logarithmic yield confirms that cryptocurrencies are noticeable "price volatility instrument", i.e. too risky instrument which does not allow crypto-currency to be considered like a store of value (treasure).
- Prices movement (analyzed yields) of cryptocurrencies is very similar (based on experience of authors) to "stock daily return behavior" or "futures on commodities" which we could observed on stock exchanges.

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Information Security in Area of Internal Audits

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Abstract. The aim of this article is information security in a multinational corporation. This article describe one part of the information security which is called compliance management from theoretical and practical point of view. The theoretical part describes basic methodology and methods used in compliance management such as Segregation of Duties. The practical part is based on expert knowledge gained by solving issues in this area.

Keywords: Information security, Internal audit, Segregation of duties.

JEL Classification: M42

1 The security approach in the multinational corporations

In the corporation there are used many information systems which are interconnected using interfaces. Each interface is used to communicate with main information system, in this scope SAP R/3. Each interface has to be managed manually including security measures because these are managed by many people. It also can be considered as a risk because the data which are transferred using interfaces can be changed (Pitner & Ministr, 2015]. For this reason, there were set rules and policies to prevent such actions. There are set use cases which describe what common user can and what cannot do with the input data. If there is a serious issue, interface manager has to be contacted in order to resolve this issue. All these rules and policies were set internally in the corporation and all people have to comply. Compliance management also includes regular reviews and checks to ensure that everything is as it supposed to be.

The organization distinguishes the following two groups of roles in relation to information system management. The first group - compliance management group which consists of employees who help administrators

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implement internal business rules, evaluate access risks, and suggest alternative controls due to permission collisions. The second group is a system administrator. This group of employees is in charge of following compliance management instructions. All employees' requests for access to information system are directed to compliance management, which is a mediator between users and system administrators.

Information systems setup and management in the multinational corporations are audited. In general point of view there are two types of audits: internal audits and external audits. External audits are performed by 3rd party companies like as Deloitte, Price Waterhouse Copper etc. usually once per year. Internal audits are performed by internal auditors or by 3rd party based on self-assessment documents.

Internal audit of information systems is focused on user authorization and evaluation of compliance management. Much information systems use a positive user authorization concept which is based on adding a new user without any rights and "need-to-do" principle. According to this principle users should have only the permissions which they needs to daily work.

2 Technical tools

There are many techniques and tools used to perform audits to help determine the actual status of user roles and permissions. Many audit firms use tools based upon the Segregation of Duties methodology. The basic idea of this methodology is that no user should have control over the whole process or key part of the process itself. The Segregation of Duties (SoD) matrix is the outcome of this methodology and is used to ensure separation of these functions, which should not be performed by one user at the same time. The goal of this matrix is a determination of functions or operations which should not be combined.

Otherwise in corporation there are also used "four eyes" principle, which is based on controlling user activities and workers themselves. This principle is used in cases where certain activities cannot be separated and must be performed by one person. This principle uses tools such as approval of the supervisor, monitoring critical indicators or metrics, or tracking user's activity.

The user's authorization analysis is either made by an external contractor for the business or internally audited using an external tool. Due to the complications resulting from the fact that each company has its own rules, it is often used tools which are evolved internally.

3 Data flows

The first step of data flow is downloading the requirement data for analysis from the information system. The quantity of the data stream depends on the size of the organization and number of users which using are the information system. Data should be in the required format for use the specific tool.

After the first step is done the data can be uploaded into the evaluation tool and evaluation can be processed. The output of such analysis is a list of users who violate the compliance rules. Although there are pressures on the automation of the whole process, there are some steps that need to be done manually.

4 Successive steps

The results of the analysis can be seen from a technical and business point of view. For example, if there is a problem with setting up user roles, this is a technical issue and needs to be addressed and fixed by an administrator of the information system. A business problem occurs if the user has the ability to perform collision actions in the system. In that case there is necessary to inform a supervisor of this user which should accept the risk in certain extraordinary cases or uncompromising interventions in the authorization of the user.

5 Conclusion

Information security is very sophisticated process and strictly audited topic in the multinational corporations. There are IT and Compliance Management staff members with high specialization for these operations. Global and regional rules are defined very precisely and there is necessary to strictly adhere to the rules and conduct self-assessment on the regular basis. Such activities are not generating profits, but reduce the cost of poor.

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Features of Projects Safety

Larysa Nozdrina[1]

Abstract. The article presents an approach to security issues as a priority in the context of ensuring sustainable development of the state and society as a whole. The significance of the implementation of the concept of a culture of security in the field of information technology is described. It is noted that safety comes the special significance in the implementation of projects. There is described the difference in the interpretation of the terms "Security Projects & Projects Safety". The components of the project-oriented organization security system and the safety management features of the project that distinguish it from the "classical" understanding of project risk management are highlighted. Considering the aim of the research, there is described the features of the management of functional safety of IT projects.

Keywords: sustainable development, IT projects, Security Projects, Projects Safety, project risk management

JEL Classification: O 220, J 280

1. Introduction

Nowadays to assure sustainable development of state and society in general safety is a priority issue in all spheres of human life. Adhering to the concept of sustainable development, such form of interaction between society and nature, which ensures the survival of the human race, the safety of future generations and the preservation of the environment, will allow building our common future (World, 1987).

Safety needs are one of the most important needs for each individual and the human race in general, as well as for economic agents: from state at the macro-level to enterprise at the micro-level. Safety needs according to the Maslow's hierarchy of needs are the second most important type of needs after physiological needs. These are basic needs, being realized in an ability to prevent and eliminate the dangers for human activity.

The international experience shows, that causes of dangerous situations, accidents and incidents are somehow related to people's behavior, namely, to their attitude to the safety issues. As a result the concept of "safety culture" has been introduced; it first appeared during the process of analysis of causes

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and effects of Chernobyl disaster, conducted by the International Atomic Energy Agency (IAEA). The importance of the introduction of the safety culture concept is also widely understood in the sphere of information technologies, what is pointed out in the "Guidelines for the security of Information Systems and Networks: Towards a Culture of Security" of the Organization for Economic Co-operation and Development (OECD, 2002).

But due to underestimation or ignoring safety issues, what indicates about insufficient level of safety culture, as stated before, annual global losses equal to more than 10% of world GDP (Проекти, 2012).

Safety assurance is especially important during realization of projects, since the purpose of every project is to create the unique product or service with clear orientation on the impact of activities and with the necessity to reach it within the determined period under conditions of limited resources.

2. Research questions and objectives

Nowadays more and more companies, organizations and institutions are using a project-oriented approach in Ukraine. IT-companies are leaders in using a project-oriented approach; their activity is directed on realization of projects of introduction of information technologies into different spheres of human activity. Many construction, engineering, and consulting organizations are project-oriented by their nature: they realize projects for their clients. But even at the enterprise, which is not project-oriented, there are plenty of other activities inside or outside the organization, which can be managed, as projects: new product promotion, launch of new production facilities, capital renewals, introduction of new systems and technologies etc (Ноздріна, 2010).

According to the project-oriented approach, the project safety is a category of project management that includes management processes, directed at assuring the necessary level of safety during the project realization and product exploitation stage.

Experts who study the project safety issues use different terms – Security Projects & Projects Safety. The project management specialists deal with the Projects Safety, while specialists, who assure security of people and objects using modern technologies, deal with the Security Projects. But these terms are associated with each other, since realization of Security Projects is impossible without project management knowledge (Pugliese, 2013).

Other project management specialists also differentiate Security Projects & Projects Safety, but in a different way. Security deals with information, and safety is a functional term, related to health, life and environmental risks. Peculiarity of information security (IS) has to assure accessibility, integrity and privacy of the management system data. Peculiarity of the functional safety (FS) has to assure proper performance of management system functions, and in the case of failure it has to put an object into a safe state.

Information security became crucial after the emergence of the Internet, while functional security had been assessed even before the emergence of digital management, because emergencies are taking place all the time (Functional Safety, 2015). So functional safety assurance will never lose its relevance regardless of the specific nature of a project.

To paraphrase Peter Drucker, the management of project functional safety assures, that proper people do proper jobs, in proper time, using proper instruments, in compliance with proper procedures and directions. FS management should be a part of the project life cycle model and is to be realized by Functional Safety managers (Project Safety, 2015).

3. Results of the study

3.1. Safety System of a Project-Oriented Organization

According to the concept of sustainable development, the safety of a parent organization, where projects are realized, especially, if this organization is project-oriented (n projects are being realized simultaneously), depends both on the project safety (Figure) in general, and on the safety of each component like IS and FS.

In contrast to other projects, e.g. in construction, information technologies are not dangerous by their nature, therefore when we consider IT project safety, we bear in mind its functional component (FS), safety related to the proper functioning of the computer system (Figure 1).

Regardless of the sphere of project activity, the project safety should be reached using the formula:

Awareness + Preparation = Safety

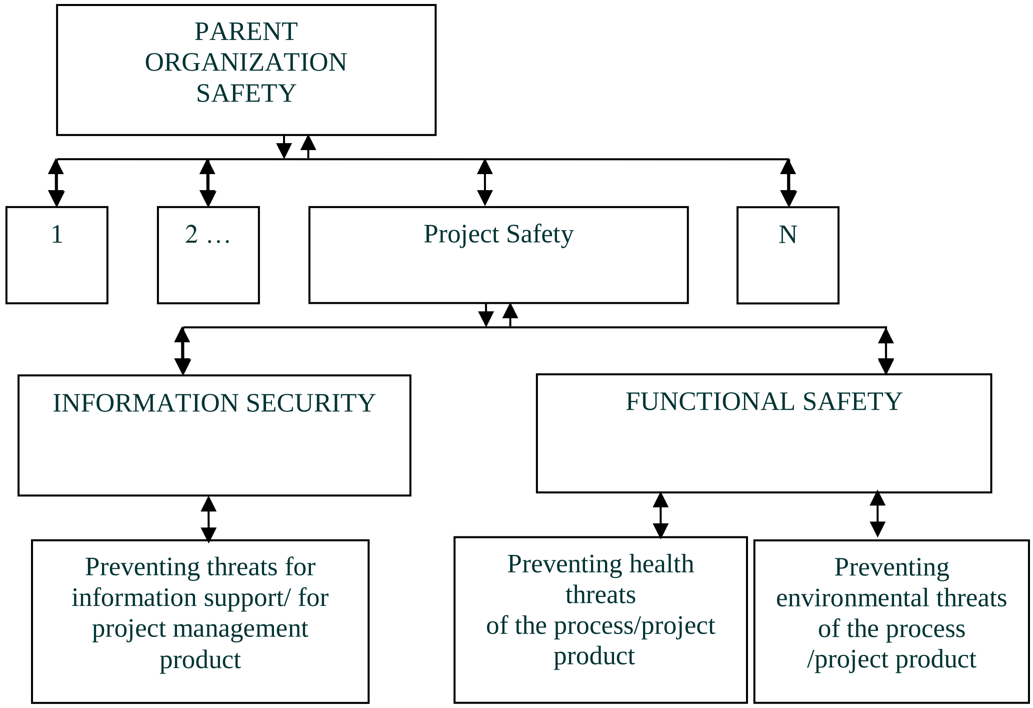

Figure 1 Components of the Safety System of a Project-Oriented Organization, Source: own.

Awareness and preparation to understanding the security issues of projects in the modern world has resulted in principles of the Project Safety Management, presented by the Project Management Institute (PMI) in PMBOK Guide® Fifth Edition (Project Safety, 2015).

The project safety management is not a joint area of management for all kinds and types of projects, it is a supplementary and obligatory for special types of projects, e.g. in construction.

According to the PMBOK there are following processes of the project safety management: 1) safety plan; 2) safety assurance; 3) safety control. Project Safety Management Plan is a component of a Project Management Plan and determines the strategy or methodology, accepted by the managing organization.

3.2. Safety as the criterion of the project management

To emphasize the relevance of safety in all spheres of project management Albert Lester offers his own modification of the project management triangle, where the project triangle developed by Martin Barnes is supplemented by the criterion of safety, located in the center of the triangle, since adhering to all other project restrictions should be safe for the project (Figure 2) (Lester, 2014). This modified triangle was included in the British standard BSI PD 6079-4 "Guide to project management in the construction industry" and is recommended for all other industries, especially for manufacturing, transport and IT.

Figure 2 Safety as the fourth criterion of the project management, Source: Lester, 2014.

During the whole period of project realization, the project manager sometimes has to change priorities among basic criteria, presented in angles of the triangle without threat for the project safety.

Such criterion as "complexity" of the project also highlights safety aspects of management. Japanese innovative methodology of program and project management inside the organization using information technologies at the enterprise level in an unstable environment P2M (Project and Program Management for Enterprise Innovation) is based on the "trilemma" – three basic concepts: Complexity, Value and Resistance, which constitute the so called "iron" triangle of context restrictions for innovative activity (Ohara, 2005). The more complex the problem is, the more value its potential solution contains and the less people are able to understand that, (what is the reason of resistance to the corresponding innovative idea), the higher the risks are and the more threats for safety arise.

Complexity is also specific for certain IT-projects, products of which are control systems like I&C, built-in systems and device layers; where functional component is crucial for their safety and assures proper functioning of both control system and corresponding equipment.

Information security (IS) is supplementary in such systems and should prevent from malicious access to the control system and equipment. One of the potential risks, as it has been shown by the analysis of cyber threats and methods of information security assurance for the Internet of Things, IoT, is a malicious physical device attack. Thus attacker may force the control system to perform dangerous tasks. In such case information security and functional safety are two sides of the same coin.

On the one hand, functional safety (FS) is immediately related to the hardware reliability (devices are capable of operating without failure for many years and there is always room for redundancy), while software is responsible for safety management (Скляр, 2017). For example, bugs in IT-projects may be very costly for companies. While for system projects that include mechanical, electronic and electric components safety issues are even more acute.

Objects, managed by computer systems, may often generate risks for people and environment (chemical industry, nuclear and other power plants, transport etc). Computer control systems of such object should perform safety functions, have special features (redundancy, resilience, self-diagnostics, resilience to external shocks etc) and be controlled by certification and licensing authorities.

3.3. Links and differences between safety management and project risk management

So project safety regardless of its classification is closely linked to the project risks and is characterized not by the full absence of risks, but only by elimination of unacceptable risks. Project safety management uses the same approaches and methods, as the project risk management (Ноздріна, 2010). Figure 3 shows approaches to the risk management that comply with a functional safety standard IEC 61508-5, in particular with the ALARA (ALARP) principle (as low as reasonably applicable/practicable).

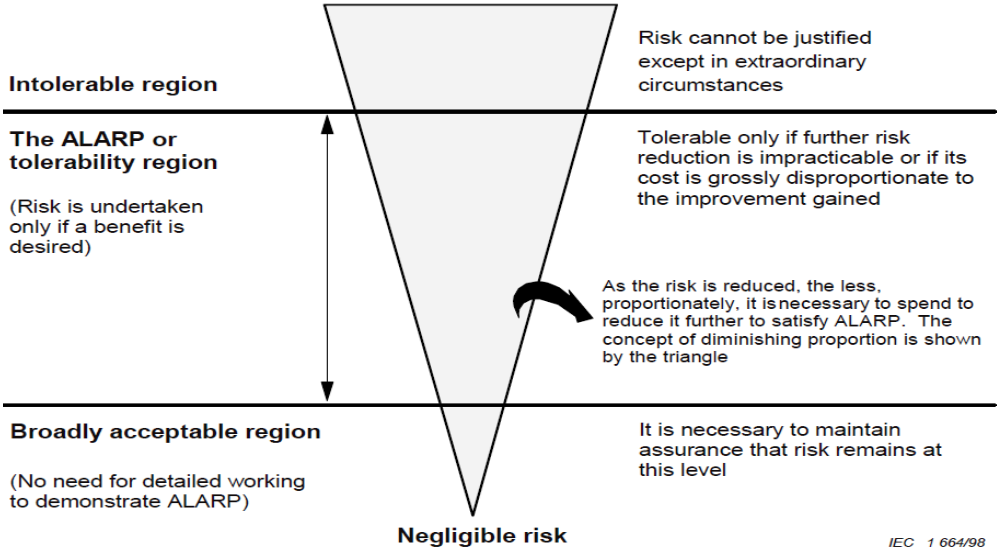

Figure 3 Risk reduction by the ALARP method, Source: IEC 61508-5, 1997

This approach (that first appeared in the nuclear energy) implies their maximum possible reduction, what can be reached using real but limited resources (Скляр, 2017).

There are certain peculiarities of the project safety management, which differentiate it from the "classical" understanding of project risk management (Table 1).

Table 1 Differences between safety management and project risk management, Source: own.

Aspects	Risk management	Safety management
Approach to project threats	The project risk management is directed at **identification and response** to the threats, influencing implementation date, cost (expenses, profitability) and quality of the project	The priority areas of safety management are: 1) **preventing** effects, which may be threatening for the health and life for the project participants and the personnel (if the project is implemented at the existing enterprise), may create possibility of damage or destruction of equipment and buildings, which are used in the project or located in the area of project implementation, and may be threatening for people and environment of the region in general, and in case of threat

		occurrence – reaction by project personnel; 2) constant aspiration of the project management group and other engaged organizations **to perform acts, directed at safety enhancement** during the whole implementation phase**.**
Management process (step by step)	▪ Identification of risks, characterizing the danger of the process ▪ Estimation of effects of the key asset risk for particular dangers ▪ Determination of risks (estimation of expected probability and effects) ▪ Determination of management elements and resources for reduction of these risks ▪ Prioritization of actions for reduction of basic risks	▪ Awareness and aspiration for safety ▪ Identification and understanding of the sources of danger ▪ Estimation of threats ▪ Management of risks with identified threats ▪ Gaining experience of safety processes management
Responsible persons	Typically, **a group of experts** from the project implementation team deals with the project risk management, the rest of the personnel follow their recommendations	In project safety management safety is assured not only by the project implementation group, but also by **all employees, engaged in the project.** For example, a **Functional Safety Coordinator** should be assigned for functional safety
Concept	**A risk management concept:** constant aspiration of the project risk management group to perform acts, directed at **minimization of risks**: their **identification and elimination** during the whole implementation phase	The project safety management is realized through **the concept of safety culture**: 1) every employee must be fully aware of the possible effects of his/her poor or delayed performance; 2) safety assurance for the implementation is an informed and the highest priority for both organization in general and every particular employee.

The project safety management is also closely linked to the quality management. Safety and quality are complementary concepts, since even the least component, non-compliant with the required quality standards, may have a devastating effect on the project.

Conclusion

Explosive development in technology, improvement of the quality of communication channels and of the data conversion rate in the modern world is a challenge for the global safety at all levels and in all spheres of life. In particular, Internet of Things (IoT), that appeared about 20 years ago, is showing "a quantum leap" of its development now, rapidly infiltrating the daily life, industry, logistics, healthcare, commerce and safety.

According to the IoT Analytics data, the largest number of IoT projects in the world in 2016 (22% of the total number) was realized for industrial objects (The top, 2016). It is confirmed by development and spread of technologies, declared in the Industry 4.0 doctrine, what makes production intellectual and flexible using cutting-edge information and communication technologies. In relation to these trends a new class of hybrid cyber-physical systems Industrial Internet Control Systems (IICS) or Industrial Internet of Things (IIoT) has appeared.

Safety assurance of the projects, products of which are control systems, requires reduction of risks below the requested levels both for the information security and for the functional safety using technical and organizational methods and means, in particular project management methods, documenting, IS and FS life cycle realization, using innovative methods and quality management standards, formal and semi-formal notations for development of specifications and design.

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Cybersecurity within IT Management Studies

Tomáš Pitner[1], Jan Ministr[2]

Abstract. Cybersecurity is not a concern just for security specialists. In the last paper, we presented considerations and propose a specialized study field for information system experts with focus to secure design and operation of information systems. In newly created complex study program aimed at Information management, cybersecurity will play a significant role among two other fields – management of services and software development management. We present a construction of such a combined study program.

Keywords: cybersecurity, information management study program, education.

JEL Classification: C61

1 Introduction

In our previous paper we discussed contemporary trends in educating IS experts with an extended focus at cybersecurity (Pitner & Ministr, 2016). Cybersecurity was one of the features of a new curriculum for IS developers called Security-assured Information Systems. Cybersecurity was not seen just a concern for security specialists but a part of – rather generic – education of future information system designers and implementers. The context is, however, changing with an increasing speed and content of the study programs must keep pace with the requirements (Danel, 2016).

2 Study programs accreditation

According to the present University Law (137/2016 Coll. extending 111/1998 Coll.) in the Czech Republic defines new, more flexible ways for new study programs to be accredited. Primarily, a university can be authorized by a National accreditation body to gain the right to independently define and manage its own study programs internally, so-called *institutional accreditation*. On one hand, it gives a university such rights, but on the other

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hand requires to have a high-quality internal planning, implementation and evaluation system for study programs.

Second major distinction from the previous system is that study programs can (must) be either *academically* or *professionally oriented*, meaning their graduates are supposed to select their professional carrier either directly (enrolling a *professionally oriented* program) or having an advanced, more scientifically oriented *academic* program enabling easier continuation to higher degree studies (BSc > MSc > PhD > academic carrier).

The discussed newly proposed study program is an *academic* one which foresees a clear potential for further extension at a PhD level.

3 (IT) Management program

Recently, Masaryk University is targeting the institutional accreditation allowing to independently propose new study programs in predefined study areas where Informatics has a strong position among two dozen of areas in total. Even before this plan can come fully in force, the new individual study programs must be designed, and if possible also implemented.

One of the innovative programs at Master level is *Management of software development, services, and cybersecurity*. It was originally created as a composition of three legacy study fields *Information systems, IT security, and Service Science, Management and Engineering.*

The idea was not only to reduce the number of study programs to make it more clear and readable for the applicants, but also take this opportunity to upgrade content of the program. The original fields are now to be just specializations of the encompassing study program colloquially called *IT management*.

A common specific feature of this program is the focus on strategic and operational management related to concept creation, planning, design, implementation and operation of software systems and services within the context of organizations of several types with a possible focus on reliable and secure operation of IT services.

The new study program on IT management currently features specializations at *information system development management*, *service management*, and *cybersecurity management*.

To some extends, this study program exposes similarities with study programs at other universities, usually of *business management (economics)* or *IT orientation*. We will now show the three specializations of the new IT Management program that are now legacy study fields. We will order them by number of students currently enrolled.

3.1 Service Science, Management, and Engineering

Services in general are vital part of a developed national and global economy. In the service sector (but also in industry), the world is dominated by ICT services. The ability to design and provide quality services in the field of information technology requires not only good technical knowledge. Many other skills such as business, marketing, management, finance, social science, communication skills are required. The ability to meet all demands about service science requires a multidisciplinary teaching. The story of Service Science, Management, and Engineering (SSME) began with this paradigm shift happening recently (Walletzký et al, 2017). SSME study field is one of many responses to rising demands for experts possessing broad skills in the field of ICT and services.

Proper understanding, design and management of services and service systems is one of the most effective way towards sustainable and profitable development not only in economics but also in society.

SSME Master studies support the concept of modern education. Beside ICT courses SSME study catalog contains other classes focused on finance, economics, management, marketing and soft skills.

Another pillar of the specialization is a half-a-year up to one-year interim stay within a company - *Interim project*, where each student gets a real work experience. Student can choose company himself or he gets position corresponding to his specialization. We support internships not only in the Czech Republic but abroad as well. Selected students even work on their own interesting projects. It is emphasized that the internship has always been multidisciplinary with respect to the SSME orientation field.

3.2 Information technology security

The program focuses on gaining knowledge of security in computer systems and networks, cryptography and its applications. The goal is to prepare a graduate who will be able to work in various critical roles to ensure IT security – specific profiling (e.g. towards cryptography, technological aspects, or security management) beyond the scope of a common subject is left to the choice of the student, see (Masaryk University – Information Technology Security, 2017).

A graduate is expected to work in a variety of roles critical to ensure security of ICT. Profiling of individual studies (cryptography, technological aspects or security management) is left to the student. There are two orientations, namely *Security of ICT* (more principles and technology) and *Cyber-security* (more management and law). For the new study program on IT Management, the *Cybersecurity* orientation is relevant.

The orientation *Cybersecurity* is focused towards multidisciplinary aspects of cybersecurity, i.e. also outside of the classical system perimeters (Doucek et al, 2011). It brings together technical, social, management and legal aspects of cybersecurity. Graduates are ready to work in organizations that are supposed to comply with specific cybersecurity regulations such as the Czech Cybersecurity Law or privacy-related regulations. They ensure design and deployment of cybersecurity and compliance processes. Due to country and legislation specifics, only some courses are in English, majority is in Czech.

3.3 Software engineering

The specialization is focused on knowledge and skills needed at all stages of development, management, and maintenance of information systems, generally other large software systems. Emphasis is placed on the knowledge needed to analyze and specify the requirements and design of the system.

Information systems are traditionally one of the main domains of software development. At present, they are increasingly moving towards users' needs, with increasing attention being paid to their usability, availability on mobile devices, safety and reliability.

Within the specialization, attention is paid to software engineering techniques, software modeling, software testing, recent enterprise technology including web and mobile, UI development, and development of accessible applications.

3.4 External inspiration

Schools offering information management university education may choose several different learning objectives and study content. The new study program at Masaryk University was inspired by several models, including programs at domestic Czech schools of economics and information technology.

As a typical example, we took an *Information Systems Management* program taught at a major Czech university of economics. The core of the program is represented by information management methods and tools. Primarily, presentation of the principles of effective usage, development and innovation of IS/ICT in firms is given. The emphasis is put on the suitable relationship between IS/ICT and business processes, metrics and measurements methods and models of IS/ICT management. Secondly, the methods of applied statistics support the better usage of information for decision making process of managers, see (University of Economics, 2016).

The course will offer students' knowledge and understanding of main information systems application used implemented in current enterprises.

Similarly, such a program is offered at another major university in Czechia, see (Economic Faculty VŠB-TU, 2017) under the name of *Applied Informatics*. It educates future professionals to apply a wide spectrum of modern information technologies in dealing with complex problems and systems. Graduates will find employment especially as IT managers, leaders of teams focusing on the application of information technologies in carrying out economic tasks (administration, databases, computer network administration, complex software systems development). Graduates will not only have a command of methods, techniques and tools offered by modern information technologies, but will also be knowledgeable about the applications environment created by institutions, companies and economic bodies. Graduates will be capable of creatively managing the development of systems and applications software, communicating with users, and managing the operation and maintenance of software. The profile of graduates will ensure that they are fully competitive on both the domestic and European job markets.

Another Master degree branch of study is *Systems Engineering and Informatics* which equips graduates with knowledge of management tools, skills for using systemic approaches and modelling, as well as the ability to apply modern computer technology. Graduates will can solve large-scale and complex problems at all levels of management, in various sectors of the economy regarding the objectives and the necessity for efficient economic development in market conditions. Graduates will find employment especially as specialists in the application and utilization of modern information technologies, IT specialists, systems designers in various fields of company activity (financial, information, social, manufacturing and executive management), specialists in project management, and organizational employees, see (Economic Faculty VŠB-TU, 2017).

Concrete example of a course is *Information Management*. The aim of the course is to acquaint students with the position of Chief Information Officer at large enterprises, and with the organization and management of the IT department in predominantly industrial enterprises and IT companies. Based on this knowledge, students should be able to orientate in the organization and processes of IT in both medium and international companies.

Such study programs and course heavily inspired the creation of the new study program in management of software development, services, and cybersecurity.

4 Conclusion

The new study program in management of software development, services, and cybersecurity at Masaryk University, Faculty of Informatics with specializations at information system development management, service management, and cybersecurity management offers a broad basis for those who want to become information managers possessing knowledge and skills required at managerial positions in IT industry but also in organizations coping with growing needs of cybersecurity and privacy protection imposed by law and reality. In the future, its continuation in form of a multidisciplinary PhD-degree in topics of secure societies is foreseen.

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Expert System for Insurance Data Fraud Detection

Jaroslav Ráček[1], Josef Daňa[2]

Abstract. The article provides a description of FRAUDES expert system which is designed to detect insurance frauds based on data related to insurance claims. The system performs two basic group of analyses over the data – analyses of textual data which are namely suitable for area of life insurances, and analyses of visual data which are applied for property insurance.

Keywords: insurance fraud detection, visual data analysis, text analysis, life insurance, property insurance.

JEL Classification: D80, D83, L86

1 Usefulness of data analysis in insurance sector

Present insurance sector records a steep increase in insurance frauds which is mainly focused on provision of tampered documentation acquired by sophisticated use of digital technologies. Specifically, this documentation contains forged pictures related to other claims (vehicles, households) that are presented as occurrences of own damage. This photographic documentation is also edited such that a new set of images is not similar to the original set; or the damaged object is photographed multiple times, therefore there are several independent sets of photos. Under normal conditions, it is hard or almost impossible to detect that these sets represent the same damaged object by comparison of images or their metadata and, consequently, that these sets represent duplicate fulfilment, i.e. a fraud.

Life insurance claims data are tampered in a similar manner. A common type of fraud is a forged medical report where bodies of text are combined from various reports to form a new, original text. These forged reports also include a stamp of a medical doctor copied from one of available reports, or an x-ray image of another person.

In a situation where the biggest insurance companies are processing from hundreds of thousands to millions of non-life insurance claims and approximately the same amount of life insurance claims a year, it is necessary

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to check millions to tens of millions of images for suspicious similarities between them per year. This amount must be multiplied several times as it is necessary to analyze claims from last few years for proper duplicity detection, as practice in insurance companies reveals. Processing these amounts of data is possible only via using advanced computer vision algorithms. The situation in text analysis (namely medical reports) is very similar. To check similarities between two samples of text and to verify authorship (i.e. whether structure of medical report corresponds with the usual textual expressions of a given medical doctor) is not possible without advanced expert text processing tools. Moreover, all these analyses are performed on the "big data" sets where time efficiency and scaling on multiple machines must be managed properly. Sooner or later, it will be necessary to deploy similar expert system in every bigger insurance company as a consequence of insurance agenda digitalization.

2 Fraudes expert system

Authors of this article are participating on the FRAUDES project which is aimed on the development of an expert system processing unstructured and semi-structured insurance data records. A long-term goal is to develop a modular system that will detect suspicious or fraudulent phenomena in the data. In the present time, the system exists as functional prototype which is tested through proof of concept activities on the real-world data of several Czech and Slovak insurance companies.

Main aim of the project is to develop a system that insurance companies can use for detection of insurance frauds in the area of non-life insurance (where belongs insurance of vehicles, real estate and movable goods) as well as in the area of life insurance (Pitner & Ministr, 2015). The modular system analyses complete documentation of a claim and compares it with other data records of a particular insurance company, eventually with data records of other insurance companies or with data from other sources (typically from the internet). Such analysis consists of two main parts:

- Analysis of unstructured or semi-structured texts,
- Analysis of pictures or videos.

2.1 Text data analysis

The aim of the text analysis is to find similarities between description of ther claims and to notify about possible fraud. This analysis is applied mainly in the area of life insurance where insurance frauds are commonly based on the technique of copying and combination of multiple parts of medical reports to create a new fake medical report that appears to be genuine and provided as a documentation for insurance claim. Based on our up-to-date experience, the modification of a medical report or its part is the most common type of insurance fraud attempt in the area of life insurance. There are groups of defrauders that focus on sharing medical reports where there is an expectation of high insurance fulfilment. These text samples are subsequently used as a part of tampered medical reports with forged signature and stamp of a particular medical doctor. Module for text analysis is searching for duplicities in medical reports and highlighting them. Apart from that, the system is also performing an authorship analysis.

The authorship analysis is based on the assumption that every medical doctor has its own style and composition of medical reports. Reports of individual medical doctors differ in vocabulary, length of sentences, the way how medical terms are abbreviated, combined, etc. Therefore, analytical module records an "imprint" of every medical doctor and specific traits of his or her written expression. Identification of a doctor is encrypted with one-way encryption function for reasons of personal data protection. It is not possible to acquire data about traits of a particular medical doctor textual expression as the system compares only the fingerprints of medical doctor identificators. The system detects a possible fraud when a medical report of a particular medical doctor is submitted into the system but it is significantly different than other recorded reports of the same medical doctor.

2.2 Visual data analysis

The aim of the visual data analysis is to recognize that the same object is on two different photos. The goal is to detect an insurance fraud based on the visual data where we are able to conclude that the same damage to an object has been photographed differently (using local visual descriptors – local markers) which is suggests a fraudulent claim with high probability, according to our experience. Such analysis is based on the occurrence of high amount of identical local markers that are correspondent to each other through their relative distance on both pictures. An example of how this is done in practice is provided on the Figure 1 below:

Figure 1 Visualization of duplicities found in the visual documentation of an insurance claim

The realization team has experience in this are from former partial projects that has been delivered for the Ministry of Interior of the Czech Republic in years 2013 – 2015 and for Czech Insurance Company in 2016. These projects have revealed that current algorithms are not usable in practice because of their low performance and high time complexity. While using the current algorithms, it is possible to process amount of order of tens to hundreds of thousands of photos, given the current computational power of insurance companies' servers. It is important to point out that the problem of computational performance cannot be solved by increasing the hardware capacity, based on the fact that common insurance company has hundreds of thousands of claims a year and every claim has tens of photos describing it and, at the same time, the detection of duplicities in images has polynomial complexity. Consequently, it is necessary to develop new system that will be faster. This will be achieved by implementation of other types of descriptors in the computational core. Specifically, the algorithms working with SIFT type descriptors will be replaced with new algorithms of KAZE and AKAZE types. Given the fact that these types of algorithms are substantially different, it will be necessary to create new data layer which in practice leads to research and development of completely new analytic module for visual data.

3 Conclusion

The development of FRAUDES system is an ongoing process that has begun in year 2014 and it is expected that it will continue to year at least 2020 which denotes a period of time for which is the project co-financed from European program EURECA.

The FRAUDES system also has another developmental direction outside the insurance sector. The system can be used as a tool for investigation of stolen art pieces – it is possible to automatically monitor art market on the internet (auctions, classified advertisements, discussions) and compare items offered for sale with database of missing artworks. Last but not least, a demand for similar solutions exists among the operators of CCTVs who would like to use local descriptors of visual data to detect occurrence of undesirable objects, to monitor movement of objects or to search for particular objects.

All abovementioned tasks could not be solved in the past, given the advancement of existing algorithms. Technologic progress is now to be achieved through their implementation into the practice.

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GDPR – Threat or Opportunity?

Jan Sál[1]

Abstract. This paper shows, how many impacts can only one point of the General Data Protection Regulation (GDPR) have and how can we evaluate risks, which come from it. We will have a look on three points – The right of access, the right to erasure and the right to restrict processing. We will take three pictures of view. The first is the point of the company's realization. It means how is it realized and how many processes should be changed. The second one is how can we monitor and evaluate risks, which comes from not respecting of these regulations. In the end, we will try to find out solutions, which can bring to organizations new ways how to deal with this part of regulation based on data mining tools monitoring and evaluating places where the data are stored and how systems communicate with each other.

Keywords: GDPR, risk management, data mining, data protection, personal data protection

JEL Classification: G32, K22, K24

1 Introduction

In this paper, we will have a look on the two rights of the General Data and Protection Regulation (GDPR). Time hurries up and for some organizations it can be easily too late. It, of course, depends on the size of the company and on the type of the company. GDPR will come into effect on 25th of May 2018. The rights for discussion: The right of access, the right to erasure and the right to restrict processing.

These rules try to give opportunity to control how many information companies have and what are they doing with them to customers. We will describe each of them in detail later on. After that, we will speak about three points of view to these regulations. We will speak about steps should be done before implementation and how case implementation should look like. Afterwards we will have a look on assurance that our processes are going as planned and in terms of usage. It can have two layer. The firs layer is on particular business units and their Internal Control System (ICS). The second one is assurance independent on business units. It can be internal or internal audit.

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2 General Data Protection Regulation (GDPR)

GDPR is a part of European directive bundle accepted on 27th of April 2016, wants to standardize approach to personal data protection across all countries of European Union. This regulation will take effect on 25th of May 2018. GPRS defines data set marked as personal. Most of countries have already implemented some laws or regulations to deal with it. Many regulations speaks about natural personal data (e.g. name, surname, ID of important cards, address etc.). GDPR establishes new data sets from which you can identify person (e.g IP address, services, photos etc.) All rights mentioned below you can find on Articles 12 – 19 of the GDPR.

2.1 Lifecycle of the Personal Data

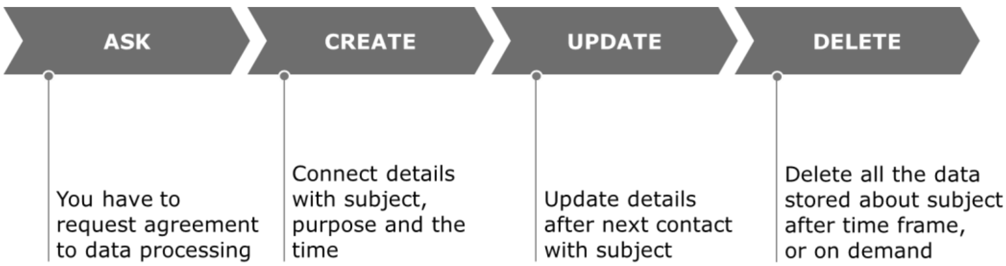


Figure 1 Lifecycle of the personal data flow

As you can see on the Figure 1 the lifecycle of the personal data is quite simple. The biggest challenge of these four steps are:

1) Right and full request for the agreement to data processing.
2) Create and update only the rights data set

In next chapters, we will have a look to the particular rights of the data protection subjects – the most common groups are customers and employees. In addition, in every right we will see where the biggest impact is.

2.2 Particular Rights

For our case analysis, we have chosen three rights connected with the place where they are stored. I do not mean the physical location because it can be small. We speak about application’s distance and data sources for them.

The Right of Access

In general, we can say that this right serves for subject to know what companies do with your personal data. In the first step, they have to agree that companies process their data. Everybody knows the scope of the requested data. Subjects can whenever ask for information, which data they have in particular time frame.

The right to erase

Shortly, everyone can say: "Delete everything you know about me." In addition, companies have to delete all the data they collected. It could sound quite easy but in next chapter, I will try to show you that it is not so easy. You have to ensure that you delete all the data from the whole environment of your systems.

After deleting all these information, you have to provide to subject official report that you have deleted all these data. If you for some reason have to store some data (e.g. for some law purposes), you have to report information to the subject with particular information – for how long will you store them, because of which law etc.

The Right to Restrict Processing

Every subject have opportunity to change agreement of data processing. For example if I say that you can do whatever you want with my data (including buying and selling to third persons) and now I do not want you to make business with them. I send to company official letter with request to change the rights to my data. Company have to change approach to my personal data and give me report that they do that.

3 Case Study with Implementation

I chose these three rights because as I said before they have similar properties and all points, are for them in some way important. The importance of them can be for all these three rights different, but in general, we can find them there. As I mentioned before I divided this chapter into three groups. The groups are as follows.

1) IT department – the department that is responsible for methodology and physical realization of all data protection systems in the company. We can

divide this department into the several sub-departments – processes, data security and something, which will centralize all IT management (e.g. systems integrators).

2) Assurance department – basically, this department do not have to take place inside of the company but companies can buy them as an external service. Big companies can handover this assurance service into Internal Audit department.

3.1 Physical Realization of Implementation

All these three rights are based on the one key factor – company should know which data do they have about every subject and where are they stored. Especially for the big companies with many departments here can raise the first problem. They do not know and what every department do.

Companies can have many departments, which are not in the strict contact with the IT department. Departments have external applications and their databases can be outside the company.

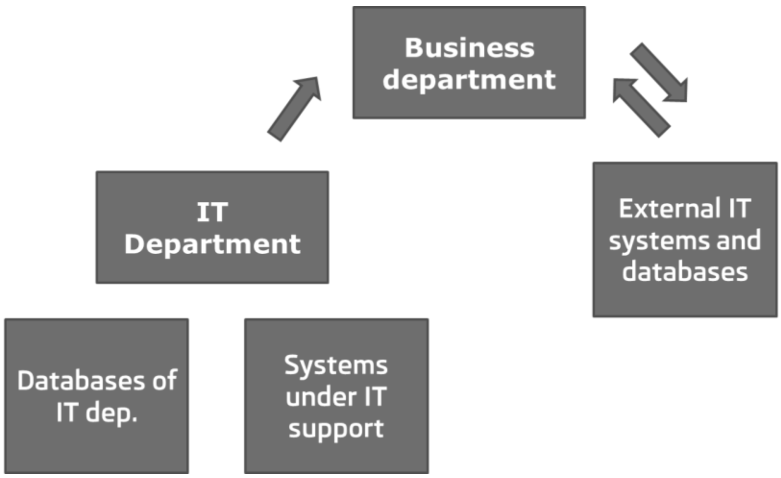


Figure 2 Scheme of the external systems in the company

Data audit – the right step from the beginning

We spoke about database of databases. Every department should do its own data flow audits and provide them into company level management. The top management will decide what to do next. In general, we have two options:

1) Continue with decentralizes processing and make some database of databases where are the personal data stored. This has to be “online” maintain and periodically updated. Of course, the administration requirements will raise but it can be quite good transformation phase solution. However, this database should contain much more data than only which data and where are stored. It have to provide information about automated reaction, which is necessary when you get request for some information or action with / about data.
2) Handover all the external sources into one database and centralize all the databases into companies’ environment. This is quite expensive, it is hard to handover various database formats, data sent, and big amount of data stored in company datacenter.

Anonymization or pseudo anonymization of data usage

We speak about anonymized data sets in moment when there is no possibility to identify the person. It means that we do not have any additional information which can we use to complete the personal profile of the subject. We can use these data sets to further analysis and we do not have to manipulate with them so strictly. You can make some statistical analysis above these data but you are not able to personalize your products and services to some specific segments (e.g. country, age etc.)

We speak about pseudo-anonymized data sets when we have some additional information in other databases that can identify the subject. Data sets divided from subject for a limited time only. Only system administrator can make identification of these subjects. Nobody else. Pseudo anonymization of data are:

- they can be processed in wider scope than was previously defined;
- they have exceptions from the notification, reporting and some other rules;
- right usage ensure the private security;
- it can serve as a cyber-security tool as well

3.2 Assurance of Compliance

As we mentioned before, the main target is to have all the data under absolute control. Moreover, this is what we want to monitor, evaluate a report to the top management. This task is in responsible of independent authority. It can be internal or external audit or you can buy some service, which will include both of these tasks.

Here we come with solution that can help organizations to deal with this problem. We developed data mining methodology based on text comparison. The philosophy of this solution is quite simple – every system or application need to be in in specific time connected to internal data source to gain more knowledge from data. The most common scenario is that your application load data in the beginning of the process and then work with them. The second scenario is that your application gained some data but you need to combine them with information we already have in centralized database. In both cases, you request personal data from internal systems.

This moment is the right place when can companies use our tool that monitors logs of these communications. We would like to build strong data model that will detect every change in communication structure. These changes detects that some other application or system requested data and that we do not know about these types of request

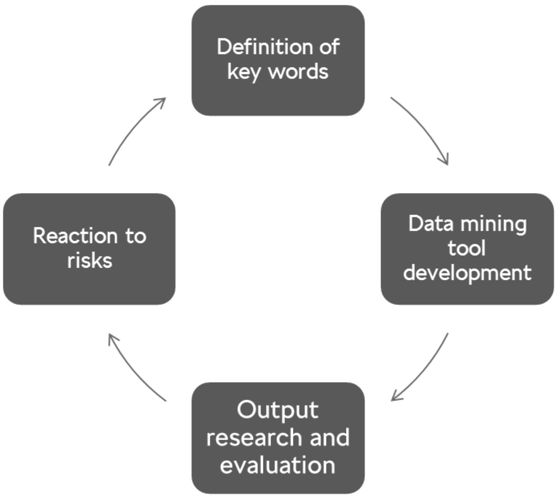
When we detect some suspicious communication or anomaly, system automatically warns independent employee who will have a look on that. If the transactions were marked as OK, we implement these behavioral patterns into the methodology. It ensure that we will detect these types of abnormalities but will be marked as known and will not require immediately reaction.

Text comparison algorithms used

We are using three string comparison methods. Levenshtein's distance is a string metric for measuring the difference between two sequences. Informally, the Levenshtein's distance between two words is the minimum number of single-character edits required to change one word into the other. The Jaro–Winkler distance uses a prefix scale, which gives bigger ratings to strings that match from the beginning for a set prefix length. This is why it marks strings with the same first word as probably similar. N-gram model is a type of probabilistic language model for predicting the next item in such a sequence. In our models, we will use combination of these methods.

How to Detect Key Words

In general, we have two methods how to gain key words for our text comparison methodology. The fist is expert rules – we absolved many rounds with specialists from wide area of companies and completed list of key words from them. We started only with them and used them as a basis dictionary.



After some basic key words, we can monitor our log files and make some

Figure 3 Process flow of the key data mining tool development

analysis on it. We are using frequency analysis from the text mining algorithms to gain new key words. Afterwards, we implemented them into data mining tool.

4 Conclusion

As you can see, the GDPR regulation does not bring only financial sanctions. In general, this new regulation is not revolution in data protection. In my opinion, we can call it evolution of data protection. To be honest, many of implementations of these regulations in the law number 101/2000 collection of laws.

We looked on the three rights of the subject of data protection. We discovered that the biggest opportunity will be to make wide data audit and companies can standardize approach to their system. On the other side here raises questions how to deal with external applications. These changes can bring some additional cost for company but in the end, we can discover that we pay duplicating applications and we can use extended version of one application in various combinations of usage. We offer assurance methodology by using data mining methodology based on text mining from logging files of communication. Discussion about this tool will come later on if this is enough and if it get the independent certificate. Anyway, it is our target to develop such a solution.

Finally, this regulation will a bit complicate implementation of ideas of Industry 4.0 principle based on decentralization of IT and data processing. But the whole concept is quite flexible and I do not distrust that we will find solution of this problems.

Acknoeledgement

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INFORMATION SOCIETY AND EDUCATION

E-museums of Social History as a Tool of Sustainable Education

Maija Burima[1]

Abstract. E-museum is a platform that preserves cultural heritage. The advantage of an e-museum among the tools used for preserving and transferring cultural heritage is in its ability to include a wider empirical content if compared to other alternative information means (traditional museum stands, printed editions, etc.); to structure it in a more diverse way, to synchronize the content in various languages, to supplement texts with audio-visual materials without any limits. E-museum is available to visitors in any point of the world. The resources included in an e-museum can be used at various education levels, be it schools with academic education, lifelong learning establishments or extracurricular educational institutions, thus enabling the implementation of the principles of sustainable education.

The creators of an e-museum need to be aware of these challenges in order to plan the mission and structure of the e-museum in accordance with capabilities of high technologies, needs of the education process and needs and topical issues of the society. The e-museum of the oral history is a complex of the individuals' testimonies about their joint history and identity. They specify universal statements and provide a set of unique experience examples. The e-museum adapts the society to the reception of significant information on the history by means of high technologies and digital platforms, motivates people to tell the stories and realize that their digitalization will contribute to the preservation of their experience for the needs of cultural heritage and history reconstruction.

Keywords: e-museum, oral history, sustainable education, high technologies, audio-visual units.

JEL Classification: I21, N90

1 Information Technology for the Humanities

Information technologies make an important component of the modern system of education regardless of the stage of education. Information technologies are widely used even at the stage of primary education and their integration into the education process continues till the stage of adult education or even that of senior education. Information technologies gain increasingly high importance in higher education and scientific research as well as in the transfer of scientific

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research results into the society, organization of extracurricular education and other stages of sustainable education.

High technologies penetrate simultaneously into all fields of science unifying and universalizing modern science framework, making the humanities and natural sciences closer despite their opposition as far back as at the end of the previous century. In the researches on language and culture in the fields of humanities and social sciences high technologies have been integrated in the following forms:

1) research resources or sources in the e-environment: electronic dictionaries, digital literature, oral historical statements in video and audio records uploaded in e-platforms;
2) tools for carrying out researches: software used to process and systematize quantitative and qualitative researches (questionnaires, surveys); translation software Trados;
3) products of research activity: e-museums, virtual guides, mobile applications with tourist routes, e-books and magazines;
4) teaching resources: text-books, such as open source, Moodle, Blackboard as platforms for distant learning;
5) tools of research management organization: platforms for project work organization, scientific communication, e-conferences, webinars, Skype discussions.

High technologies act as one of mediators between humanities and life sciences. They form interdisciplinary bridges between the humanities, social sciences and art.

2 Information Technologies for the Preservation of Cultural Heritage and Educating the Society

The society has always been influenced by technologies: in the 19th century - emergence of photo and cinema industry; in the 20th century - television and the internet; in the 21st century - various hybrid forms of technologies, for example, I-phone, Skype. Technologies socialize people. Modern humanities and social sciences study how representatives of the society interact with each other and make a place for themselves in the society. Creative learning strategist Barbara Bray who coined and trademarked the phrase “Making Learning Personal” in 2000 and who is also called “Digital Pioneer” in her article "Technology and Its Impact on Society and Culture" points out, that *"…the Internet and mobile technology are changing the way people interact, work, and learn. Everyone can report the news or share a picture from their cell phone. You can produce your own music, publish your own book, blog your thoughts that you usually keep to yourself, create a website with even personal information, and talk on your cell whenever and wherever you want."*[1]

We are using technologies for our own use yet they infringe on others. Language and culture products are created not only by professionals. With the support of high technologies this privilege nowadays has become an opportunity of self-expression for each individual. The boundaries between products of elite and mass culture have been erased. New hybrid forms of mass and elite culture emerge in order to attract a larger segment of the consumer society. At the same time, language and communication norms and forms are changing. Technologies as a complex construct simplify verbal communication, make it laconic, and often bring simplicity nearer to profanation. Barbara Bray points out that "with more people and crowded conditions, new technologies will be necessary to support and sustain us. Let's also make sure we use these tools to tell and protect our stories. Video, audio, images, and interactive features open doors to worlds and cultures that children could never learn in a book. We need to allow for private spaces for confidential discussions and provide guides for tentative and eager participants."[2]

The responsibility of educators of students and the society is to deliver our knowledge in a modern way without avoiding high technologies but rather opposite, fully integrating all manifold opportunities given by them into their work, in order to give students a chance to become innovative producers who possess skills to use high technology tools to reach their fullest potential.

Washington State University College of Arts and Humanities in their platform discuss how the humanities can benefit in this time of intense focus on technology. Not only WSU professors, but leading high-tech companies,

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[1] Bray, Barbara. Technology and Its Impact on Society and Culture. http://my-ecoach.com/blogs.php?action=view_post&blog=8&post=3922 September 25, 2007

[2] Bray, Barbara. Technology and Its Impact on Society and Culture. http://my-ecoach.com/blogs.php?action=view_post&blog=8&post=3922
September 25, 2007.

discuss it, too. Adrian Aume in his article “High tech ‘hearts’ humanities” 1 provides several arguments:

- Graduating into gainful employment
- Creating mindful citizens, driving social change
- Meeting the market’s needs
- Thinking beyond the bounds of tech

Michael Hanly, who teaches medieval literature and culture, argues that “Virtually all college students nowadays will have acquired some substantial technological skills by the time they graduate. What they can learn in the humanities goes beyond that, into communication, critical thinking, and the breadth of perspective needed to solve larger problems.” DTC-Pullman Director Kristin Arola said: “Even in humanities classes that don’t involve composing digital texts, they learn how to critically engage with the world around them. This is an incredibly valuable marketable skill, and it helps to create mindful citizens of the world.” The development of technologies is the basis of researches on language and culture changes brought about by technologies, expectations, diagnoses and recommendations as to how it is going to and has to develop.

3 The E-museum of Oral History - a Tool of Involving the Society in the Formation of Social Memory: “Vitamemoriae”

E-museums as a tool of transferring digital knowledge and experience are a significant means of preserving historical experience, which simultaneously fulfill another important social function, i.e. commemoration. Commemoration preserves the memory of an individual and groups of individuals about their involvement in the historical events. Commemoration is closely related to the identity as “identity is oriented toward the future but is based on a history, often via the act of commemoration”2. In the individual’s subjectively stated memories of the past the objective event is interweaved

[1] Aumen, Adrian J. High tech ‘hearts’ humanities https://cas.wsu.edu/connect/august-2013/high-tech-hearts-humanities/

[2] Joachim Wolschke-Bulmahn. Places of Commemoration: Search for Identity and Landscape Design, edited by Joachim Wolschke-Bulmahn. Washington, D.C. Dumbarton Oaks, 2001, P. 3.

with its interpretation, which is affected by the psychological and emotional attitude of an individual towards the event, his/her national identity matrix, the age and experience. "Recollection of the past is an active, constructive process, not a simple matter of retrieving information. To remember is to place a part of the past in the service of conceptions and needs of the present."[1] The e-museum "Vitamemoriae"[2] that has been established by The Faculty of Humanities of Daugavpils University and is coordinated by The Centre of Latvian Studies of Daugavpils University is a compendium of 360 audio-visual forms of oral history – segmented units of life stories. They enable one to juxtapose individuals' memories with the official history thus developing an active and inclusive attitude towards one's region, its history and population; to compare the history of the Latvian – Belarusian border area thus crystallizing the views concerning common and different characteristics within the interpretation of the socio-political and the cultural-historical.

While establishing the museum, the creators faced a challenge of combining the challenges of high technologies with the platform that would correspond to the content of the oral history, which in addition would provide a view on historical events the interpretation of which differs in Latvia (Europe) and Belarus, such as, for example, the World War II. In order to even out the controversial nuances of socio-political events of that time, to make the museum content attractive for visitors and attract a wider society and more social groups, the museum content was formed on the basis of universal concepts and historical events in their widest meaning: First childhood memory; Before war[3]: Parents, Family, School, Confessional and international relations; During wartime: Beginning of the war, Wartime, Mode of Life, End of the War, Confessional and international relations; After War: Study and Work, Man and Authority, Holidays and Traditions, Residence and Weekdays. In order to collect the materials for the e-museum content, there were representatives of older generations interviewed. In accordance with the methodology of "preservation" of oral historical testimonies, the stories told by these people have been transcribed, systematized and catalogued.

[1] Schwartz, Barry. The Social Context of Commemoration: A Study in Collective Memory. *Social Forces* Vol. 61, No. 2 (Dec., 1982), pp. 374-402. Oxford University Press, P. 374.

[2] www.vitammoriae.eu

[3] World War II.

The e-museum does not provide for the upload of extended full-volume texts. These are kept by interviewers in electronic data storages and print-outs. The e-museum is meant for a wide audience, therefore the interviews, which often can last for several hours, will not address many individuals interested in the history and its interpretation through the perception of a certain individual. Due to this reason it is recommended to organize the e-museum by placing thematically segmented audio-visual units. An audio-visual unit of a transcribed oral text is a segment of an audio-interview or a video-interview (depending on preferences of interviewees), a fragment or photo evidences that are displayed from the whole context of the life story in relation to the general strategy of the e-museum and certain thematic aspects. While forming the e-museum, the most complicated task is to establish correlation between the museum content, which during the research is being supplemented with new sections, and technical abilities of the platform maintenance. It is equally important to form the e-museum as an open resource, platform, which accepts new content and creates new thematic branches.

4 Conclusion

Not all issues have been solved in the e-museum "Vitamemoriae". The collection is not being supplemented by newly-sent materials as it concerns the issue of authorship rights; the principles of distant interviews have not been completely worked out. However, even now it is obvious that the e-museum has a great number of unique and repeated visitors. This testifies to the fact that there are people who are attracted by an opportunity to identify their life stories with the stories of other people and learn more about the historical and universal human experience regarding both Latvian - Belorussian border area specificity and individual experience when being in the epicenter of great political events at the conflict of two great authoritative countries during the war and to compare common and different features of the respondents' national identities of both countries represented in the e-museum.

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www.vitammoriae.eu

Experience with Teaching using Videoconferencing System

Roman Danel[1], Michal Řepka[2]

Abstract. The paper describes our experience with teaching courses in the area of automation for a 500 km remote site (Institute in the town of Most) via a videoconferencing system. Thus, lessons, on the one hand, bring savings due to the reduced number of teachers´ business trips but, on the other hand, also a number of problems. As an alternative, we tried to implement lessons using Skype, which did not work well for our purposes. We are also trying to attract lessons using remote access to an automation technology lab (with the possibility to learn through experiments). Despite a number of benefits there are still some subjects in the field of automation that are necessary to teach with the personal participation of the lecturer.

Keywords: teaching automation; videoconference system; remote access to laboratory; lectures via Skype.

JEL Classification: D8

1 Introduction

The Faculty of Mining and Geology ("FMG") of VŠB - Technical University of Ostrava provides teaching of numerous fields, from historically specified fields in the field of mining, geology and geodetics, through automation and economics in the raw materials industry, to modern fields related to geo-sciences and environment engineering. The faculty is active primarily in the Ostrava region, where mining of black coal is concentrated. Extensive mining activity takes place in North Bohemia (mining brown coal); therefore, VŠB opened a branch office in North Bohemia – Institute of Combined Studies in Most. The form of remote teaching is used here for teaching numerous fields taught in Ostrava; the Institute also provides for attendance and also postgraduate re-qualification. The interest in studying at the Institute in Most is very high, which can be seen from the numbers of registered students. Throughout the existence of the Institute, fields related to automation and IT/ICT in the raw material industry are also taught here – bachelor´s courses "Information and systems management" (until 2014) and "Systems engineering in industry" (bachelor's degree and also follow-on). Due to the

[1] University/Institute, department, address, e-mail.
[2] University/Institute, department, address, e-mail.

distance of the Institute from Ostrava (approx. 500 km), it was necessary to make use of frequent business trips by teachers to ensure teaching, which represents a substantial cost. Therefore, FMG purchased a videoconference system which enables the provision of some of the teaching from Ostrava (parallel teaching of combined fields in Ostrava and Most), or conversely teaching from Most (for Most and Ostrava simultaneously). If we consider that the average stay of one teacher in Most constitutes 2 nights (CZK 1,600), travelling expenses (approx. CZK 1,500) and board, we can easily calculate the total costs of teaching based on the approximate cost of CZK 3,500 for one business trip. If we know what income the university receives from teaching one student, and we know the purchase costs of the videoconference system, we can easily calculate the return on this investment. After ten years of operation we can state that the videoconference system has significantly affected the cost-effectiveness of such a remote workplace.

2 Problem definition

Indeed, the above view of the cost-effectiveness of teaching using a videoconference system is a managerial view assessing the economic aspects of the issue. However, another question is the quality of education and the students´ assessment of the videoconference system. Last but not least, technical reliability and costs of maintenance also play a role.

The videoconference system is designed to enable connection with other videoconference systems. In our case this means connection between the classrooms in Ostrava and Most.

The equipment in Ostrava includes the following main parts:

- Equipment for connection with the other site enabling transmission of audio and video – Polycom HDX 8000
- Two SONY EVI-D100 controllable cameras (controllable direction of view, 10x optical zoom, automatic focuses)
- 4x4 matrix switch of video and audio signals - Gefen 4x4 DVI KVM
- Data projector Epson 450WI
- Digital visualizer (PS400 Digital Visualizer)
- Sony 55X4500 TV televisions (size 55“)
- Lights - Parabeam 200DMX
- Mixing panels and audio amplifier, including 6 speakers.

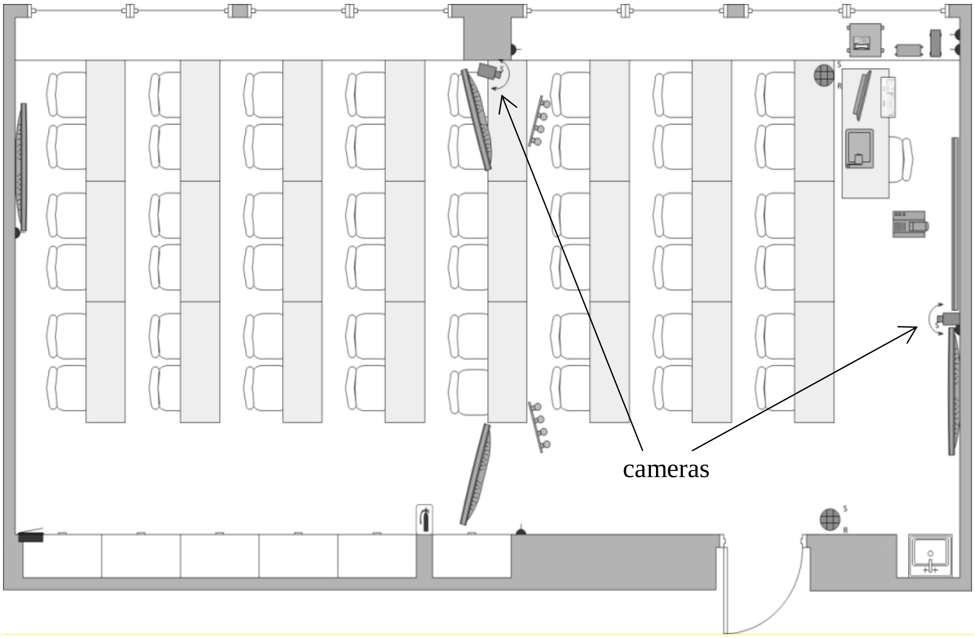

Figure 1 Placement of technical means in the classroom in Ostrava (Vavřinec, 2015)

Figure 2 The view how students see the teacher in Most [Photo: M. Řepka].

The videoconference system in Most includes the following equipment:

- Equipment for connection with the other site enabling transmission of audio and video – Aethra X5

- Two controllable cameras SONY
- VGA signal hub
- Two EPSON EB-1980WU data projectors
- Mixing panels and audio amplifier, including six speakers.

During teaching via the videoconference system interaction with students at the remote site is limited; the teacher cannot perceive the nonverbal information (whether students understand the material being taught, their facial expressions and reactions). Also, the possibility of practical demonstration of experiments is limited, which is problematic for some technical subjects (Ministr and Pitner, 2014) e.g. automation subjects. Therefore, selected subjects are taught live, or a compromise is made, where lectures are given via the videoconference system and practical classes are live.

As the equipment ages, the costs of maintenance are increasing. In 2014 the system started experiencing connection failures, especially audio, which started to impact on the quality of education. Therefore, at the end of 2014 the system was innovated; the system was, amongst others, supplemented with a more user-friendly control setup using a tablet PC application. However, this innovation investment did not remedy all the problems. Moreover, in the summer of 2016 the location of the Institute in Most was moved to another building. So it was necessary to completely dismantle and re-assemble the videoconference equipment – either by a specialized company (however, the costs of this option were disproportionally high) or through our own resources. Another possible solution was to provide remote teaching through other technical means which were not available at the time of construction of the videoconference system, but due to the advancement of information technology can now replace the videoconference system.

Besides the problems with the operation of the technical equipment and provision of the technical quality of education, we have also detected a problem on the students´ part. Repeated questionnaire surveys amongst the students of technical fields of automation and information science found that in general, students rate teaching via videoconference negatively and prefer live teaching (Danel, 2016). This also resulted in lower participation at some lectures or requirements for repetition of some lectures during live onsite teaching. Requirements for personal consultations increased, negative standpoints in students´ assessment of teaching started to arise in the Edison university information system, and in 2015, final-year students raised a direct written requirement for the subjects included in the final state exams to be taught without the use of the videoconference system.

3 Solution

One of the problems of the present videoconference system was its gradual construction and improvement which, however, means that it does not present an integral whole but a group of interconnected technical equipment from various producers. Also, the installation documentation is missing in the system; therefore, numerous components and their interconnection were a black box at the time of their innovation. For this reason, the solution was chosen to replace the system with another one, whereas the original videoconference system will gradually be put into operation as a backup system. Therefore, in September 2016, webcams were added at the Institute´s new site and teaching via Skype (with Hangout from Google as a backup system) was put into operation.

To be able use Skype as a videoconference backup system we had to find suitable audio settings. Our videoconference system is design to send and receive audio from all places in the room. During the audio tests we found big echoes. These echoes were caused generally when someone talked. But Skype system is designed to speak with one to one. It means that audio source must be close to microphone. We discovered that maximal distance can be about 50 to 100 cm. Although the Windows operating system contains anti echo system our experiments showed us that it is not work very well. To solve the problem we had to add extra microphone for student side and set very low sensitivity. Thanks to this settings students could listen lectures without headphones and speakers were without own echoes. When students wanted to ask the lecturer they had to use the wireless microphone.

Soon after putting this solution into operation it was found to be unsuitable. This is due to the method of teaching, where combined (long-distance) courses have teaching concentrated into six-hour blocks mainly on Friday morning, Friday afternoon and Saturday morning. This means that on Fridays the video transmission via Skype was continuous for over 10 hours. Subsequently, this was evaluated by the operator of Skype services as transmission of excessively large volumes of data and the account was blocked. Therefore, in November 2016 we put into operation the original Polycom videoconference system as the primary tool for teaching and Skype/Hangout is now operated as a backup system.

To support teaching of automation subjects remote access to the laboratory was proposed where, through an internet application, students have access to physical equipment in the laboratory (Řepka and Danel, 2015). Equipment is monitored by a webcam and students can remotely perform simple experiments using robotic laboratory equipment Bioloid from the Robotis Company (Bioloid, 2017).

Figure 3 Web application for the remote control of the Bioloid robot (Černín, 2014).

A prerequisite for the functional solution is to ensure access to the controlled physical model, so that in a given time only one user can control the model. For this reason a reservation system has been programmed within this application. The access system works in a way that any user who wants to work with this laboratory model must make a reservation for a certain period of time. In this period of time one is ensured an access to manipulate remotely with the laboratory model. Other users can only monitor what is happening there - they cannot have any influence on this model.

For now, one assignment has been put into operation – control of a robotic vehicle, which can be used to present some know-how from automatic control (Řepka and Danel, 2015). The internet application for login, ordering access time and actual control of the robot were solved by students as their final thesis (Černín, 2014). More assignments are planned which the students can use to verify their knowledge from control and automatic regulation theory (Danel, 2016).

4 Assesment

Although it seems like a simple way of providing teaching at a remote site, the current software solutions such as Skype/Hangout are still not suitable as full-blooded replacements for videoconference systems for teaching long-distance students. The big drawback is the dependence on an external service provider (Microsoft, Google…), and their conditions of operation. In December 2016, for example, Google services had a several hours' long failure throughout the Czech Republic – in such a situation teaching would not be possible.

Recently, the trend is to integrate more and more digital technologies into education, use of multimedia tools, lectures in the form of videos, videos demonstrating experiments in laboratories, etc. Consequently, there is an opinion of complementing the teaching of technical subjects via videoconference with multimedia teaching materials. This is of course possible, but even the use of multimedia has its limitations and cannot absolutely replace the direct contact of teachers with students (Spitzer, 1999). In his book, Manfred Spitzer (2015) shows the results of a test which assessed the study results of teaching in two classes. In the first class, teaching was performed in the classical way with printed literature; while in the other class teaching was performed using tablets and multimedia teaching materials. In the case of the second class, student´s results gradually deteriorated. Spitzer gave a reason for this that studying using multimedia materials leads to compromised concentration on the actual content.

5 Conclusion

Teaching using a videoconference system is suitable only for certain subjects which are more descriptive in nature (e.g. subjects such as Information systems). In the case of subjects where experiments must be performed, examples explained and which require interaction with students, direct contact with students is more suitable. Remote access to laboratories in this field is only a complementary tool and cannot replace the presence of a teacher. Therefore, we assume that the method of providing teaching at a remote site should be a sensible compromise between cost-cutting using teaching via videoconference for selected subjects, and the direct presence of teachers in classes which require a personal approach. Excessive pressure on changing the majority of teaching to videoconferencing can paradoxically lead to a reverse economic effect, where a school will receive lower income based on a decrease in the numbers of students due to dissatisfaction with the quality of education.

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Cognitive Application designed to digitize Teaching in Regional Education

Veronika Kubáčková[1], Ivo Martiník[2]

Abstract. The project *Electronization of Education in the Czech Republic* (CZ.01.4.04/0.0/0.0/15_005/0002733) aims to make teaching for children and youth of primary schools in the Czech Republic more attractive and to provide teachers with state-of-the-art ICT technologies to attract pupils to education. One of the main goals of this project is also the implementation and deployment of the newly created portal ceske-skoly.info, which will provide access to digital educational objects that should have a clear link to school education programs. In order to create these links, then, cognitive applications allowing natural language classification will be piloted by analyzing the texts of the existing learning curricula discussed in this article.

Keywords: digital educational objects, cognitive application, natural language classification, text analysis.

JEL Classification: C63, C88

1 Introduction

In 2005, the so-called curricular school reform was introduced in the Czech Republic, as in the other EU countries. It allows schools to create their own educational programs to meet the minimum requirements that schools can differentiate between themselves and respond to the school's focus or region specifics (NÚV, 2011).

With the introduction of state-of-the-art technology into schools, it is possible to extend the teaching of a wealth of complementary materials, which, unlike conventional textbooks, may be multimedia or interactive. In preparing the lesson, it is therefore necessary to monitor both the requirements of the Framework Educational Program and the range of digital educational materials available to teachers. VRK plus s.r.o., which has been developing software support for school curriculum development for several years, has decided to respond to this situation and to extend its programs to the

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possibility of establishing DEOs[1] to FEPs[2] or SEPs[3], thus enabling teachers to more easily select support materials based on well-filled educational standards. This module will be developed within the project *Electronization of Education in the Czech Republic* (CZ.01.4.04/0.0/0.0/15_005/0002733, full title in Czech *Electronization of Education with the Link of Digital Educational Objects to Framework Educational Programs)* which will receive support from the European Structural Fund (VRK plus s.r.o., 2017).

The project will test the possible use of cognitive applications to search for links between DEOs and individual educational standards. When creating an expert system, it will be necessary to work with the native language, because the resources used are in the form of both semi-structured and unstructured text data.

2 Educational cycle

After the introduction of curricular reform, the curriculum was replaced by so-called framework education programs issued by the National Institute for Education (NÚV). They set minimum requirements for graduates of individual educational fields, in the form of competencies, expected outcomes and subject matters.

In general, the FEP is divided into individual educational areas, subjects (which do not have to coincide with the final subjects defined in SEP) and thematic units in which the outcomes and the curriculum are set. Both competences and outcomes are in the form of short descriptions of what the pupil has to achieve after completing the course.

Competencies are more general, they relate to the whole education. It is divided into general, or key and professional competencies. Outcomes, on the other hand, are issued for individual thematic wholes (see Figure 1), so they are much more specific. They can be divided into the minimum and optimal level achieved.

[1] Digital Educational Object
[2] Framework Educational Programme
[3] Scholar Educational Programme

ANTIQUITY

Expected Outcomes

The pupil shall:

- explain the contribution of selected ancient societies, of Antiquity and Christianity to civilisation as the basic phenomena from which European civilisation has developed
- elucidate Judaism (the link between Judaism and Christianity) and other non-European religious and cultural systems
- describe the determining processes and events, and list the important figures of ancient history

Subject Matter

- **ancient Oriental states (Mesopotamia, Egypt, India, China)**
- **ancient Greece**
- **ancient Rome**
- **our lands and the rest of Europe in Roman times; civilisation and barbarism, the Limes Romanus as the boundary of Western civilisation**

Figure 1 Example of expected outcomes and subject matter in the thematic whole Antiquity, Source: Framework Education Programme for Secondary General Education (Grammar Schools) (NÚV, 2007).

Based on these documents, the school prepares a school education program. In SEP, the school specifies the content of individual subjects, unlike FEPs according to years of education. SEP is an essential document that specifies the content of the lesson, but the teaching itself is based on the training developed by the teachers themselves. They can add to each topic an explanation of additional educational materials such as worksheets, videos, or interactive whiteboard games. Both pupils' and teachers' assessment should be followed by a review of both the school and the framework educational programs, including the evaluation of the usefulness of individual study and teaching disciplines (schema of the cycle see in Figure 2).

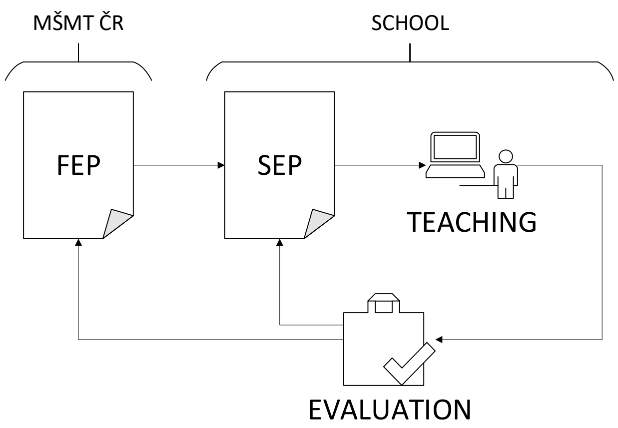

Figure 2 Schema of the educational cycle, Source: own.

3 The project Electronization of Education in the Czech Republic

VRK plus s.r.o. has been involved in educational programs since 2005. Its core product is the Smile software, which serves schools to simplify SEP creation. This is an On-Premise application that shows the individual parts of the FEP and allows them to build the corresponding parts of the SEP. This ensures compliance with the FEP and the fulfillment of all requirements.

The full title of the project in Czech is *Electronization of Education with the Link of Digital Educational Objects to Framework Educational Programs.* The purpose of the project is to create a ceske-skoly.info information portal intended for teachers, which will, among other things, allow the DEO to be assigned to the topics covered by the SEP. If the school inserts or imports its SEP, teachers will find the most appropriate DEO according to subject matter, subject taught and pupil age. Teachers will thus be deprived of the job of finding suitable DEOs, and it will be possible to easily verify the adoption of the curriculum. DEO will be linked to the FEP, so the portal will be usable even without uploading a specific SEP.

4 Using cognitive applications

The problem solved in the project is ideal for testing the use of state-of-the-art approaches such as cognitive computing. It is not based on common algorithms but uses artificial intelligence. By using cognitive applications, efforts will be made to identify the keywords of individual educational standards and digital materials and to find links between them. The most fundamental problem will be to understand the native language in the Czech language. The example of link that could be found with the usage of cognitive applications is illustrated in figure 3:

Watson is a range of IBM products that focus on quantitative and cognitive analysis. Some products are separate and some are provided in the form of services that are included in the IBM Bluemix platform (Gliozzo, 2017). Currently, IBM Bluemix is a service for text, word and image recognition services, these are:

- *Conversation* - allows you to create chatbots and virtual agents;
- *Conversation* - allows you to create chatbots and virtual agents;

DEO – Vocabulary used in the airport

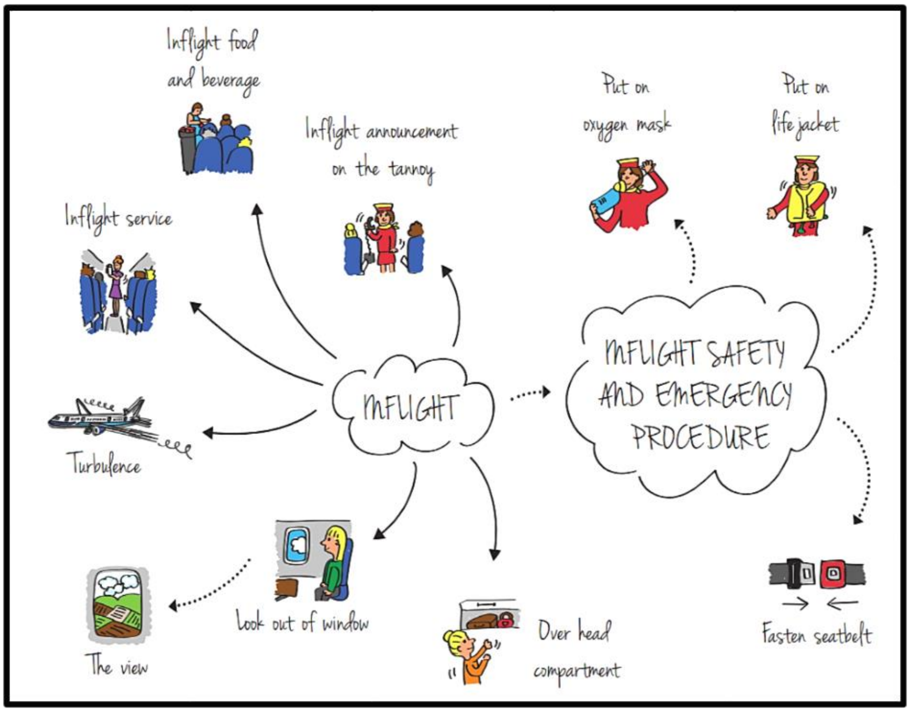

Figure 5 Example of related outcome and DEO, Source: own

- *Conversation* - allows you to create chatbots and virtual agents;
- *Discovery* - creates reports and analyzes of large unstructured texts;
- *Document Conversion* - converts documents to text;
- *Language Translator* - features a translator;
- *Natural Language Classifier* - allows you to classify text inputs;
- *Natural Language Understanding* - used to extract meta-data from content;
- *Personality Insights* – identifies psychological traits from data;
- *Retrieve and Rank* – used to find relevant results;
- *Speech to Text* - converts the spoken word into text;
- *Text to Speech* - converts text into a spoken word;
- *Tone Analyzer* – allows you to detect of conversation;
- *Visual Recognition* - recognizes images and text in them (IBM, 2017).

Most of these services are available to a limited extent free of charge. Watson services are not limited to English, they can work with different languages, some of them already have implemented Czech.

The *Document Conversion* service is suitable for converting PDF, HTML or DOCX files to normalized text in HTML or JSON format. It could be used to convert released PDFs to structured documents that can be processed electronically and to automatically process some types of DEOs.

For identifying keywords and categories in educational standards can be used the *Natural Language Understanding* service. According to them can be standards paired with DEOs. Demo service output in English is illustrated in Figure 4.

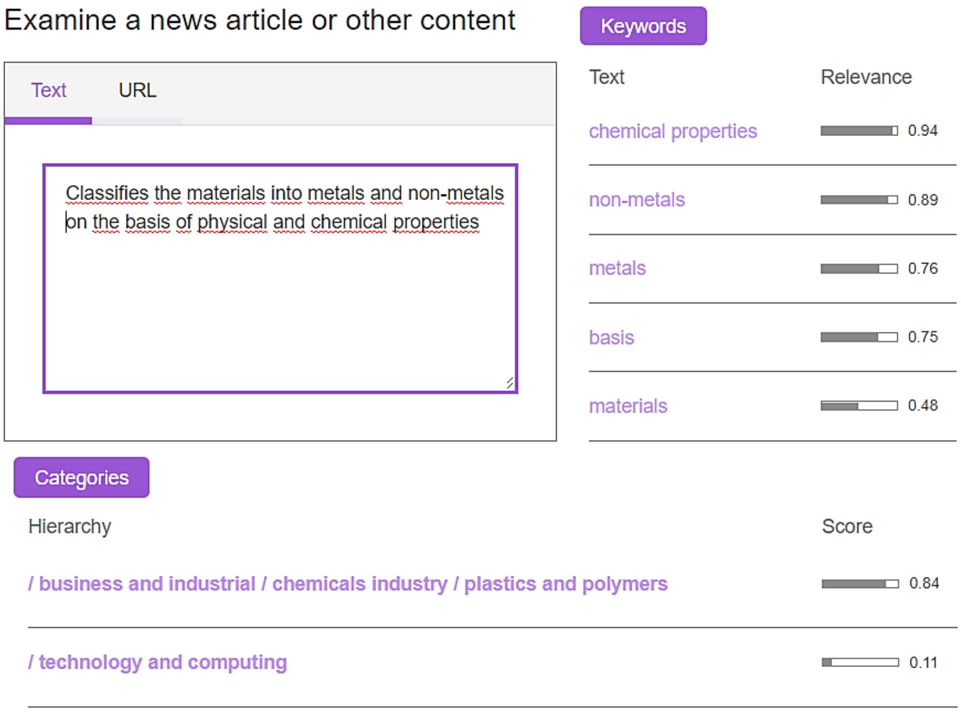

Figure 6 Output of Natural Language Understanding service, Source: own

Using *Natural Language Understanding* can be expanded by another IBM Watson product *Knowledge Studio*. This provides additional options for classifying unstructured text and identifying links in it based on inserted expertise (Vergara, 2017).

One of the services available in Bluemix the *Visual Recognition* is designed to identifying pictures and text in them. This service could be used to automatically assign keywords to some forms of DEOs. The output of the Demo service is illustrated in Figure 5.

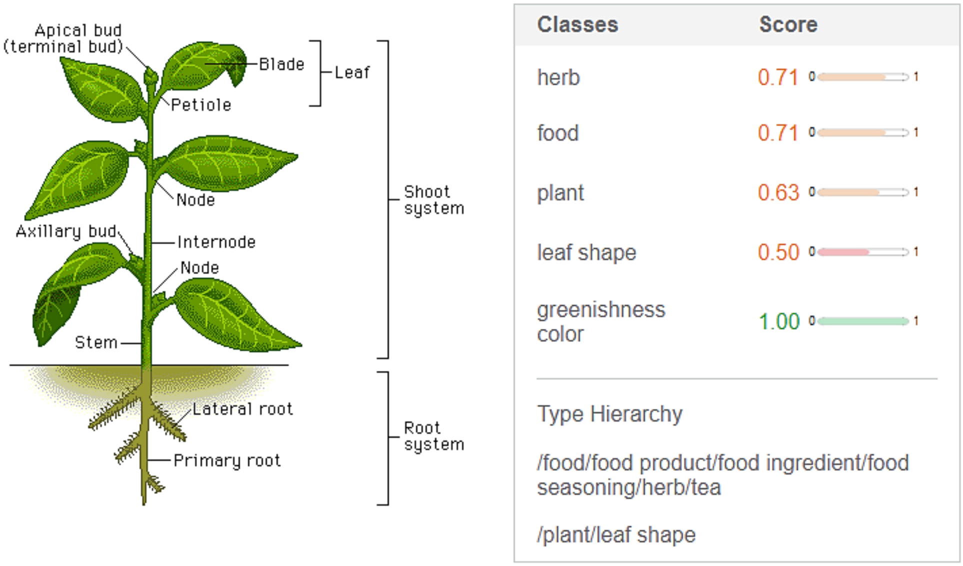

Figure 7 Output of Visual Recognition service, Source: own

Conclusion

The application using cognitive computing for analyzing educational programs and materials will be developed within the project *Electronization of Education in the Czech Republic*.

The biggest problem in analyzing FEPs, SEPs or DEOs is the natural Czech language processing. In development of the application, the IBM Watson services available in the Bluemix cloud platform will be used due to their accessibility and free of charge usage.

Acknowledgements

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Gender and Personality Traits' (BFI-10) Effect on self-perceived Tech Savviness

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Sudzina František[3]

Abstract. Today's students are considered as digital natives that grew up digitally. They use smartphones and services like social media on a regular basis. The aim of this paper is to analyze if gender and personality traits (Big Five Inventory-10) influence self-perceived tech savviness of Slovak business students. The tech savviness is investigated in two dimensions - in one's own opinion and in the eyes of others. In both cases, neuroticism significantly influences self-perceived tech savviness, and the relationship is negative. It may be because more neurotic people are more afraid of using various new features of tech devices. Moreover, self-perceived tech savviness in eyes of others is significantly influenced also by gender, i.e. men consider themselves more tech savvy.

Keywords: tech savviness, personality traits, gender, empirical research, quantitative methods.

JEL Classification: L15, L68, O33, J16

1 Introduction

Social media and devices like smartphones and tablets allow people to be online everywhere, have changed relationships among them and influenced how people connect, share and interact with others (Switzer and Switzer, 2013). Today's students, who grew up with these new technologies and use them effortlessly, are often referred to as "Digital Natives" (Prensky, 2001) and are considered as tech savvy. But, as Pegrum (2011) points out, the digital generation is less homogeneous than the naming implies. Moreover, Hargittai (2010) discusses that factors like, gender, socioeconomic status or education level influence young people's use of technology.

Additionally, personality might have an influence on the state of knowing a lot about modern technology, which is also called tech-savviness.

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For describing personality, the Big Five Inventory (John and Srivastava, 1999) can be used, which is the de-facto standard for investigating personality traits in information systems literature. The Big Five Factors describe personality with using the dimensions “conscientiousness”, “openness to experience”, “neuroticism”, “extraversion” and “agreeableness”. *Conscientiousness* includes thoroughness, dependability, responsibility and achievement orientation (Digman, 1990). Conscientious students are more likely to use internet for academic purposes than for leisure (Landers and Lounsbury, 2006). Students who are o*pen to experience* are more curious and willing to learn and have therefore have a higher intension to use technology in the classroom (Barnett et al, 2015). *Neuroticism* is related to worried and insecure. Neurotic people are more likely to view technological advances as threatening and stressful (Devaraj et al, 2008). *Extraverted* as social and assertive people may readily adopt information systems to complement their interaction avenues (Barnett at al., 2015). *Agreeableness,* characterized with good-naturedness and trust, has not been found as influencing technology use (Svendsen et al, 2013).

Sudzina (2015) already investigated the influence of gender and personality traits on tech-savviness among Danish students. He found that men consider themselves as more tech-savvy than women.

The objective of this paper is investigate the influence of gender and personality traits among management students in Slovakia and such to replicate the results achieved by (Sudzina, 2015). Begley and Ellis (2012) discovered that only six of selected 53 high-profile papers could be reproduced in the field of cancer biology. In the field of psychology, Open Science Collaboration (2012) project replicated 100 investigations of which 39 matched the original results and another 24 were at least "moderately similar" to findings of the original experiments. Therefore, replications are necessary in order to figure out whether findings hold under any conditions.

The rest of the paper is organized as follows: The next section describes gathered data and methods used to analyze them. The following section reports results of multiple analyses. The final section summarizes the findings.

2 Data and methodology

A questionnaire was constructed for investigating the influence of personality and gender on the-savviness. The instruction to measure tech savviness was “Please indicate to what degree you agree with the following statements”:

- “People consider me to be tech savvy”;
- “I consider myself to be tech savvy”.

Gimpel, Sudzina and Petrovcikova (2014; 2016) used such statements to measure tech savviness as a part of a self-identity construct. A 1-5 Likert scale was used where 1 meant strongly disagree and 5 stood for strongly agree. Despite both answers are self-reported, they provide an insight in how respondents perceive their tech savviness in the eyes of others and in their own opinion.

Personality traits were measured using the Big Five Inventory-10 questionnaire (Rammstedt and John, 2007), i.e. a 10-item version of the longer, John and Srivastava's (1999) questionnaire for the Big Five Inventory. The instruction was to rate “How well do the following statements describe your personality” with statements "I see myself as someone who...”

1. ... is reserved;
2. ... is generally trusting;
3. ... tends to be lazy;
4. ... is relaxed, handles stress well;
5. ... has few artistic interests;
6. ... is outgoing, sociable;
7. ... tends to find fault with others;
8. ... does a thorough job;
9. ... gets nervous easily;
10. ... has an active imagination.

on a 1-5 Likert scale where 1 meant strongly disagrees and 5 stood for strongly agree. The Big Five Factors were constructed from the questionnaire items as follows: Extraversion was calculated as an average of the 1st (reversed-scored) and the 6th answer, agreeableness as an average of the 2nd and the 7th (reversed-scored) answer, conscientiousness as an average of the 3rd (reversed-scored) and the 8th answer, neuroticism as an average of the 4th (reversed-scored) and the 9th answer, and openness to experience as an average of the 5th (reversed-scored) and the 10th answer.

Data were collected in February 2017. Respondents were students of the University of Economics in Bratislava, Slovakia, that can be considered as digital natives. In total, 136 students (of whom 44 were male and 92 female) answered all relevant questions. Moreover, there was one respondent who did not provide information on gender but filled in all other answers. This additional, 137th respondent will be used in streamlined models, which do not contain gender.

A generalized linear model (GLM) was used to analyze the impact of gender and of five personality traits (extraversion, agreeableness, conscientiousness, neuroticism, openness to experience) in three models where the dependent variables were respectively:

3) tech savviness in the eyes of others (“People consider me to be tech savvy”);
4) tech savviness in one's own opinion (“I consider myself to be tech savvy”);
5) tech savviness in the eyes of others minus tech savviness in one's own opinion.

A multivariate approach to testing was used. To measure correlation between answers for statements “People consider me to be tech savvy” and “I consider myself to be tech savvy”, Pearson product-moment correlation coefficient is used. To test a difference between these two variables, a paired samples t-test was used. SPSS software was used for all the tests.

3 Results and discussion

Parameter estimates for the generalized linear model analyzing impact of gender and of personality traits on self-perceived tech savviness in the eyes of others are provided in Table 1. The model per se is significant (p-value = .023), R^2 = .106, R^2_{adj} = .064. In (Sudzina, 2015), the model per se was not significant (p-value = .107), R^2 = .061, R^2_{adj} = .026 and only openness to experience had a p-value below .05, while p-value for gender was .125.

Table 1 Parameter estimates for model 1, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	4.133	.794	5.203	.000
Extraversion	-.079	.123	-.645	.520
Agreeableness	.053	.119	.446	.656
Conscientiousness	.008	.108	.077	.938
Neuroticism	-.234	.103	-2.274	.025
Openness to experience	-.022	.099	-.218	.828
Gender (female)	-.462	.205	-2.248	.026

Carlson and Wu (2012) suggest to exclude independent variables that are not significant. Parameter estimates for the streamlined model are provided in Table 2.

Table 2 Parameter estimates for streamlined model 1, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	3.955	.286	13.815	.000
Neuroticism	-.227	.097	-2.341	.021
Gender (female)	-.436	.193	-2.259	.026

The streamlined model per se is significant (p-value = .001), R^2 = .102, R^2_{adj} = .088. In (Sudzina, 2015), the streamlined model per se was significant (p-value = .011), R^2 = .052, R^2_{adj} = .041, openness to experience stayed significant, and the significance of gender changed to 0.06.

Parameter estimates for the generalized linear model analyzing impact of gender and of personality traits on self-perceived tech savviness in one's own opinion are provided in Table 3.

The model per is significant (p-value = .016), R^2 = .112, R^2_{adj} = .071. In (Sudzina, 2015), the model per se was not significant (p-value = .277), R^2 = .044, R^2_{adj} = .009), and gender had to lowest p-value of .129.

Table 3 Parameter estimates for model 2, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	4.185	.872	4.799	.000
Extraversion	-.050	.135	-.372	.710
Agreeableness	-.055	.131	-.421	.674
Conscientiousness	.135	.118	1.138	.257
Neuroticism	-.323	.113	-2.857	.005
Openness to experience	-.020	.109	-.180	.858
Gender (female)	-.312	.225	-1.385	.169

Parameter estimates for the streamlined model are provided in Table 4. The streamlined model per se is significant (p-value < .001), $R^2 = .091$, $R^2_{adj} = .084$. In (Sudzina, 2015), the streamlined model containing only gender was borderline significant (p-value = .065), $R^2 = .020$, $R^2_{adj} = .014$, and the significance of gender improved. If gender was included in the model in Table 4 alongside neuroticism, its significance would be .241.

Table 4 Parameter estimates for streamlined model 2, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	4.178	.311	13.420	.000
Neuroticism	-.376	.102	-3.677	.000

The correlation coefficient for tech-savviness tech savviness in the eyes of others and tech savviness in one's own opinion is .779, p-value < .001. (In (Sudzina, 2015), the correlation coefficient was .696, p-value < .001.) This translates into Cronbach's alpha of .874 (while in (Sudzina, 2015), it was .82), i.e. higher than Nunnally's (1978) threshold of .7.

On average, tech savviness in the eyes of others was lower by .085 (compared to .064 in Sudzina (2015)) compared to tech savviness in one's own opinion, pairwise comparison t-test p-value of .175 (compared to .186 in (Sudzina, 2015)). In other words, respondents on average thought their tech savviness was higher than perceived by others but this difference was not significant. Parameter estimates for the generalized linear model analyzing impact of gender and of personality traits on the difference between self-perceived tech savviness in the eyes of others and in one's own opinion are provided in Table 5.

Table 5 Parameter estimates for model 3, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	-.052	.550	-.095	.925
Extraversion	-.029	.085	-.342	.733
Agreeableness	.108	.083	1.313	.192
Conscientiousness	-.126	.075	-1.693	.093
Neuroticism	.089	.071	1.246	.215
Openness to experience	-.002	.069	-.030	.976
Gender (female)	-.150	.142	-1.052	.295

The model per se is not significant (p-value = .267), R^2 = .057, R^2_{adj} = .013. In (Sudzina, 2015), the model per se was also not significant (p-value = .625), R^2 = .026, R^2_{adj} = -.010, and it was not possible to find a submodel with p-values < .1. Parameter estimates for the streamlined model are provided in Table 6. The streamlined model per se is significant (p-value = .032), R^2 = .033, R^2_{adj} = .026.

Table 6 Parameter estimates for streamlined model 3, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	.445	.257	1.730	.086
Conscientiousness	-.154	.071	-2.161	.032

4 Conclusion

The objective of the paper was to analyze the impact of gender and of personality traits on self-perceived tech savviness. Two versions of the dependent variable were used - tech savviness in the eyes of others and tech savviness and in one's own opinion. In both cases, more neurotic respondents believed to be less tech savvy. This is in line with the findings from (Devaraj et al, 2008) who concluded from their literature review that neurotic people are more anxious and struggle with computer usage at the workplace. Our study also found that male respondents rated higher their tech savviness in the eyes of others.

Tech savviness in the eyes of others and tech savviness and in one's own opinion were correlated (the correlation coefficient was above .7) and the difference between the two was not statistically significant. But when considering also personality traits and gender, we found that conscientiousness significantly influences the difference between the two measures – how people consider themselves as tech savvy and how other people consider their tech savviness.

To summarize, out of the Big Five personality traits, neuroticism and conscientiousness were in our study influential on the tech savviness of the Slovak students. Interestingly, Barnett et al (2015) by investigating the influence of Big Five factors on the perceived and actual use of IT systems, also found that only neuroticism and conscientiousness have a direct effect.

The results show that digital native students cannot be considered as a homogeneous group as already discussed by Pegrum (2011). Even if students use computers and mobile devices as well as social software a lot for leisure activities, it does not mean that all of them consider themselves as tech-savvy. University teachers have to address digital literacy and prepare students for the digital world, e.g., by including learning management systems and social media in the classroom (Kirchner and Razmerita, 2015).

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Smarter Moravian-Silesian Region „Action Plan”

Miroslav Svozil[1]

Abstract: The Moravian-Silesian region follows a large number of world cities and regions that claim to be "smart cities" or "intelligent regions". The Regional Assembly therefore decided to develop a medium-term strategy for "intelligent conceptual solution" - a "Smarter Region". This strategy includes five target areas - transport, information and communication technologies, infrastructure, de-bureaucratization and savings.
A new document, "Action Plan", which contains detailed project descriptions for the years 2017-2019, has recently been approved. The aim of these projects is to increase the efficiency and productivity of public services and save time and money for the region's inhabitants.
Another goal is to achieve a higher competitiveness of the region in the global economy and to create an innovative environment capable of creating a new intelligent solution.
The paper talks about the scope of the Master Plan. The main criteria that need to be met in the solutions and assumptions that the design must respect.
The experience of preparing and implementing the "Master Plan" will be discussed.

Keywords: smart cities, smart regions, traffic control and monitoring, telemedicine, data analytics centre.

JEL Classification: L86, O31

1. Introduction

In 2017, the Moravian-Silesian Region launched a cooperation with key performers in the field of smart technologies. The purpose was to draft the Moravian-Silesian Strategy for applying the ”smart“ concept under the „Smart region“ title. More than a hundred public, private, and academic representatives from the strategic group of key stakeholders were contacted and invited to join expert teams and comment on the Strategy under five work groups.

The Smart Region Strategy was approved by the Moravian-Silesian Assembly on 12 June 2017 as the Strategy for Developing a Smart Moravian-Silesian Region 2017 – 2023, „Smart Region“.

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The Moravian – Silesian aims to create the best examples of ICT use and innovation help the region´s people save time and money, while also improving the quality of the environment they live in (BeePartners, 2010).

The Moravian – Silesian Region sees the Smart Region Strategy as a long – term, systematic process of seeking optimal solutions and innovations.

The Action Plan is forecasted for the years 2017 – 2019 and presents 24 projects, whose common element is the application of ICT and also meeting the following three "smart criteria"

- Application of ICT and smart technologies.
- Application of the partnership principle.
- Introduction of innovations and experimental elements.

The Action Plan fulfils the following prerequsities:

- It contains 24 projects as standardised project fiches.
- Each project concentrates on improving the quality of life in the region, primarily in savings money and time for citizens.
- It proposes the key activities, finances and time frame of individual projects and events.
- It proposes indicators to measure progress in fulfilling the plan.
- It defines the entities responsible for individual activities. It describes the system of coordination and cooperation between the Smart Region Development Section and the carriers of individual projects.

2. The Content of Action Plan

The Strategy for a Smart Region contains a proposal for flagship projects in five priority areas. It´s key role consists of tuning the key players in specific priority projects, their objectives, activities, financial resources and time.
The Action Plan aims to answer the following key questions:

- WHAT – Which projects/ activities should go ahead and what changes does region want to achieve?
- WHO – Who is the carrier of the project and activities?
- WHEN – When will the projects be implemented?
- RESOURCES – How many people and what resources are needed to implement the Action Plan?
- COMMUNICATIONS – Who should know about project implementation and how should they find out?

3. Prerequisites for Successful Implementation

- Resources and capacity
- Strategic management, marketing, and cooperation
- Rationalisation and evaluation
- Leadership in the region and the Czech Republic
- Evaluation efficiency

4. Action Plan Summary

ICT Infrastructure

Number of projects: 4

Project carrier: Moravian- Silesian Region

The introduction of ICT will place demands on the infrastructure for transport and data storage and evaluation. The Action Plan contains 3 project aimed at strengthening and expanding data and IT transfer and usage infrastructure, and 1 project for analytic infrastructure, i.e. the Data Analytics Centre (IBM, 2012). The common goal of the projects is to increase the capacity of ICT infrastructure for current and future use. Thank to these priorities, the Moravian – Silesian Region plans to interconnect its funded organisations via high speed internet backbone network, expand WiFi connection availability in its buildings and in cooperation with regional transport operators, also expand WiFi in public transit vehicles, and support the development of a data transfer network for the Internet of Things.

The Data Analytics Centre will monitor and evaluate obtained data in cooperation with the computer centers of the Technical University of Ostrava.

Transportation

Number of projects: 5

Project carrier: Moravian – Silesian Region and funded organizations

The Moravian – Silesian Region will support a greater proportion of sustainable transportation with emphasis on increasing public transit use, electromobility, and hydrogen mobility. The first project will be the construction of dozens of smart stops in regional transportation. A WiFi network will also be available at these stops and on public transit vehicles buses, trains.

To evaluate changes in traffic flow and it´s impact on people lives, the region wants to support a traffic survey by the regional Data Analytics Centre. The aim of research and development in transportations should be to develop intelligent navigational systems with accurate and reliable information about current traffic (Cejnarová, 2012). The region also wants to help improve parking, particularly in larger cities, by supporting the development of smart parking lots.

Under the project to introduce intelligent traffic control systems, investments will be made into mapping road conditions, information systems concerned with road conditions, and the movement of regional vehicles for infrastructure maintenance.

Savings

Number of projects: 4

Project carrier: Moravian – Silesian Region with cities, and municipalities, The Moravian – Silesian Energy Centre

The Moravian – Silesian Region aims to achieve energy savings and improve the environment with the help of ICT.

To achieve energy savings, the region will support testing of smart technologies at the region´s selected buildings and properties, in cooperation with the Technical University of Ostrava and the Moravian – Silesian Energy Centre.

To monitor and evaluate air quality, the region aims to support an expanded sensor network and improve the avilability and reliability of data obtained, also providing it to citizens in real time. The region wants to support instruments to promote a circular economy, it´s aim is to minimize waste creation and maximize recycling of materials. The region thus wants to support an information network to promote the waste collection and recycling (BeePartners, 2017).

Healthcare

Number of projects: 5

Project carrier: Moravian – Silesian Region and its Healthcare Facilities

Under the project to digitalize health care, it will support the introduction of telemedicine, meaning treatment and communication between patient and physician via remote means enable electronic booking of appointments. The region increase the reliability and speed of sharing information among patients, physicians and healthcare facilities. The region will systematically work to involve regional healthcare facilities in the national and European information sharing network under eHealth. The region also wants to improve navigational systems at hospitals and enable tong-term patients to video – conference with their relatives under the VideoCall project.

De-Bureaucratisation

Number of projects: 4

Carrier: Moravian – Silesian Region

The common goal of the projects is to improve the efficiency of regional government,

Under the Regional Authority, it will follow up on ongoing processes in corporate governance and control. Information systems and agendas will be unified. The creation and use of electronic content in processes at the Regional Authority will be supported, as well as greater use of open data sharing for the citizens and business entities. The region also wants to inform citizens via special information portals.

Table 1 List of Strategic Projects in the Action Plan For 2017 – 2019, Source: own

Strategic objective	Project name/activity
1.1.	Smart parking
1.2.	Intelligent systems, traffic control and monitoring
1.3.	Traffic flow monitoring and evaluation (traffic surveys)
1.4.	Smart stops
1.5.	Development of electromobility and expasnsion of charging station infrastructure for electromobility
2.1.	High speed data network
2.2.	Regional Data Analytics Centre
2.3.	Regional coverage with the internet of things
2.4.	Uniformly accesible WiFi network in regional buildings and subsidised carrier lines
3.1.	Intelligent metering and energy management of buildings owned by region
3.2.	Support for a circular economy and smart waste management
3.3.	Air quality management
4.1.	Digitalisation of Processes in healthcare and improved quality of care
4.2.	Electronic ordering systems
4.3.	Telemedicine – sensors, telemonitoring, telecommunications
4.4.	Navigation systems at healthcare facilities

4.5.	First responder system
4.6.	Expansion of the information sharing network under eHealth
4.7.	VideoCall for patients
5.1.	Eletronic submission forms for citizens and businesses
5.2.	Effective corporate management of regional organizations
5.3.	Secure databases with open data for further use by the professional and general public
5.4.	Information portal for citizens

5. Description of Projects and Projects Fiches

Projects in the action plan are documented in two versions:

- Communication versions
- Project fiches – detailed description describing short term activities and outputs, and serving as an instrument to coordinate and regulate partners under the project.

The project fiches work with the following information:

- Name of the project
- Inclusion in a strategic objective
- Name of the author, date of last revision
- Responsible deputy
- Fiche sponsor – guarantees the accuracy of content
- Responsible person
- Collaborators
- Project necessity
- Links to other project
- Implementation period, planned activities
- Financial resources
- Partnership
- Inspiring examples of projects
- Examples of exploitable technologies under implementation

Example:

Strategic Objective 1.2. Intelligent Systems and Traffic Control

Project venture: intelligent systems and traffic control

Carrier: Moravian – Silesian Region

Expenses:

- Financing: Moravian – Silesian Region co-financed by national or European funds

Project objectives:

- Manage traffic and provide information about traffic to commuters, with the aim of improving road traffic flow and safety without having to build a costly infrastructure. Adaptive traffic control, provide traffic information in real time, reference public transit vehicles at lighted intersections, develop parking information and navigational systems, adapt light signalisations to traffic, and methodical support and cooperation in introducing intelligent traffic control systems and municipalities.

Changes to current conditions:

- To introduce intelligent traffic control systems, four specific pilot projects have been selected: construction of weather station network on 3th and 4th class roads, electronic passport for2nd and 3rd class roads, finalisation of a complete GPS system for MSR vehicles, creation a Regional traffic information system.

Outputs:

- Weather stations with CCTV and mapping of 2nd and 3rd class roads
- Mapping of 3rd and 4th class roads, creation of a Geoportal
- Superstructure for the GPS system for vehicle tracing
- Regional transport system

Benefits:

- More effective management of winter maintenance vehicles
- Road traffic flow and safety
- Election of the mode of transport and most suitable route given all the available traffic information and data

6. Conclusion

Strategic governance will be represented by key performers of the region, who will comment on the Smart Region´s strategic objectives (BeePartners, 2017). For this reason, the Moravian – Silesian region wants to base the smart Region Strategic Group. The Strategic Group will consist of the main performers for the Smart Region and Smart City, ministry representatives, representatives of the statutory cities of Ostrava, Opava, Havířov, Frýdek-Místek and Karviná, and representatives of smaller cities, and in the future, representatives of leading technological performers in the smart technology fields.

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Impact of Personality Traits and Demographic Factors on Relationship to Deal Sites

Sudzina František[1], Pavlíček Antonín[2]

Abstract. There is an increasing body of research about deal sites. But there is still exists a gap when it comes to factors influencing potential or existing users of deal sites. The aim of this paper is to investigate impact of gender, city of origin, and personality traits on relationship to deal sites. Big Five Inventory framework is used for personality traits. The research was conducted in the Czech Republic. With regards to the findings, city of origin has a significant effect, and openness to experience a borderline significant effect on the relationship to deal sites.

Keywords: deal sites, personality traits, demographic factors, empirical research, quantitative methods.

JEL Classification: L15, L68, O33, J16

1 Introduction

Deal sites are social promotion sites that usually offer vouchers or coupons for local businesses at a deeply discounted price. As Gros and Grosova (2006) pose, price of goods or services is just one of the selection criteria, though still very important. Groupon and LivingSocial (acquired by Groupon in October 2016) were launched about a decade ago. Although it was by far not the first one, these days, probably most people think of Groupon first when talking about deal sites. Possible reasons are summarized in (Sudzina, 2016b).

Within the business model framework compiled by Taran et al. (2016), Groupon can be classified as affinity club (Johnson, 2010), round-up buyers (like Linder and Cantrell's (2000) buying club), and trade show (like Timmers' (1998) third-party marketplace). According to the same framework, aggregators of deal site offers are infomediaries (Rappa, 2001).

The Groupon-style shopping has spread from the US to Europe and has achieved great popularity in the Czech Republic. Deal sites are present in the Czech Republic since 2009, they gained general popularity in 2010 with the advent of the company Slevomat. In 2011, when the number of deal sites

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peaked, there were 204 registered servers (4 times more than nowadays). Since 2015, the market cleared in the period of consolidation – it has achieved its growth limits, the overall market turnover has stabilized. In the market, there currently operate 45 active deal sites, top 5 of which control 90% of the market share, and the share of the leader (slevomat.cz) alone is 40%. A preliminary analysis of deal sites operating on the Czech market has revealed an interesting finding just by comparing their headquarters location. Vast majority of them is situated in Prague. Similar results have been observed also by Suchacek et al. (2017) who investigated location of Czech large enterprises.

The aim of the paper is to investigate impact of gender, or the city of origin, and of personality traits on relationship to deal sites.

The rest of the paper is organized as follows: The next section describes gathered data and methods used to analyze them. The following section reports results of multiple analyses. The final section summarizes the findings.

2 Data and methodology

Data were collected in December 2016-January 2017 using an on-line questionnaire. Respondents were 264 university students from the Czech Republic, of which 140 respondents indicated that they use deal sites, and 124 do not. (From this data set, the analysis of use versus non-use of deal sites was published in (Sudzina and Pavlicek, 2017b); the analysis of extent of use of deal sites was published in (Sudzina and Pavlicek, 2017c); the analysis of customer satisfaction with goods and services purchased on deal sites was published in (Sudzina and Pavlicek, 2017a); the analysis of use of coupons from deal sites as gift was published in (Pavlicek and Sudzina, 2017); and the analysis of preference to use aggregators rather than individual deal sites was published in (Sudzina and Pavlicek, 2017d).)

SurveyXact was used for the questionnaire. Unlike Qualtrics, it does not allow to show/hide questions based on answers to questions on the same page. Therefore, the questionnaire was split into two pages and questions for deal sites users appeared on the second page. Seven respondents stopped after the first page. So, the effective sample size is 133 (43 men, 90 women; on average 20 years old).

Besides gender, another demographic variable that was collected was the side of the city of origin. Respondents were asked to mark from where they come from

- township up to 500 inhabitants (coded as 4),
- town up to 10,000 inhabitants (coded as 3),
- town up to 50,000 inhabitants (coded as 2),
- county seat (coded as 1),
- Prague (coded as 0).

Personality traits were measured using Rammstedt and John's (2007) Big Five Inventory-10, i.e. a 10-item version of the Big Five Inventory questionnaire developed by John and Srivastava (1999), and translated to Czech by Hřebíčková et al. (2016). The instruction was to rate "How well do the following statements describe your personality" with statements "I see myself as someone who..."

1. ... is reserved,
2. ... is generally trusting,
3. ... tends to be lazy,
4. ... is relaxed, handles stress well,
5. ... has few artistic interests,
6. ... is outgoing, sociable,
7. ... tends to find fault with others,
8. ... does a thorough job,
9. ... gets nervous easily,
10. ... has an active imagination

on a 1-5 Likert scale where 1 meant strongly disagrees and 5 stood for strongly agree. Extra-version was calculated as an average of the 1st (reversed-scored) and the 6th answer, agreeableness as an average of the 2nd and the 7th (reversed-scored) answer, conscientiousness as an average of the 3rd (reversed-scored) and the 8th answer, neuroticism as an average of the 4th (reversed-scored) and the 9th answer, and openness to experience as an average of the 5th (reversed-scored) and the 10th answer.

Relationship to deal sites, i.e. the dependent variable, were measured using the following question: "What is your relationship to deal sites?

- I am a fan - I like shopping on this type of sites (coded as 1),

- I do not like them (coded as -1),
- I do not have a strong opinion (coded as 0).

The questionnaire contained additional questions which were not used in the analysis presented in this paper. General linear model was used to test the model. A multivariate approach to testing was used. SPSS software was used for all the tests.

3 Results and discussion

Parameter estimates for the generalized linear model analyzing impact of gender, of size of the city of origin, and of personality traits on relationship to deal sites are provided in Table 1. The higher the value, the more positive relationship to deal sites. The model per se is not significant (p-value = .122), $R^2 = .114$, $R^2_{adj} = .042$.

Table 1 Parameter estimates for the full model, Source: own.

Parameter	B	Std. Error	t	Sig.
Intercept	.086	.465	.184	.854
Gender (male)	-.048	.108	-.444	.658
From (Prague)	.133	.151	.878	.382
From (county seat)	.479	.173	2.773	.006
From (town up to 50,000 inhabitants)	.199	.172	1.158	.249
From (town up to 10,000 inhabitants)	.211	.160	1.318	.190
Extraversion	.033	.054	.621	.536
Agreeableness	-.044	.063	-.703	.483
Conscientiousness	.038	.057	.666	.507
Neuroticism	.057	.046	1.236	.219
Openness to experience	-.094	.054	-1.740	.084

In order to improve p-values, certain independent variables will be omitted. Parameter estimates for the streamlined model are provided in Table 2.

Table 2 Parameter estimates for the streamlined model, Source: own.

Parameter	B	Std. Error	T	Sig.
Intercept	.344	.206	1.675	.096
From (Prague)	.149	.148	1.007	.316
From (county seat)	.487	.170	2.868	.005
From (town up to 50,000 inhabitants)	.211	.165	1.275	.205
From (town up to 10,000 inhabitants)	.228	.155	1.475	.143
Openness to experience	-.088	.051	-1.735	.085

The streamlined model per se is significant (p-value = .049), $R^2 = .083$, $R^2_{adj} = .047$. There is a significant difference between respondents from townships up to 500 inhabitants (the baseline) and county seats. The latter have a more positive relationship to deal sites. Respondents more open to experience have a more negative relationship to deal sites. This finding is consistent with investigation of frequency of use of deal sites conducted in Denmark (Sudzina, 2016a) in a sense that the impact of openness to experience is significant and negative.

4 Conclusion

The aim of the paper was to investigate impact of demographic variables, and of personality traits on relationship to deal sites. The study was conducted in the Czech Republic, and the sample consists of university students studying in Prague. In brief, the size of the city where students come from has a significant effect on their relationship to deal sites; and openness to experience has a borderline significant effect.

It is possible to interpret the results in a different manner. As it was suggested in (Sudzina, 2016a), it can be that people open to experience do not need any price incentive to try new things; and it is rather people not open to experience who enjoy a possibility to buy coupons through deal sites at a discount, so trying out new things is not so risky (i.e. the loss will be smaller in case they do not like the product or the service).

With regards to the city of origin, respondents from county seats have a more positive relationship to deal sites than respondents from townships up to

500 inhabitants. In general, respondents from townships up to 500 inhabitants have the least positive relationship to deal sites, although the difference was not significant in all the pairs. In future research, if there is a need to shorten the questionnaire, it may possible to have only two sizes - up to 500 inhabitants, and more than 500 inhabitants.

In case the sample in future research is more heterogeneous, it may be advantageous to add a question about acceptance of the Internet, as Dakduk et al. (2017) found that "[i]ndividuals showing more acceptance of the Internet" find " the Internet as an easy way of buying".

Another idea for future research is to investigate which deal site(s) are used by individual respondents, and sentiment for a particular deal site could be also taken into consideration. Dorcak et al. (2017), although in a different industry, discovered that advanced sentiment analysis significantly correlates with number of Twitter followers; so Twitter analysis could be the next step in the further research. Ministr and Racek (2011) describe sentiment evaluation of unstructured Czech text, so the analysis of tweets and social media posts would be logical next step in further analysis.

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IT INNOVATION

Information technology as a tool of lean manufacturing in medicine

T.G. Avacheva[1], Sergey Yablochnikov[2]

Abstract. The article discusses the possibility of using approaches from lean manufacturing for the organization of work of medical organization using information technology. Provides specialized systems automate the activities of medical institutions, implementation of which is carried out in Russia. Describes the experience of organization of professional training of doctors in the field of information technology.

Keywords: lean manufacturing, medical information system, automated workplace of the doctor, digital medicine, the competence of the doctor.

JEL Classification: L 86, I 18

1 The project "hospital lean"

The project "Lean hospital" is implemented in Russia from the end of 2016. Developers were the Ministry of health of the Russian Federation, administration of the President of the Russian Federation and the state Corporation "Rosatom". The project is aimed at reduction of inefficient processes in healthcare institutions of the country. Goals:

- ireduce the time of stay of the patient in the clinic;
- optimize the registry, staff, physicians and laboratories;
- create a friendly atmosphere;
- increase the availability and quality of health services and to improve the conditions of rendering of medical aid;
- improve the working conditions of employees of medical institutions.

The project "Lean hospital" includes a number of optimization decisions that will change the process of appointment will reduce the time of stay at the therapist, will increase the capacity and, therefore, will increase the number of patients. In addition, the initiative will affect the procedure of the examination,

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receive the discounted drugs, care for citizens with disabilities health and disability.

1.1 The possibilities of modern information technologies in the organization of work of medical institutions

One of the directions of the project "Lean hospital" is the widespread adoption of information technologies for organization of electronic document management and electronic record on reception. When optimizing business processes in the clinic with the use of modern information technologies necessary to streamline workflow, reduce paper-based information to reduce paperwork, reduce time spent on patient visits to outpatient clinics, to ensure continuity in the work of structural units, go to the statistics in a single system.

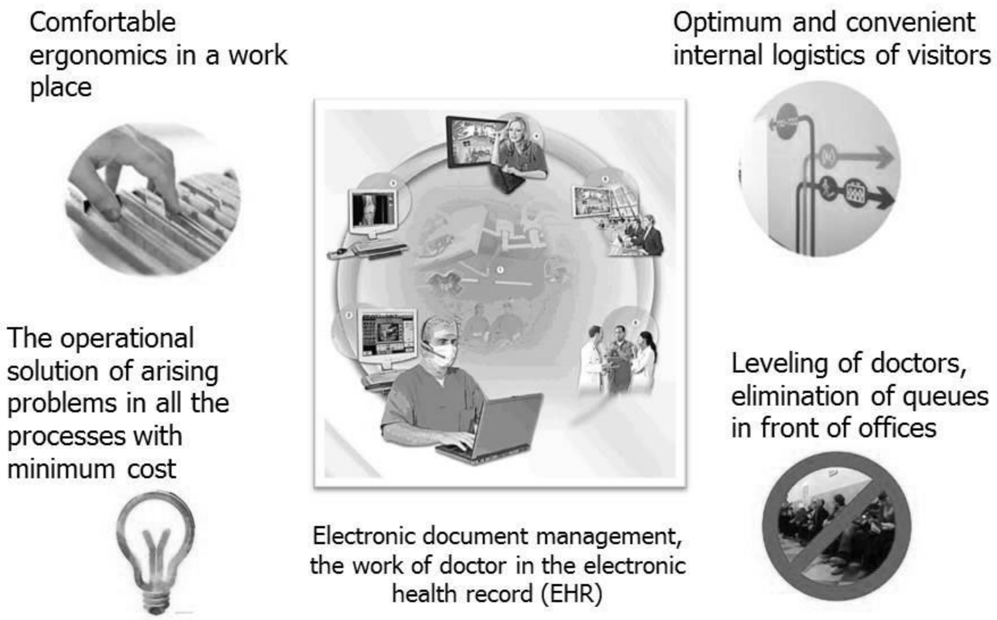

Figure 1 The image of a lean clinic

The use of information technologies allows to solve the following problems:

- analysis of the current situation of informatization in the clinic;
- the introduction of electronic medical records;
- the introduction of a unified system of referral from a pediatrician of the district to the experts;

- the transfer paper directions for laboratory examination in electronic form;
- electronic management of sick leave.

2 The complex system of automation of medical institutions

In the Ryazan region for the implementation of lean technology are being implemented in medical institutions program-technical complex of personified registration of medical care medical information system (MIS) "Trastmed: MIS".

MIS - hierarchical software system designed to automate the activities of medical staff in maintaining medical records and reporting. The MIS will include 17 automated workplaces (AWP) of specialists.

In the first stage of training is recommended to use the AWP "Reception clinic" and "Medical clinic". In the module " Reception clinic" is the entire patient record at the reception, the design of the stamps of various kinds, working with medical records (MR), the rapid establishment of the MR, call the doctor at home, etc. The Module "Medical clinic" includes all of these features, as well as extensive work with MR comprising a plurality of additional tabs, such as "Clinical supervision", "Direction in the lab", "Sick leave", "Procedures", etc.

The software package "Trastmed: MIS", recommended by the Ministry of health of the Ryazan region, designed to:

- automation of activities of health facilities providing outpatient and inpatient;
- automate common business process activities of medical institutions;
- creating a single information space, both within the health care facility, and the interaction with external organizations (the mandatory health insurance Fund etc.);
- the creation of information infrastructure of personified registration of medical aid at the level of subject of the Russian Federation;
- interaction of MIS in a single information space with the State system of personified registration of healthcare of the Russian Federation.

3 The formation of competencies of health workers in the field of information technology

The widespread introduction of information technologies is not possible without the formation of the necessary competencies of the medical staff. Therefore, on the basis of the Department of mathematics, physics and medical Informatics at Ryazan state medical University organized courses of improvement of qualification of medical workers with use of remote educational technologies (pillbox), types of classes – lectures in the form of multimedia presentations, seminars and laboratory work.

Avacheva, T. G., Moiseeva, E. A., Treskov, V. G. (2016) think is right, that for effective implementation approaches of lean production medical personnel must have the following skills in the field of information technology:

- development of templates of electronic cards;
- organization of electronic records to a specialist doctor and laboratory studies;
- medical records in electronic form;
- registration of sick-lists in electronic form;
- creating documents medical statistical reporting.

In the learning process have identified the following key issues:

1) different level of computer literacy of health workers often complete rejection of computer technologies (applied individual approach to learning, use of multimedia projector for the demonstration of all operations);
2) the presence of features of the input medical data in the field of e-forms (used to work with filters and patterns);
3) the presence of features of documentation for different types of reception (technical professionals need consulting specialists in health organization);
4) the need for step-by-step instructions for students (elaborated in a clear step-by-step instructions for performing of laboratory works).

In the process of training the students more noted benefits of using information technologies in medicine in general, registration of medical documentation and organization of work of policlinic.

According to V. Skvortsova (2017), Minister of health of the Russian Federation, the use of information technologies as a tool for lean production in the medicine has had dramatic results. The time of the physician's work with patients has increased in 2 times, the queue has decreased in 8 times, and the waiting time in the doctor's office 12 times.

4 Conclusion

The proposed approach is the introduction of information technology in the organization of work of medical institutions allows to achieve the purpose of improving the availability and quality of medical care by optimizing processes, training of health workers, as well as a tool for the development of healthcare Informatics.

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Digital Transformation of Ukraine and Czechia: Perspectives and Risks

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Abstract. This article is devoted to a comparative analysis of the state, prospects and risks for Ukraine and the Czech Republic in the field of digitalization and digital transformation of the economy and society.

Keywords: innovation, digitalization, digital transformation, economics, society, perspective, risk.

JEL Classification: O3, C40, F29, L86

1 Introduction

The global economy is becoming more and more digital and this process is constantly accelerating. Information and communication technologies (ICT) have gone far beyond the scope of science and technology and are already transforming the main sectors of the economy, the processes of public administration and the life of society.

The Information as the main factor of ICT production open great opportunities for high-quality economic growth at the expense of such tools and factors (Yudina T., 2016): “limitlessness of commercial sites on the Internet; reducing the size of the companies to successfully compete in the markets; multiple use of the same physical, labor and other resources to provide various services within the framework of cloud infrastructure; fetishization of the client; the increasing of economic effect of digitized products and the emergence of new economic growth points (the Digital Valleys)”.

Digital transformation ICT-based is a powerful driver of economic growth. It allows to receive, so-called, “Digital Dividends”: shall provide opportunities more widely for business development, creating new jobs,

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managing socio-economic processes, helps to reduce the digital inequality. At the same time, ICT also requires transformation the society for adequate mastering of opportunities, which are available with adequate application of new technologies.

Transition of economy and society to new digital standards will be revolutionary. Obviously, that all industries sooner or later will be forced to go through such a digital transformation. At the same time, "Digital" tools are taking part as an enabler of all, without what in the context of globalization no country can survive: from increasing the efficiency of production till development of competitive goods and services Infrastructure and processes, which are not based on innovative technologies, cease to be effective. They will inevitably disappear in the coming years, unable to withstand competition with "Digital" leaders. Today market leaders are becoming not those who have a long history of success in the past or large amount of assets and capital, become those, who is able to quickly change their business models and exploit digital innovations.

As noted in the Report (Deloitte, 2016) “the emergence of Amazon, Netflix, Google and Apple has destroyed a whole range of industries and opened up new markets. And this is only the beginning. The challenges of tomorrow are globalization and competition with free goods by means of creating new products and constantly reassessing the customers’ needs“. From the market will go those companies, in which internal changes will occur slower than changes in the external business environment.

It should be noted, that the success of digital transformation depends not only on mastering of technologies, but most importantly - from the ability at all levels (mega-, macro-, meso-, micro-, nano-) formulate dividends of digital technologies for the future both for the European Union or a single country, as well as for each industry, organization, society and a particular person. The ability to digital transformation of economic agent are determined in many respects by a clear digital strategy, supported by leaders. For determining development strategy based on digital transformation for each country separately, as well as within the framework of interstate unions, develop its own Digital Agenda for the future until 2020-2035 years. The main thrust of these documents is not only on technological innovation, but on people: on the culture of thinking, competence and experience, which are necessary for the development and usage of the latest technologies in the creation of an ecosystem of a successful country.

2 Analysis of the digital transformation of Ukraine and Czechia within the framework of the world economy

Comparing the development of the economies of Ukraine and the Czech Republic over the past 27 years, it can be noted that in 1990 they were almost equal by the GDP per capita. Unfortunately, in the 1990s, Ukraine, by having high-tech instrumentation and scientific and technical potential in the field of informatization did not use its chance of developing the economy with the widespread use of information and communication technologies. And now the difference between the economies of these countries has become enormous. Also It affects their pace of the innovation and the digital economy development. So, over the past 10 years, Czech Republic has sharply increased exports of high technology. It is ahead of Poland and Slovakia together for this indicator and brought over 20 Billion current US$ in 2016. Unfortunately, during this time Ukraine reached 20 times less results yielding to Poland and Slovakia since 2004 (Fig. 1).

Modern development and the introduction of innovations in the countries of the world are reflected in the report "Global Innovation Index" 2017, prepared jointly by Cornell University, INSEAD and WIPO. By this Index Czech Republic takes 24th place, Slovakia and Poland - at 34th and 38th places respectively and Ukraine is only on the 50th position from 127 countries of the world.

The Global Innovation Index contains two complex factors: Innovation Output Input Sub-Index (Knowledge and technology outputs, Creative outputs) and Innovation Input Sub-Index (Institutions, Human capital and research, Infrastructure, Market sophistication, Business sophistication). By the each of them Ukraine also much lagging behind from the Czech Republic, which occupies 27th and 16th places, respectively. If the first index the gap is taken 24 positions then by Innovation Input Sub-Index Ukraine lags behind on 61 and takes only 77th place.

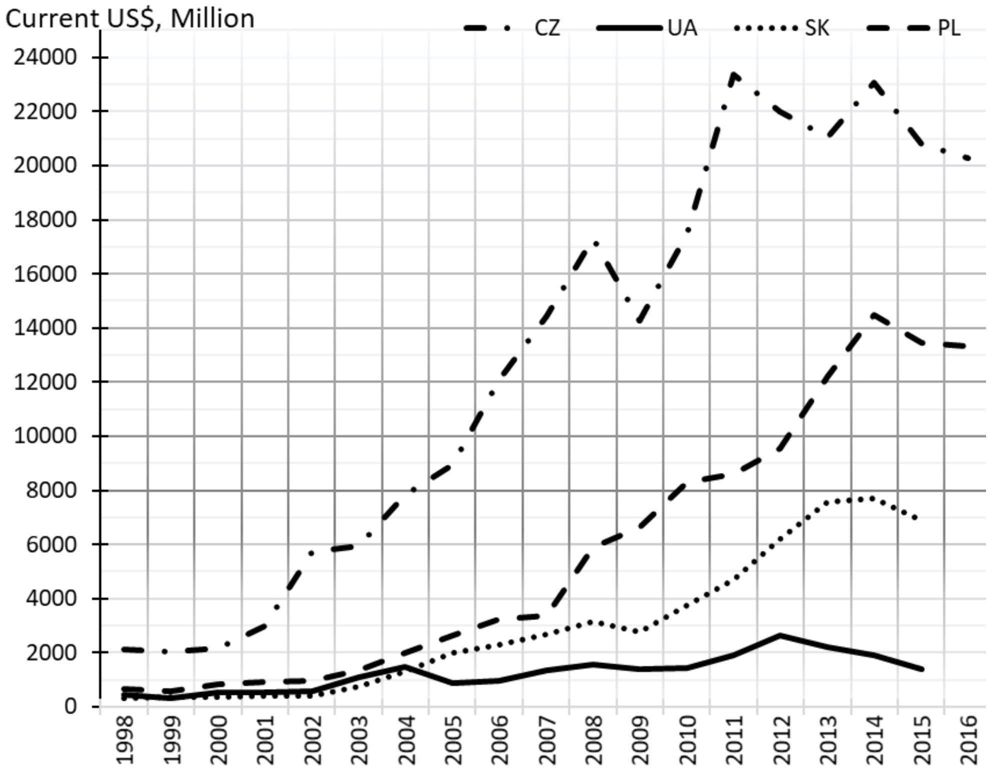

Figure 1 The Dynamics of High-technology exports of Czechia and Ukraine in comparison with the neighboring countries (Slovakia and Poland), Source: own study based on the World Bank, 2017

The Czech Republic's successes in the field of innovation and digital transformation on our opinion are associated with such components. First of all, it is conducive business climate in the country, which stimulates the company to introduction of innovations. Secondly, a high-quality human capital, which perceives innovation and ready to accept active participation in the processes of digital transformation. Third, it is an effective management at all levels of the economy and society to use the potential and evaluate the effect of digital technologies application. Due to this in the ranking of global competitiveness Global Competitiveness Index (World Economic Forum, 2016), the Czech Republic ranked 31st place, and Ukraine is only at 85th out of 138 countries.

However, Ukraine, despite the difficult economic situation, has a sufficiently high-quality human capital (41st position in Human Capital & Research Sub-Index of the Global Innovation Index) and effective introduction tools of technological innovations (32nd place in Knowledge & technology outputs Sub-Index). This potential should be used for accelerating the processes of digital transformation in the country.

It should be noted that the introduction of innovations completely depends on the owners and managers of business. Many existing industries and professions will disappear or will transformed into others. Today the introduction of robots displace not low-skilled labor, namely link of intellectual labor. There are robots, which completely replace at work recruiters, lawyers. Artificial intelligence displaces the middle link chain. Only low-skilled and very highly qualified work are remains. It is impossible to Protect obsolete production and services on the global market. Therefore, the task of the state and business is to create a new jobs, already within the framework of the new "Digital Economy".

3 Perspectives and Risks of the digital transformation of Ukraine and Czechia

The engine accelerated movement of Ukraine towards digital transformation should be the area of information and communication technologies. In this area Ukraine is constantly increasing the volume of IT outsourcing. Today, the IT industry generates about 3.4% of gross domestic product of Ukraine and under favorable conditions; it has all chances to grow to 4.5% in 2020. In 2016, the growth of the industry amounted to 15-20%, and the market grew from $2.5 billion to $3 billion. Over 80% of the nearly 4000 outsourcing IT companies in Ukraine operate in foreign markets, thereby contributing to the "digitization" of other countries, which become more effective and competitive on the global arena.

At the same time, the domestic ICT market does not grow in Ukraine. There are several reasons. This is a complicated economic situation, and devaluation of the national currency, and inequality of salaries of IT specialists in Ukraine and abroad. If the situation in the field of digital transformation does not fundamentally change in the coming years, the Ukrainian economy will continue to lag behind, will increasingly turn into a resource-agrarian. That is why the ICT industry needs special attention in terms of infrastructure development, direct investment, and the improvement of the B2G dialogue. State support in the two areas is very important for the development of the industry: stimulating domestic demand for domestic developments and facilitating the export of services. The latter noted positive developments with the adoption of the law "On Amendments to Some Laws of Ukraine on the elimination of administrative barriers for the export of services» (Verkhovna Rada of Ukraine, 2016).

At the First International Forum of Innovators "Digital Ukraine - Switch on your business" On 27 April 2017 in Odesa, Deputy Minister of Economic Development and Trade of Ukraine Mykhaylo Titarchuk presented the key goals of the Government in implementing the Digital Agenda of Ukraine, among them: "to provide citizens access to the broadband Internet, especially in villages and small cities, and the export of "digital" products and services (IT outsourcing). "He also noted that within the framework of the Association Agreement and the Digital Community, Ukraine, together with the EU, is working to harmonize legislation, develop common approaches and practices in the field of telecommunications, trust services and cybersecurity, the development of ICT infrastructure, the development of e-commerce, including electronic customs and digital transport corridors and other initiatives. At the same time, "the state should become the main driver of" digitization "and building a digital economy, and" digitalization "is a priority of economic policy and a key element of the reform" (Titarchuk M., 2017). At the same time, the key task of "digitization" of Ukraine should be the formation of domestic demand for "digital" technology and their implementation in all sectors of the economy, public administration and public life.

However, Ukraine remains virtually the only country in Europe without approving of the "Digital Agenda for Ukraine" and, accordingly, without a single state body which coordinates and controls the implementation of strategic plans for the development of ICT and digital transformation in accordance with the Digital Agenda.

We are witnessing another situation in EU and in Czech Republic particular. Almost all EU countries have already approved and implemented their own "Digital Agenda" or "Digital Strategies". So, Digital Agenda for EU countries was initiated in 2010 and provided a set of measures to achieve ambitious goals by 2020 year. At that, the priorities and essence "Digital Agenda" of the leader countries is gradually shifted from the sphere of ICT, informatization, information society to "digitization", digital economy, digital citizenship. An important point of the EU's of Digital Agenda is the creation of Digital Single Market. It is planned to allocate about 700 billion euros.

According to the calculations of the Digital Economy and Society Index (European Commission, 2017) the Czech Republic takes a worthy place in the EU in the development of the digital economy and building an information society (Figure 2).

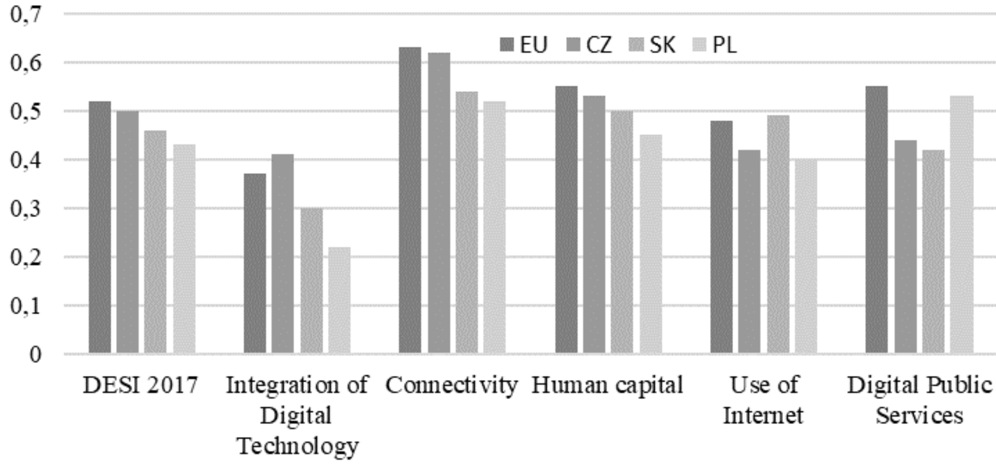

Figure 2 The value of the Digital Economy and Society Index (DESI) 2017 and its components for the Czech Republic in comparison with Slovakia, Poland and the average in the EU, Source : own construction based on the European Commission, 2017.

The state bodies of Ukraine and EU countries consider provision for citizens is access to broadband internet as the priority task in the field of digital transformation. Analysts say that every additional 10% of broadband Internet users make an increase of 1.2% to GDP. Similarly, an increase in the speed of access to the Internet gives rise to GDP. In terms of fixed broadband speeds, both countries in July 2017 took rather high adjacent positions (39 and 40) in the Speediest Global Index (Speediest, 2017) among 133 countries. But ranking mobile speeds Ukraine is at 109 positions and significantly behind Poland, which ranks 49th. The leaders of mobile Internet at present are Norway, the Netherlands and Hungary (46-52 megabits per second). Therefore, for both our countries, building and developing mobile networks of new generations - 4G and especially 5G is important. This was emphasized by the speakers at the Impact'17 Forum in Krakow from 31.05 to 01.06.2017

(Impact Foundation, 2017). They believe that this will be one of the factors of the intensive development of the Polish economy in the coming years.

This focus on mobile 5G networks is due to the fact that they are beside the user's mobile internet; they are the basis for automation of processes and management of mobile objects in Industry 4.0. This includes, inter alia, the Internet of Things and industry-based automation systems such as Smart City, Digital Farming, eHealth, and access to Artificial Intelligence, Virtual Reality, and the like. It should be noted that the main requirement for the implementation of such applications is to ensure the safety and preservation of both data and processes. That is, the issues of cybersecurity, as well as user identification, must be resolved.

In Ukraine, in order to accelerate the information society, they plan to launch Mobile ID service in the second half of 2017 and intensify the deployment of 4G mobile networks. Mobile ID is now successfully operating in 28 European countries. This service will simplify access to administrative services and documents reduce queues in state agencies. In addition, the Mobile ID service will give the subscriber access to secure electronic documents, allow digital signature, and in the long run also vote and make purchases. But in order for the service to work, changes are needed in the legislation. Experts also warn that there is a threat to the protection of personal data of citizens. These issues were the focus of the European Forum on Electronic Signature and Trust Services - EFPE 2017, which took place on June 6-7, 2017 in Szczecin. In the Declaration of the European Forum (European Forum, 2017) was noted that "the construction and development of a holistic electronic identification system will bring tangible benefits to both public authorities and citizens and the commercial sector in the planning of digital transformation".

For Ukraine, which significantly lagging behind in development even mobile networks 4G, it makes sense to just focus on preparing the deployment of networks 5G. At the same time it is necessary to stimulate the economy, government, society corresponding demand for new services and create conditions for growth opportunities such customers pay for more expensive services.

Ukraine is significantly behind the EU in the development of the digital economy and building of information society. This gap does not allow Ukraine to fully integrate into the digital European space today. Therefore, a promising for Ukraine in the field of digitalization is a fruitful cooperation with the EU institutions and with the neighboring countries. In 2013, the HDM initiative on harmonization of digital markets of the Eastern Partnership countries and the EU came into being.

In March 2017, within the framework of the Industrial Dialogue between Ukraine and the EU in Brussels was meeting with Stepan Kubiv, First Vice Prime Minister / Minister of Economic Development and Trade of Ukraine, and Andrus Ansip, Vice-President of the European Commission for the Digital Single Market, at which mutually beneficial priority areas of cooperation in the digital sphere were discussed, in particular, joint steps to extend the "Roam like at home" initiative to Ukraine and other countries participating in the Digital Community, as well as the possibility of extending to Ukraine the initiatives of the European Commission "FreeWiFi4EU" and other joint projects in the field of digitalization. Andrus Ansip noted that "it is necessary to establish cross-border cooperation on digitalisation between countries, because then the security system will work most efficiently, transparency and business will work most effectively" (Ministry of Economic Development and Trade of Ukraine, 2017).

This fully concerns Ukraine's cooperation with the countries of the Visegrad Group (Poland, Hungary, Czech Republic, Slovakia). For our countries the experience of Poland in introducing the new digital mobile service - mDocuments - would be interesting. She will use a mobile phone instead of ordinary documents. The first document available in the new service is the Identity Card (Passport). Next, there will be other documents such as driver's license, registration certificate, insurance, etc. Instead of carrying all these documents with you, you just have to activate the service and have a personal mobile phone. With this activated service, a citizen can check the history of viewing his personal information: who is trying to do it, in which office and when it happened. You can block or unlock personal information. It should be noted that the issue of registration of a mobile phone number may not be resolved on the way of introduction of such a service in Ukraine.

Such experience in Poland, the Czech Republic and other countries suggests that broadband fixed and mobile networks already serve as the basis for digital transformation using state-of-the-art technologies. These technologies are: Cloud and Mobile services, Cloud and Foggy computing, Big Data & Digital platforms, Artificial intelligence, Paperless technologies, Social networks, Digital media, Identification technologies, Blockchain, Internet of things, Additive technologies (3D printing) and many others.

However, intensive digitalisation not only stimulates the development of the economy, but also entails certain risks. Among them: monopolization on the global digital market; the loss of state control over the activities of global businesses (data security, cartel conventions, ...); threats to critical infrastructure of the state; threats to the information security of the state, business and citizens; possible impact on social behavior of client's citizens based on Big Data analysis; risks for clients of financial marketplaces (intermediary sites that aggregate data on financial products and services and act as agents for their sale).

There are risks for the labor market. Many existing industries and professions simply disappear or are transformed into others. Even today, the introduction of robots replaces not low-skilled labor, namely the link of intellectual labor. there are robots that completely replace recruiters, lawyers. Artificial intelligence displaces the middle link. There are only low-skilled jobs and very highly qualified work. It is impossible to protect obsolete production and services on the global market. Therefore, the task of the state and business create new jobs, already within the new "digital economy".

4 Conclusion

For the effective use of innovations for economic development, changes in the standard of living of society, industrial, ICT and scientific culture, freedom of entrepreneurship and active life position of the majority of people are of great importance. The following are important factors for using the chances and levels of threats and risks of the digital transformation of the economy: state regulation and proactive legal support; state support for innovation and stimulation of private investment in the ICT industry; state control over the activities of global digital businesses; cyber defense of the state, business and citizens; digital literacy and digital skills of workers and citizens; preparation and continuous development of IT specialists.

On this path, support of the Czech Republic and other neighboring countries of the European Union is necessary for Ukraine to eliminate digital inequality and the rapid integration of Ukraine into the Single Digital Market is very important for Ukraine.

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Predicting High Frequency Data: Latest Statistical and Neural Network Approach for Time Series

Dušan Marček[1]

Abstract. In the article we alternatively develop forecasting models based on the Box-Jenkins methodology (ARIMA, ARCH-GARCH models) and the neural approach based on classic and fuzzy logic radial basis function neural networks. We evaluate statistical and neuronal forecasting models for monthly platinum price time series data. In the direct comparison between statistical and neural models, the experiment shows that the neural approach clearly improve the forecast accuracy. Both approaches are merged into one output to predict the final forecast values. The proposed novel approach deals with nonlinear estimate of various radial basis function and various number of hidden neurons applied in neural networks.

Keywords: ARIMA-GARCH methodology, cloud activation function, forecasting, neural networks

JEL Classification: C81

1. Introduction

In economics and in particular in the field of financial markets, forecasting is very important because forecasting is an essential instrument to operate day by day in the economic environment. The manager as decision-maker uses forecasting models to assist him or her in decision-making process. Various methods have been developed and applied to forecasting problem. The econometric approach adopted from early days of econometrics is referred to as “AER” or Average Economic Regression, see e. g. (Kennedy, 1992), (Holden, 1997), and it is concerned with the functional form of the multiple regression or structural model. Economic theory might give some prior view to the relationship between the explanation variable and the independent variables. Using the time series data the model is estimated and checked for the validity.

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In many cases economic theory do not give the assumption above the functional form of the model, or the assumption of independent errors and hence independent observations of the explanation variable is frequently unwarranted. If this is the case, forecasting models based on AER may be inappropriate. Box and Jenkins (Box, Jenkins, 1976) developed a new modeling approach based on time series analysis and derived from the linear filter known as AR or ARMA (AutoRegressive Integrated Moving Average) models. The fundamental aim of time series analysis is to understand the underlying mechanism that generates the observed data and, in turn, to forecast future values of the series. Given the unknowns that affect the observed values in time series, it is natural to suppose that the generating mechanism is probabilistic and to model time series as stochastic processes.

Several new approaches to dynamic modeling in economics have become popular in recent years. One of the most attractive approaches is the neural network. According to (White 1992a, 1992b), (White, Gallant, 1992) the reasons to use neural networks for forecasting are many. First, neural networks are nonparametric and nonlinear in nature. They do not require any specific assumptions about the underlying model form and are powerful and flexible in modeling real-world phenomena which have more or less non-linearities. Second, neural networks are universal functional approximator and they can capture any type of complex relationship. Third, neural networks are data-driven and self-adaptive. They have the capability to learn from experience. All these features of neural networks make them a very useful tool for forecasting tasks.

The paper is organized as follows. In the following section we present the data, describe basic the ARMA/ARCH-GARCH models and characterize the neural-fuzzy logic (soft) modelling approach. In the section “Results and Discussion” we put an empirical comparison. Section four briefly concludes.

2. Data and Development of Forecasting Models

In this section we present the data, introduce the development of statistical (ARCH-GARCH) forecasting models and models based of soft (fuzzy logic) RBF neural network in order to forecast the development of monthly data of platinum price time series. Both types of models will be developed with the same database. Our database is composed of 610 monthly observations of the closing platinum prices (denoted yt (see Figure 1 left)

2.1 Construction of an Appropriate ARMA-GARCH Type model

As we would like to develop a ARMA-GARCH time series model for one month ahead forecast of the platinum price time series, the sample period for analysis from 1960M01 to 2008M12 was defined, i.e. the period over which the forecasting model can be developed and the ex post forecast period from 2009M01 to 2010M10 (denoted as validation or testing data set).

In *Figure* 1 left, we see that the series rises sharply with time with a rising trend, clearly signaling the non-stationary nature of the series, and indicating the need to transform the data to make it stationary. Firstly, we remove trend and then we difference the series to obtain a zero mean series. The time plot of the data after the differencing is depicted in *Figure* 1 right. In this figure it is seen that the mean appears steady, we assume the series has a constant mean, clearly signaling the stationary nature of the series.

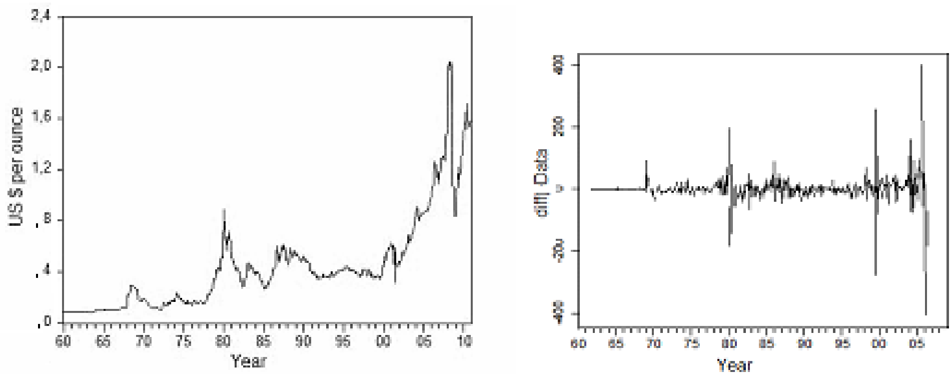

Figure 1 Time series of monthly platinum prices 1960 – 2010 (left), the time plot of the data after the differencing (right). Source: Author´s own processing.

Input selection is crucial importance to the successful development of an ARCH-GARCH model. Potential inputs were chosen based on traditional statistical analysis: these included the raw data of the monthly data of platinum price time series and lags thereof. The relevant lag structure of potential inputs was analyzed using traditional statistical tools, i.e. using the autocorrelation function (ACF), partial autocorrelation function (PACF) and the Akaike/Bayesian information criterion (AIC/BIC). According to these criterions using the R-system software the final ARMA(1,1)+GARCH(1,1) GED model was specified and fitted in the following form

$$y_t = -2{,}08398 + 0{,}8429.y_{t-1} + \varepsilon_t - 0{,}5328.\varepsilon_{t-1} \tag{1}$$

and variance equation

$$h_t = 0.104759 + 2.7901\hat{\varepsilon}^2{}_{t-1} + 0.3912h_{t-1} \tag{2}$$

2.2 Neuronal Approach

A fully connected feed forward neural network was selected to be used as the forecasting function, due to its conceptual simplicity, and computational efficiency (Marcek, M., Marcek, D., 2006). The neural network used for this research was the network of classic or soft RBF type (Orr (1996), Kecman (2001). The same data used for ARMA(1,1)+GARCH(1,1) model was also used to train the neural network, i.e. the input variables forming the right hand site of the *Eq*. (1). This network is one of the most frequently used networks to capture a variety of nonlinear patterns (Marcek, M., Marcek, D., 2006). The transfer function in the hidden layer is the radial basic function (alternatively with the cloud concept (Li and Du, 2008), whereas for the output unit a linear transfer function was applied.

The values of centroids were used as initialization values of weight vector *w* between the input layer and the hidden layer. To find the weights $\mathbf{w}_j$ or centers of activation functions we used the adaptive (learning) version of *K*-means clustering algorithm for *s* clusters

The synaptic weights between the hidden layer and the output neuron were trained by the Back-Propagation algorithm.

The difference between the structures of classic and fuzzy logic (soft) RBF networks is that in fuzzy logic (soft) approximation the output value from the hidden layer is “normalized” (Kecman, 2001) where the normalized output signals from hidden layer neurons signify the output signals whose sum is equal to 1.

We also combined the soft RBF neural network with the statistical ARMA(1,1) models expressed by *Eqs*. (1), (2), in one unified framework. The scheme of such proposed hybrid model is depicted in *Figure* 2. The thought of this proposal consists in economic theory of co-integrated variables which are related by an error correction model (Engle, Granger, 1987). The simple mean

Eq. (1) can be interpreted as the long-run relationship and thus it entails a systematic co-movement between variables y_t and y_{t-1}. If there exists a stable long-run, then error (residual) ε_t from the *Eq*. (1) should be a useful additional explanatory variable for the next direction of movement of y_t. According to (Engle, Granger, 1987) this mechanism called as an error correction mechanism.

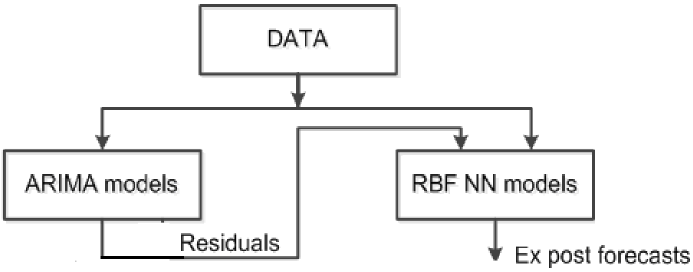

Figure 2 Time series of monthly platinum prices 1960 – 2010 (left), the time plot of the data after the differencing (right). Source: Author´s own processing.

3. Results and Discussion

To evaluate the predictive accuracy we used the Root Mean Squared Errors (RMSE). The benchmarking was performed between latest statistical techniques and neuronal approach used in high frequency financial data. *Table* 1 presents the accuracy results of 4 prediction methods. As can be also seen from *Table* 1, all models are very good and they follow the pattern of the actual very closely.

Table 1 Statistical summary measures of model´s ex post forecast accuracy for ARMA(1,1)+GARCH(1,1) model and RBF networks. Source: Author´s own processing.

Model	RMSE
ARMA(1,1)+GARH(1,1) GED	72.155
RBF NN (classic)	76.206
RBF NN (soft/granular)	67.974
RBF NN (hybrid)	33.601

4. Conclusion

In this paper, we established a statistical model based on Box-Jenkins methodology and as an alternative to that model three models based on Radial Basic Function network (classic, soft and hybrid RBF NN). We showed that the RBF hybrid neural network model outperforms latest statistical models based on ARMA + GARCH approaches. Moreover, RBF networks have such attributes as computational efficiency, simplicity, and ease adjusting to changes in the process being forecast. Thus, neural networks are usually used in the complicated problems of prediction because they minimize the analysis and modeling stages and the resolution time. These models can help managers make better decision-making.

Acknowledgement

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Self-service Business Intelligence

Milos Maryska[1], Petr Doucek[2]

Abstract. The Self-service Business Intelligence (SSBI) is important topic which is solved in a lot of companies. International research agencies like Gartner, BI-Survey etc. are highlighting this topic as one of important areas of next phases of development of companies IT. Importance of SSBI is increasing. Implementation of SSBI expects fulfilling several preconditions and companies have to be very careful to avoid traditional reason of failing in SSBI projects. The first success in SSBI, when we achieved of reducing costs for reporting and data analysis, we are identifying that current situation is not sustainable in a long period. The biggest problem of the SSBI is, that all users have access to everything and we don't have one version of the true, which is contrast to traditional BI principles.

Keywords: Business Intelligence, Self-Service Business Intelligence, Reporting, Trends, Failure.

JEL Classification: M15, M16

1. Introduction

Business intelligence (BI) is among the key IT applications that most significantly affect how well and efficiently enterprises and their activities - including business activities - are managed. For example, surveys and analyses performed by technology research firm Gartner show that BI is enterprises' highest investment priority in IT, globally and in the long term. This is due mainly to the strong possibilities that BI offers for supporting analytical, planning, and decision-making activities, and to its influence on a company's overall success and competitiveness.

One significant trend within business intelligence is the application of methods, tools, and applications that can be termed "self-service business intelligence" (self-service business intelligence, SSBI). The standard, comprehensive systems with which BI began are characterized by their company-wide scope, enormous data volumes, complexity, and expense; self-service BI solutions, meanwhile, are aimed primarily at the individual needs

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of single users, or small groups of them. SSBI solutions are also based on tools and products with a different scale than standard BI systems (Power BI, PowerPivot, Tableau, QlikView, …). However, the basic principles - solution, analysis, proposal - remain essentially similar.

Self-service BI systems represent one of the most important trends in business intelligence, one much-discussed in recent years. SSBI can be described as follows: "*a process wherein end-users design and utilize their own reports and analyses within approved and supported architectures and tool portfolios*" (Gartner, 2017).

These are applications that respect the core principles of business intelligence such as an orientation towards analytical and planning tasks in enterprise management, multi-dimensional data storage and processing, efficient and simple data access, and more. And yet meanwhile they enable the implementation of these applications with simpler and more easily available technologies as their foundation, and based on some degree of user independence during their design and implementation. In the vast majority of cases, SSBI supplements comprehensive BI rather than replacing it.

Its two key benefits are its flexibility and the speed with which new analytical applications can be implemented. But at the same time, Self-service Reporting cannot be used e.g. to handle company-wide tasks (Pour, 2014).

2. BI and Self-service BI

The article (Alpar et al, 2016) summarizes current events in the field of Business Intelligence on the basis of other studies. E.g. (McAfee et al., 2012) states that enterprises today process more data today than ever before. Meanwhile, Business Intelligence tasks are switching levels from the strategic into the operational (Böhringer, 2010). As a result, a greater demand for Business Intelligence services is forming, (Alpar et al, 2016) and likewise businesses are demanding more changes (Yu et al, 2013). The end result is that BI experts simply cannot manage to attend to all the requests that arise. (White et al, 2011) suggests - indeed - Self-service Business Intelligence as the solution (SSBI): with SSBI, not all BI operations require BI experts, as they do in the existing situation (Stodder, 2015). Meanwhile, when SSBI is used, the typical "consumption" and "utilization" of data by business users is shifted towards data "discovery" - exploration a discovery (Stodder, 2015).

Schlesinger et al (2015) also sees a shift in user demands. Business users want to make quick decisions based on the latest information, redefine reports, and make greater use of filtering and “drilling down,” i.e. breaking the analyzed data down into the lower hierarchical levels of the dimensions used for analysis. Alongside these user demands, many SSBI tools have also appeared that offer broad data-analysis functionality and are easy to use for, indeed, data exploration/discovery, manipulation, formatting, and visualization. (Schlesinger et al, 2015), however, points out that when business users have access to a wide range of an enterprise’s data, errors often occur due to their guessing at the data’s meaning, joining various datasets over inappropriate columns, etc. The article suggests that in order for users to discover, use, and share information, they must first understand the data. Thus the need for a semantic layer - (definitional) metadata - arises. (Schlesinger et al, 2015) describes one relatively specific case of creating such a layer, with the help of a model applied onto the standard physical data model of a data warehouse, made for use along with a tool.

2.1 SSBI’s Standing Within Enterprises

The current significance and standing of Self-service BI in companies’ perception can be substantiated via the image below. Here one can see that in a survey with a sample of 2,772 BI professionals (performed by BI software review website BI Survey), the area of Self-service Business Intelligence achieved a value of 7.1 (on a scale of 0–10) — that is, companies found this area to be very important. This was the second highest value. The companies participating in the survey placed the very highest value (7.2) on the area of Data Discovery; this area, however, relates very closely to that of Self-service BI.

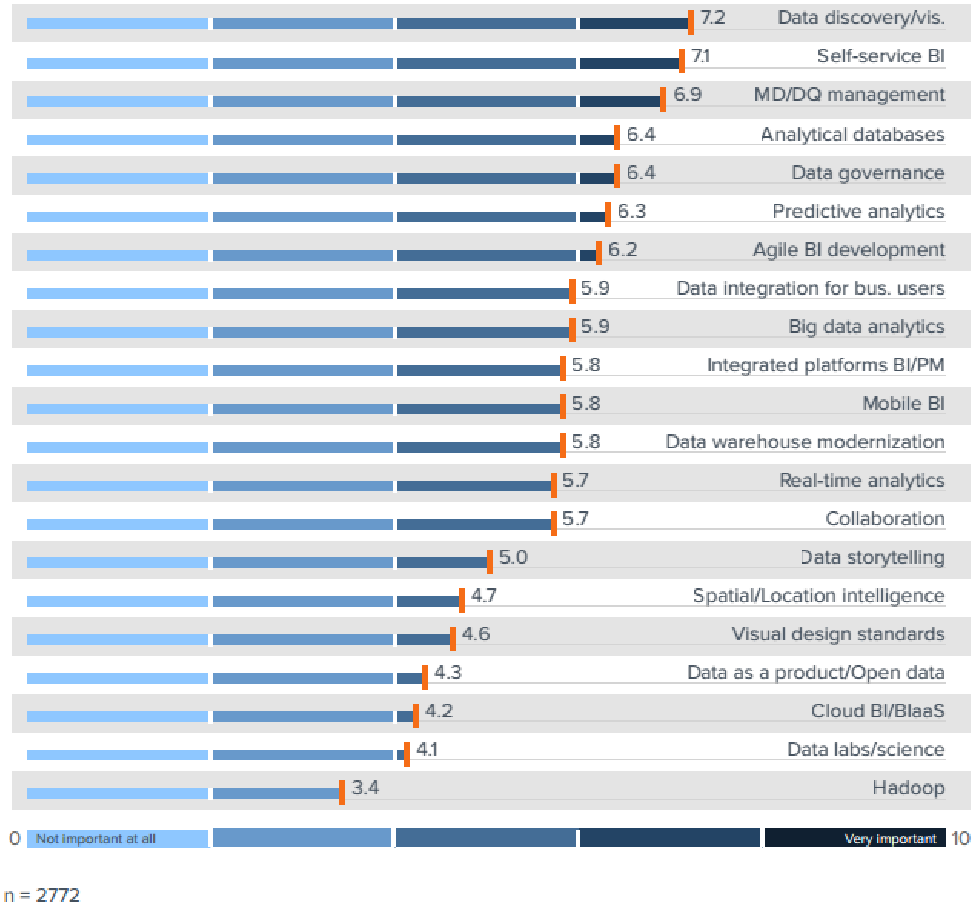

Figure 1 Importance of BI Trends in 2017 (BI-Survery, 2017).

The individual trends can be described as follows:

- Data Discovery / Visualization: Tools that enable business users to quickly grasp the content of a studied dataset through the use of visual and other elements
- Self-service BI: Tools offering business users a chance to create their own queries for data, reports, models, and dashboards
- Master Data / Data Quality Management: Tools, methods, and approaches ensuring the correctness of analyzed data
- Analytical databases: Databases oriented towards analytical use from the standpoints of data storage (column-oriented stores), the use of appropriate hardware (processing in RAM), integrated functionality (text analysis), and their architectural approach

- Data Governance: Principles and methods for managing the data used in analytical and operational systems, with the aim of enabling it to be utilized effectively
- Predictive analytics: Advanced analytical methods based on mathematical and statistical models whose aim is to deduce new information and to uncover behavior patterns and dependencies and form predictions

Five of these seven trends are very closely related and have one common goal - providing business users with the foundations they need for making quicker and better decisions than they could in the past. The quality and suitability of data for analytical use is handled in the framework of Master Data / Data Quality Management.

Speeding up the provision of source materials for decision-making (and ensuring their relevance) is the goal of Agile BI development.

This demand is then accentuated all the more in Self-service BI and Data Discovery/Visualization, where a business user is provided with "raw" data, and this data (along with user-friendly applications) enables them to find answers faster than they could via the standard BI/IT development process. Moreover, when a business user is applying this approach, it is possible that the process of analysis itself will enable them to uncover new connections and relevant questions that would escape their eyes if the required output were prepared by a BI/IT specialist, who may not necessarily possess the deep domain knowledge that the business user possesses. The effectiveness and maintainability of the whole process, meanwhile, are topics covered within Data Governance.

The change in the perception of individual BI trends by professionals relative to 2016 is shown in the next illustration. It also shows the growing importance of Self-service Business Intelligence.

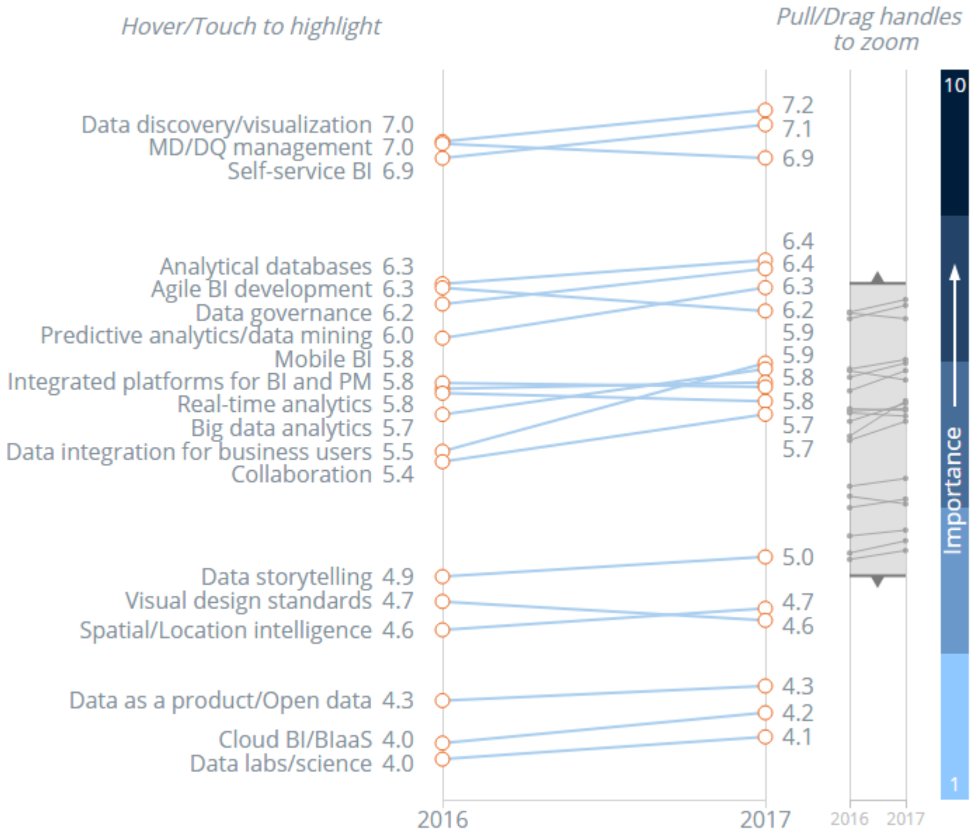

Figure 2 Importance of BI Trends Timeline (BI Survery, 2017).

2.2 SSBI and Organizational Shifts in IT

SSBI is an attempt to resolve the conflict between two opposing needs in enterprise. The first is the need of BI output "consumers" for flexibility and independence in their data analysis. Against this stands the second need: the IT department's need to have undisturbed control over data and over the creation and distribution of information inside the firm. SSBI extends the traditional BI environment, adding the option to perform one's own user analyses of the published data and to do reporting on it without the need for action by IT staff. It gives non-IT workers more options, more flexibility, and more independence, with their now being able to answer a given question in a significantly shorter time. This is also confirmed by a number of surveys which emphasize that slow arrival of needed information is a key problem strongly affecting the certainty of managerial decisions.

However, even within an SSBI environment, IT-unit staff fulfill the role of central administrators for a company's data. Moreover, this function actually even takes on a much greater importance in this case. For users to be able to produce reports and other BI outputs correctly, it must be ensured that they have access to sanitized data in a form that they can understand, and that they will be able to process this data without needing constant help from IT staff. According to (Imhoff, C.; White, C., 2011), the change in IT's role in the SSBI environment brings with it the following effects:

- for users – users are handed data and access to it, and can analyze it and evaluate it at any time based on their current needs, with the help of provided tools;
- for IT units – instead of IT departments constantly being clogged up with new (and inconstant) requests for reports and analyses, they pass a "large volume" of data processing over to the hands of users themselves. Simultaneously they can concentrate on administration and on activities that do more to bring value for the company;
- for the organization itself – the change make users more satisfied with the organization's IT department overall—it is transformed, in their eyes, into a flexible helper that can better satisfy business demands.

2.3 Adoption and Failure of SSBI Initiatives

Pour (2014) lists the key characteristics of, and reasons for, the adoption of Self-service Reporting. They include its flexibility and the speed with which it can implement new analytical applications, as well as the need to provide data management abilities to the lower levels of management, where a greater understanding of the business resides.

Nevertheless, at the same time this approach also has its downsides, such as e.g. limited possibilities for consolidation and for sanitizing data. As a result of this, the applications that can be produced in the form of Self-Service Reporting have a narrow scope in terms of their subjects. According to (Pour, 2014) for example, Self-service Reporting cannot generally be used for handling enterprise-wide tasks.

Burke et al, (2016) similarly lists the possible reasons for failures of Self-service Business Intelligence:

- Users spend too much time preparing and sanitizing data

- No processes and governance exist to enable validation of the data used
- The application used does not meet architectural requirements for life-cycle sustainability and management
- Users do not have the capability to prepare outputs that are suitable for supporting decision-making. This can thus lead to poor utilization of employees' time, and to outputs that are hard to use, based on inappropriate data that can be badly interpreted. (Burke et al., 2016) suggests as a solution the creation of a centralized team whose members would have the needed knowledge and abilities. This team would then produce SSBI outputs based on business users' requests.

3. Discussion

In what way is the SSBI approach different from standard centralized report development — whose disadvantages SSBI exists to address? Does SSBI still reduce the workloads of highly specialized staff? Does it enable swift analysis and discovery of the data that business users demand today? In my opinion it does not, and other solutions will need to be sought.

Weber (2013) mentions similar benefits for SSBI as the above-mentioned articles do. However, this source describes how after the initial success of SSBI — where direct data reporting and analysis costs can be brought down—it is often found that this post-SSBI state is not sustainable. Among the problems mentioned is the situation where "everyone has access to everything," that is, to all enterprise data. This situation can be in opposition to the traditional BI principle of "one version of the truth," since users can draw different conclusions from the same data, and thus the mentioned problems with misinterpretation and inconsistent outputs can occur. In light of the fact that during the deployment of SSBI, the competencies for data warehouse development and data product development (reports, dashboards, analyses, etc.) are separated, the design of the data warehouse may not necessarily be appropriate for the intended use and the SSBI tool used. To resolve these problems, this text thus suggests the preparation of outputs directed at solving problems relating to a particular field or department. These can be for example data marketplaces containing only data relevant for that field/department. (Weber, 2013), meanwhile, suggests cooperating with experts in the given SSBI software right from the beginning of development, to ensure the appropriateness of the data model proposed. The application of BI/Data

Governance principles is then a matter of course, as is the setting up of the needed bodies, roles, and processes.

Meyers (2014) cites a statistic from (Eckerson, 2012), who states that BI experts have found that 64% of “self-service initiatives” have had only an average or lower degree of success. Meyers (2014) ties into this by stating that every BI program, no matter whether or not it is self-service, fails the moment its users do not trust the data it provides. For SSBI there exists — as has repeatedly been mentioned above — a higher risk of inconsistency and low-quality outputs than exists when everything is prepared by a centralized BI team. This study’s author thus accents the important of implementing a Data Management and Governance (DMG) program before deploying SSBI. Within this program, it is then necessary to establish standards for data quality and access, and to introduce the principles of data modeling (which enables easy application of semantic layers) and of data ownership and “stewardship,” which in the broader context enable the creation and administration of business (definitional) metadata. Likewise this program should address the deployment of a catalog with reports, the principles for their documentation, development standards, and the management of (data) quality for reports and outputs, etc. (Meyers, 2014) goes on to recommend the introduction of a model for “Power Users,” who would organizationally fall into individual Company Departments, but would be trained in established DMG standards. These Power Users would then act as a support for the other business users in their use of SSBBI and in the application of DMG standards and principles.

4. Conclusions

This direction for Business Intelligence development is also confirmed by research and advisory specialist Gartner in its Magic Quadrant for Business Intelligence and analytical platforms, from February of 2016 (Parentau et al, 2016). It states that demand on the Business Intelligence market has shifted towards tools that are easy to use, whose functionality supports the complete analytical workflow and does not demand significant involvement of IT staff in predefining data models and datasets as a prerequisite for performing specific analyses. The reason for this is the growing need for speed and agility in the development of analytical tools and applications and for the performance of ad-hoc analyses when the need for new, previously undermined information is determined.

It is evident that Self-service Reporting, which is a trend in BI at the moment, addresses problems that are currently relevant in this area. But likewise the research shows that numerous problems need to be addressed in its usage in practice. Individual authors' approaches differ, but they usually share the commonality of distinguishing the need for the existence of metadata, which is even more important for SSBI than for that which was, until recently, the traditional BI architecture, wherein information outputs generally tended to be developed centrally. In contrast to this are the findings from studies concerning metadata, which have uncovered its general importance and effect in Business Intelligence and simultaneously a relatively dismal situation in practice, wherein metadata fails to correspond to users' needs.

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Innovative Aspects of the Application of the Method of Cluster Analysis in the Financial and Economic Sphere of Activity

Nadiia Melnyk[1]

Abstract. One of the primary tasks of a banking institution is to determine its development strategy, that is, work based on analysis. The decision on which strategy to choose should be made on the basis of internal and external environment assessment, which was obtained as a result of research. The article discusses the method of artificial neural networks, in particular clusterization, as one of the methods for processing multi-parameter banking information. Innovative methods of clustering of information in different spheres of activity are analyzed.

Keywords: financial sphere, economic, neural networks, cluster analysis, systems, aplication.

JEL Classification: C61, C63, G21

1 Introduction

The activity of any unit as a component of the financial and economic sector of the economy is characterized by a large number of indicators. Regardless of their meaning, they all contain information that affects the end result. Methods of processing this information - one of the most difficult issues that are studied in the modern world. Most of these methods are based on statistical analysis with the further work of the analyst. However, such methods do not always justify hopes and the time spent on research is quite large. Mathematical methods of data analysis are widely used in the study of various systems and processes - natural, technical, environmental, economic, social, etc. Given this, the formation of relevant knowledge and skills is a necessary component of the training of specialists in the field of system sciences and cybernetics, computer science and many other fields of knowledge. The success of any method of data analysis depends on the compatibility of the data analyzed with its original assumption. Methods suitable for one type of data may lead to serious errors when used for other types of data. Scientists of different directions are trying to apply innovative methods using the latest technology. The technology of

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cluster analysis requires significant investments from the technical part. Therefore, most scientists carry out this kind of analysis using the simplest interfaces without explicit illustration in different spaces.

2 Description of the application of the cluster analysis method

In the literature, the interpretation of cluster analysis is highlighted in different ways. In the economic dictionary, the businessman has the following definition: "Cluster - English. cluster - a group of objects in the recognition of images, united by common features" (Moldovanov, 1993). In (Volkova, 2001) it is noted that: "Cluster analysis - one of the ways to classify objects by their features." Cluster analysis is a multidimensional statistical procedure, which "... involves collecting data that stores information about the sampling of objects, and arranging objects in relatively homogeneous groups" (Harkavenko, 2002). The application of this method is quite broad. Author of scientific research in the field of cost management for the creation of new products (SNP) M.V. Reta for testing the proposed methodological approach to analyzing these costs at machine-building enterprises investigated 20 enterprises of Kharkiv region for the purpose of grouping them (Reta, 2010). For this, the author proposed the use of a multivariate statistical method - cluster analysis. The hierarchical agglomeration method of Ward using the Euclidean metric was used to classify the enterprises. The graphic interpretation of the results is presented in the form of a hierarchical dendrogram of combining selected for the analysis of machine-building enterprises. Then, within each cluster, an integral indicator of the level of innovation and financial and economic activity of enterprises was assessed in accordance with the purpose and objectives of the author's research (Reta, 2010).

Most of the practical work is done using cluster analysis using the STATISTICA program. The STATISTICA package implements data analysis, data management, data mining, data visualization. However, long-term analytics training is required to process data using this software product.

According to the recommendations of Ukrainian leading specialist in the field of marketing theory and practice S.S. Garkavenko in the paper (Harkavenko, 2002) noted that in marketing, cluster analysis should be used for segmentation of the market by consumer groups, by main competitors and by product parameters. The paper describes the scheme of the market segmentation algorithm for selected product parameters (natural leather for the manufacture of shoes), followed by the definition of direct competitors of the product suppliers in each group (segment). An agglomeration hierarchical classification algorithm was used to segment this market. For a distance between objects the usual Euclidean distance was chosen.

Scientific scientist A.V.Voronin in the article considered the methodological issues of using cluster analysis in the system of strategic management of the firm (Voronin, 2010). Cluster analysis allowed to identify groups of mutually compatible and those that support each other's local strategies of the firm. This requirement is essential for the effectiveness of the organization's overall strategy. Collaborators N.A. Volkova and O.V. Student considers in (Volkova, 2001) the evaluation of the quality of working life of workers of the enterprise with the use of cluster analysis. In this example, it was shown that cluster analysis by the k-medium method is an effective method for analyzing the level of satisfaction with labor, that is, the socio-psychological response of workers to the extent to which their expectations from work correspond to real experience.

The application of cluster analysis in the field of banking services, which is one of the components of the financial and economic sector of the economy, was almost not investigated. In the vast majority of analysts banks work with statistical methods without the use of the latest technologies. Since, the main purpose of any bank to profit, the main task of the analyst to anticipate and avoid bankruptcy. In the literature you can find four basic approaches to the definition and prediction of the probability of bankruptcy of banks: expert methods, economics and mathematical methods, artificial intelligence systems, methods for evaluating the financial state. Each approach has its advantages and disadvantages. The most acceptable methods for assessing the bank's propensity to bankruptcy are economic and mathematical methods and models. It should also be noted that artificial intelligence systems have become increasingly popular in recent times.

3 The technique of factor analysis

Methods of cluster analysis can be used to determine the probability of bankruptcy. Namely, with their help, the initial set of structural units of the bank, which are characterized by a number of financial indicators, is divided into classes. The next step is to identify the resulting clusters on the basis of qualitative analysis, that is, to identify the names of clusters in terms of the probability of bankruptcy. Thus, it is possible to determine to what class the probability of bankruptcy will belong to a separate branch (branch) of the population under study.

However, the application of cluster analysis methods to determine the probability of bankruptcy in the bank has a number of significant drawbacks. First, different methods of cluster analysis can produce different results, which complicates the problem of pattern recognition. Secondly, these methods provide a static assessment of the bankruptcy probability of the bank at the present time and do not predict the threat of bankruptcy in the future, which prevents the timely detection and prevention of a crisis. Thirdly, the methods of cluster analysis are methods of classification without training, ie the resulting classification can be used to determine the probability of bankruptcy of a separate branch only during the current period.

Eliminating these disadvantages is possible with the use of methods of cluster analysis in the neural network. Under the neural networks understand the computational structures that simulate simple biological processes, which are usually associated with human brain processes. They represent distributed and parallel systems capable of adaptive learning by analyzing positive and negative influences. An elementary converter in these networks is an artificial neuron or simply a neuron, named so by analogy with the biological prototype.

The neural network is a collection of neurons that are in some way linked to each other and to the outside by means of bonds that are determined by weight factors. In the process of functioning of the network, the transformation of the input vector into the output, some processing of information. The specific type of transformation that the network performs is due not only to the characteristics of the neurons, but also to the peculiarities of its architecture, namely, the topology of interneuronal relationships, the choice of certain subsets of neurons for input and output of information, methods of network learning, the presence or absence of competition between neurons, the direction and ways of managing and synchronizing the transmission of information between neurons (Tkachenko, 2011).

Since, auto-associative non-iterative artificial neural networks on the basis of a machine of geometric transformations have particularly high rates of speed, accuracy and ability to solve complex, multidimensional tasks of an economic nature, they are able to cope with our task.

4 Application of artificial intelligence tools to analyze the performance of the Bank

The basis of modeling with the help of the Machine of Geometric Transformations (IHP) is the basic principle of representation of the hypersurfaces of reviews in orthogonal coordinate systems (both linear and curvilinear) models, which as much as possible coincide with the basic measurements of hypersurfaces. As a close analogue of the neural-like structures of the MMGP, one can consider the two-layer perceptron of autosocial type, constructed by the method of "narrowed throat". At the inputs of the perceptron, all the components of the existing sample vectors are fed simultaneously, the same components are repeated as output of the perceptron training vectors for the study. In the general case of the "narrowed throat", when the number of neural elements of the hidden layer is less than the number of inputs (outputs), the input vectors transformation into identical outputs occurs with a certain error. Output signals of the neural elements reflect the signals of the main components. Due to the application of optimization training procedures, the error of the transformation of input vectors in identical to them output is minimized, and the output signals of the neural elements of the hidden layer set the optimized representation of the input vectors in the new coordinate system of reduced dimension. If the input vector of the autosocial neural network includes input signals and feedback signals, and the number of neural elements of the hidden layer corresponds to the dimension of the space of the diffusion ellipsoid, then at the exit of the network the surface of the reviews is approximated by hyperplanes (planes), and the magnitudes of the additional measurements represent the errors of such approximation.

Quite close, because of the allocation of main components, there is also a mode of displaying reviews based on given inputs (projective task), since there is a one-to-one correspondence between the coordinates of the points of the ellipsoid of scattering of inputs and hyperroles. On the basis of a single approach, problems of compaction, factor analysis, clustering in the mode of self-study, signal filtering, etc. are also solved.

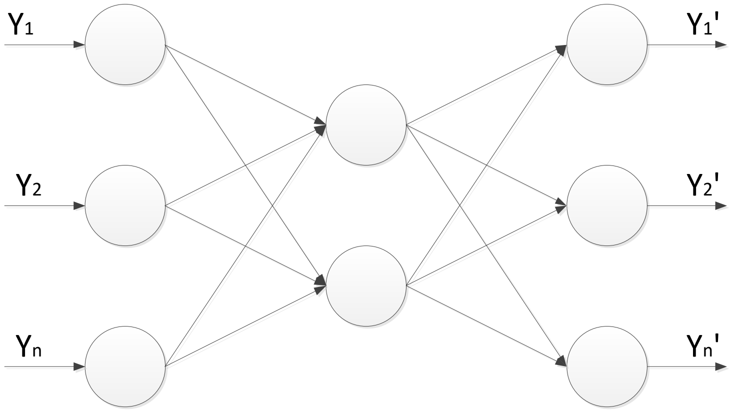

Figure 1. NM MGP autosocial type

Given the main purpose of the neural networks of the IHP, that is, modeling, predicting behavior, or studying the objects set by a set of its characteristics, we consider it advisable to use, as a tool of our research, this particular method. The objects of the study can be observed (evaluated), where the controled observation of the object - the vector of implementation (implementation), consisting of input and output characteristics. Moreover, the division into input and output characteristics is not fundamental. The set of implementations forms a matrix of implementations. The submatrix, consisting of training pairs of inputs-outputs (known vectors of implementations obtained during the observation of an object), is called the "training matrix".

The training and operation procedures are performed by means of step-by-step geometric transformations in (n + 1) -dimensional realizations, where n is the number of inputs of the model; in the first step of the transformations, the longest axis of the ellipsoid of scattering is determined, which will coincide with the first coordinate of inputs on the ellipsoid; We approximate the hypersurfaces of the response (each of them separately) by an elementary hypersurface from the first coordinate of the inputs; We obtain the remainder of this approximation, as the difference between the initial coordinates of the hypersurface and the elementary approximating hypersurface; the dimensionality of the task was reduced by one; in the second step we determine the next largest axis of the ellipsoid (the second coordinate of the inputs); Approximate the remainder of the previous step of approximation by an elementary hypersurface from the second input coordinate; the number of transformation steps does not exceed n; the learning outcomes are the parameters of the input coordinate system on the ellipsoid and the parameters of the elementary hypersurface models for each transformation step.

In the mode of application of the trained model of IHP there is a fundamental possibility of analyzing the coordinates (components of the model) for the predictability and extraction of noise components.

The method of setting the neural network depends on the types of tasks that are being solved. The method of solving predicate tasks is the base for solving other types of tasks, such as classification, prediction of time series and clustering.

5 Conclusion

The conducted studies and experiments confirmed the effectiveness of the use of neural network clustering technologies for the financial and credit market and gave grounds for confirming the appropriateness of their use for solving the problems of analysis and obtaining knowledge in data repositories in this subject area.

Based on the research conducted, it can be argued that the approach proposed by us can contribute to solving the problem of developing common approaches to managing certain classes of branches of large systemic banks in order to improve their performance and improve the positions of these banks in the financial and credit market of Ukraine. Therefore, the proposed approach to solving the problem of research of the work of branches of systemic banks will increase the efficiency of management, and the proposed method will save time and obtain reliable results for further resolution of the question of obtaining maximum profit.

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Dynamic Identification of Complex Systems Based on Chaotic Processes

Elena Nyemkova[1], Taras Kostyrko [2]

Abstract. Many artificial and natural complex systems demonstrate the chaotic behavior of time series. Negligible differences in the subsystems of complex serial systems lead to changes in the dynamics of series. The article is devoted to the method of dynamic identification of complex serial systems based on the autocorrelation function. The algorithm of dynamic identification is developed, which includes: selection of the time series range, definition of the identifier, calculation of the identification coefficient, decision making about identification. The result of the algorithm can be transferred to the executive mechanism, depending on the practical task. False positives and false negatives are discussed for this method of dynamic identification.

Keywords: nonlinear chaotic dynamics, autocorrelation function, dynamic identification, complex system.

JEL Classification: C53

1 Problems of dynamic identification

Identification of complex systems attracts the stable interest of researchers. In Diligenska (2009) we can see bibliography of the question, many methods and models of identification and their classification. The two main tasks are solved in the study of complex systems. The first task is the identification of the system. Identification of the system means finding certain invariant characteristics. The second task is the prediction of the behavior of the system. Often the first task precedes the second, because the mathematical prediction is based on the basic properties of a complex system, such as the dimension of the embedding, the correlation entropy, as Loskutov (2009) shown. Usually, complex systems are non-linear systems with dissipation, in which the development of chaotic processes is possible.

Active and passive methods for the identification of complex systems are currently used. An external signal is applied to the system and its response is examined at an active approach. The study of the response can be carried out

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on the basis of a mathematical model of a complex system or with the help of neural networks, as Patra (1999) shown. Patra and Kot (2002) improved the method significantly. But this method requires a large amount of calculations, a lot of time and many examples for training.

The passive method is based on the analysis of the system's own signals. This is actually in those cases when the process under study is almost impossible to describe mathematically. Suppose the observed variable, a series of N numbers, is present. These are the values of some measured dynamic variable $x(t)$ with a constant step τ in time, $t_i = t_0+(i-1)\tau$: $x_i=x(t_i)$, $i=1,...,N$. The main requirement for identification is the following. The invariant characteristics of the initial system and those obtained from the time series must coincide. These characteristics can be determined from the experiment without knowing all the dynamic variables of the system.

Sometimes, to identify complex systems, researchers use the calculated spectrum of a dynamic variable (Dyvak et al, 2012). At the same time, the danger of aliasing is with uniform sampling. For signals in telecommunication systems, the process of digitizing an analog signal is preceded by filtration, and the aliasing effect disappears. For some practical cases, the dynamic variable is represented only as a discrete series, filtration is impossible in principle. The use of non-uniform sampling is also impossible. Therefore, the identification of such systems by means of the spectrum has a fundamentally unrecoverable error. The identification of a complex system by means of an autocorrelation function is free from the aliasing effect. Dyvak et al (2013) provide the identification of specific complex system by means of the autocorrelation function.

Identification, followed by the prediction of cross-currency exchange rates, is necessary to play for raising or lowering stock prices on exchanges or for buying and selling currencies. The speed and accuracy of performance evaluation are important to do this. The new method of forecasting of economic indexes was significantly improved (Loskutov and Kotlyarov, 2008).

Identification should be based not on the logical name of the system, but on the essence of the processes occurring in the system itself. Since each system is unique at the microscopic level, the dynamic variable $x(t)$ will have a unique trajectory. If it is possible to find invariant characteristics for each complex system based on the sequence *x(t)*, then this is a solution to the problem of identifying the system without constructing mathematical models.

There are deep analogies in the organization and functioning of complex systems, despite the fact that they can differ significantly in specific manifestations and details. Most real systems are dissipative with chaotic dynamics. As Nikulchev (2010) shown, reconstruction of attractors is possible. It should be noted that most complex systems are characterized by flicker noise. Dynamic variable shows the properties of flicker noise. As shown by Kuzovlev (2015), this property is inherent in natural systems.

The identification of complex systems is necessary to obtain access rights to confidential information or a control system for the tasks of the Internet of things. The main requirements for such identification are as follows. First, among the many such systems, it is necessary to identify the one that has access rights. Secondly, identification should be carried out in real time, i.e. for a very short time. Thirdly, the identification procedure should not require many calculations. The second and third conditions limit the volume of mathematical operations with the time series of the dynamic variable *x(t)*. Now identification of devices in telecommunications networks is carried out using logical names or cryptographic protocols. Evaluation of parameters of mathematical models of technical devices takes a long time and involves the participation of a man; this problem is well-known (Petrovich, 2011).

The task of this study is to find the invariant characteristic of complex system on the basis of the time series data $x(t_i)$ without carrying out external influences on the complex system and without computing the spectral characteristics. The solution must assume full automation.

2 Identification of stationary complex systems

A stochastic process is called stationary, if its basic properties are unchanged in time. The stationary process (stationary series) is characterized by the following four properties:

1) The mathematical expectation *E* of a stationary series is a constant

$$E(x_i) = \overline{x} = const \tag{2}$$

2) The variance of the stationary series *D* is a constant quantity

$$D(x_i) = E(x_i - \overline{x})^2 = const \tag{2}$$

3) The autocovariance of the stationary series R is a constant, it depends only from the lag value l

$$R_l\,(x_i) = cov(x_i, x_{i+l}) = E\big((x_i - \overline{x})(x_{i+l} - \overline{x})\big) = R_l \tag{3}$$

4) The autocorrelation coefficient ρ_l of a stationary series with lag l is a constant

$$\rho_l = \frac{E((x_i - \overline{x})(x_{i+l} - \overline{x}))}{\sqrt{E(x_i - \overline{x})^2}\sqrt{E(x_{i+l} - \overline{x})^2}} \tag{4}$$

If these four properties are satisfied, then the process is stationary.

Consider a few almost identical complex stationary systems, which do not significantly differ in their components. The temporal realization of the series of dynamic variables $x_j(t_i)$ of each system j will be different. It can be expected that the values of the autocorrelation and autocovariance coefficient for a given lag l will be slightly different for another systems. Each system will demonstrate the constancy of the autocorrelation function of the time series, regardless of the count start. Thus, each virtually identical complex system can be characterized by its autocorrelation function. The autocorrelation function can be taken as a template - an identifier for a complex system.

In practice, the time series of the dynamic variable of a stationary system is noise-like. Slow trend for the dynamic variable $x_j(t_i)$ will cause to that condition 1 and 2 will not be executed. If the systems demonstrate quasi-stationary behavior, then the feasibility of conditions 3 and 4 will depend on how much the mathematical expectation of the series deviates from the original value at the length of the autocorrelation function definition.

All assumptions made about the behavior of systems should be tested experimentally for each type of complex systems that require identification. The graph of the autocorrelation function of the time series is a discrete set of points. If we connect these points by direct lines, we obtain a broken line. For each complex system there will be calculate own broken line. The identification of a complex system among many other similar ones reduces to finding one among the set of broken lines (autocorrelation functions) that corresponds to this system.

3 Experimental identification of complex systems with chaotic processes

The experimental study of the noise of a sound card was carried out using the Oscillometer program. The sampling frequency was 44.1 kHz. The amplitude of the noise was small - about 0.2 mV. The calculations were made in the Mathcad program.

In the experiment 12 computers of the same series were used. The noise file was recorded three times on each computer. The recording lasted a few seconds, which made it possible to use one file to organize many sequences of noise.

Fig. 1 shows the function of autocorrelation of the sound card noise. The samples distance along the abscissa axis is equal 1/44100 sec.

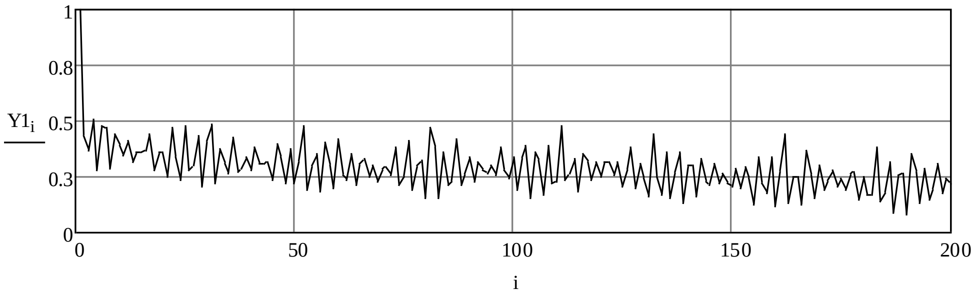

Figure 1 Function of autocorrelation of the sound card noise.

It turned out that the plot of the function of noise autocorrelation is different for each computer. Autocorrelation functions for noise files recorded from one computer are almost identical in shape. The functions of noise autocorrelation for two different computers are shown in Fig. 2. Only part of the autocorrelation functions plots is shown in figure 2, starting with a hundredth sample. The length of the sequence (32 samples) is due to a specific type of plots from Fig. 1.

In order to reliably distinguish plots of one form from another, the following procedure is proposed. Firstly, a linear interpolation function, which connects the points of the autocorrelation function, is calculated. Secondly, on each linear section the derivative is calculated and the plot of the derivative is constructed, Fig. 3. The differences between two computers are even more noticeable on the plots of the derivatives.

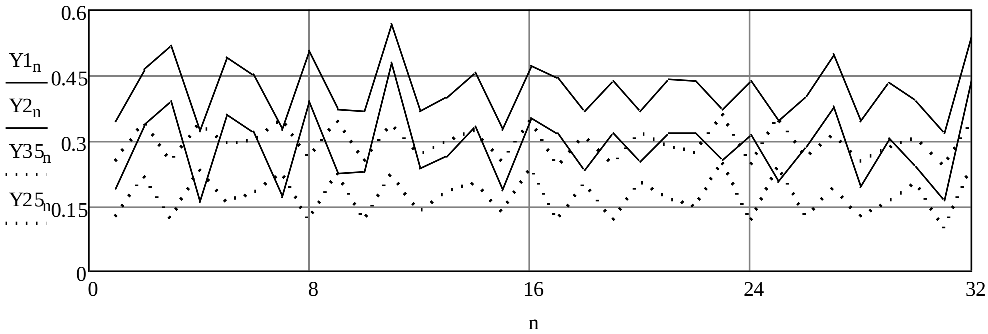

Figure 2 The functions of noise's autocorrelation from sound cards of two computers, starting from 100 sample.

Thirdly, the bit sequence is written according to the rule: if the derivative value is positive, then it corresponds to one, if negative, then it corresponds to zero. As a result, the sequences were received: for the first computer (solid line) it is 1101001011011010010110101101001, and for the second computer (dotted line) it is 1010110101011010101001010101101.

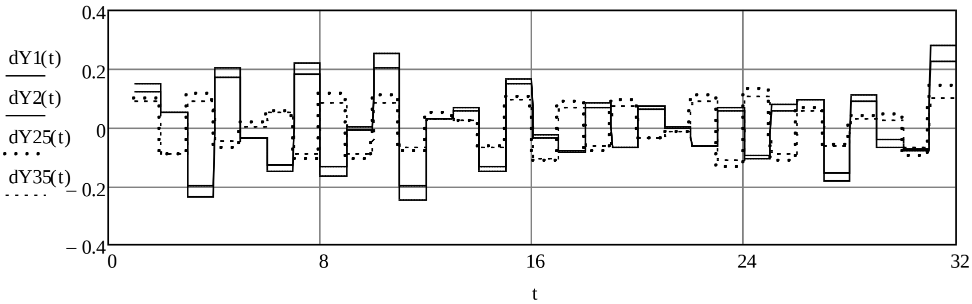

Figure 3 Derivative functions of noise's autocorrelation from sound cards of two computers.

Hamming's distance between sequences was 18 at a total length of 31 bits. Thus, sequences on 58% are not identical.

For the practical implementation of the method, it is recommended not to build an interpolant and not to calculate derivatives. Bit sequences are written by the rule: if the next value of the autocorrelation function is greater than the previous one, then the unit is written, if less than the previous then zero is written. This procedure significantly accelerates the authentication process.

Note that the use of noise as an identifier requires verification that this noise sequence is used firstly.

Similar calculations were made for noise signals taken from the collection of audio files on the Internet, as well as cross-currency exchange rates data. The obtained results give grounds to assert that for noise-like signals it is possible to identify complex systems through the function of autocorrelation. Automation of the identification procedure is possible thanks to the proposed method of comparing two broken lines.

Any identification has limitations in accuracy, which leads to false positives and false negatives. In our experiments, the autocorrelation functions differed visually at all times. Heming distance is a rather rough tool and will not always provide the necessary accuracy. More advanced methods for comparing two broken lines are necessary to improve the accuracy of recognition.

4 Conclusion

The method for complex systems identifying with noise-proof signals is proposed. The method is based on calculating the Heming distance between two bit sequences formed when comparing the autocorrelation functions of two signals from similar systems. The experimental study confirmed the proposed method of identification.

The method does not require large computational powers and can be used for real-time identification. The area of such identification is the Internet of things, the identification of devices and people using their noise-like signals.

The limitations of the proposed identification are as follows: external conditions should not lead complex systems out of a quasi-stationary state. Additional identification parameters can reduce false positives and false negatives.

Acknowledgements

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A Framework for Innovation Enterprise Support Based on Intelligence Agent Approach

Celina M. Olszak[1], Tomasz Bartuś[2]

Abstract. The article presents the characteristics of innovation enterprise and intelligence agent. The research studies are fragmentary and do not present how to use intelligence agent approach for innovation enterprise support.
The first to be introduced in the subject of innovation enterprise and intelligence agent. Further it proposes and describes the unique concept of a computer system to support the innovation enterprise. The research results may help in the design of computer systems to support the innovation enterprise.

Keywords: Enterprise Innovation, Intelligence Agents.

JEL Classification: D23

1 Introduction

Results of preliminary tests showed that the issue of innovation and innovation enterprise and economy is of great interest (e.g. National studies: Kraśnicka, Ingram, 2014, Foreign: Global Innovation Index, European Innovation Scoreboard). In the case of computer support systems and intelligent agents without finding study that were associated with power of innovation with the use of intelligent agents. Research on intelligent agents conducted mainly in the following areas: simulation of multi-agent (ang. Agent based modeling and simulation, ABMS) (Colander et al., 2008), a systematic approach (Law, 2007; Gilbert, Troitzsch, 2005; Miller, Page, 2009), the use of multi-agent system in the customer relationship management (Olszak, Bartus, 2013) and creativity organization (Olszak, Bartuś, Bartuś, 2014, Olszak, Bartuś, 2015, Olszak, Bartuś, Lorek, 2017), in public administration (Bartuś, 2013), the analysis platform of agent (Żytniewski, Klement, 2015) modeling of economic markets (Kaminski, 2012; Bartus, Bartuś, 2010), Agent-based modeling in the study of educational decisions (Kuszewski, Shapiro, Szufer, 2015). Cited studies and their results indicate the need to conduct research in support of innovation companies using intelligence agents.

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2 Enterprise innovation

When beginning a discussion on enterprises innovation one should start from defining its fundamental concepts. One of the pioneers of the theory of innovation is Joseph Schumpeter. The approach proposed by J. Schumpeter puts focus on innovation as market experiments and large, wide-ranging changes that would fundamentally alter the structure of entire sectors and markets. In his opinion, economic development is driven by innovation in a dynamic process in which new technologies replace the old ones. This process is called "creative destruction". J. Schumpeter believed that "radical" innovations lead to big disruptive changes, and "incremental" innovation constantly push forward the process of changes. Schumpeter (1934) distinguished five types of innovation (Oslo Manual, 2006):

- Introduction of new products;
- Introduction of new methods of production;
- Opening of new markets;
- Development of new sources of supply for raw materials or other inputs;
- Creation of new market structures in an industry.

According to R. Gryffin, innovation can be defined as the effort of organization directed towards the development of new products and services or new applications for existing products and services (Griffin, 1996). According to P. Kotler, innovation refers to any good, service or idea that is perceived by someone as new. The idea could exist for a long time, but it is an innovation for the person who perceives it as a new one (Kotler, 1999). On the other hand, M. Porter adopts a more detailed definition of innovation characterizing its main media. According to him, innovations are technological improvements, better methods and methods of doing a given thing. It may appear in changes in product, process, new approaches to marketing and new forms of distribution (Porter, 1990). The quoted definitions are connected by the practical application of novelties.

The development of innovation is innovativeness. According to R. Nowacki and M. Adamska, innovation is understood as the willingness and ability to create new and improve existing products, new technologies and organization and management and motivation systems. Constant willingness to innovate and take investment risks is considered on the important feature of entrepreneurial behavior which are the "heart" of the microeconomic development mechanism. Looking at innovation solely through the prism of the need for market competition, without paying attention to the rationale behind the purchasers can lead to the generation and implementation of innovative solutions that do not contribute to the improvement of relations with end buyers, becoming only unnecessary ballast unnecessarily aggravating company's budget (Nowacki, Adamska, 2010).

The conducted critical analysis of the literature on innovation and innovativeness has demonstrated that it is considered in several major prospects. Some of the studies focus on the determinants of innovativeness sand treat innovation in their exact meaning (Cho, Pucik, 2005), while the other ones indicate that innovativeness allows to work out one definite result (Pichlak, 2012; Hilami, Ramayah, 2010, Nowicki, 2010). Fig. 1. depicts this framework from the perspective of the firm, the target of innovation surveys.

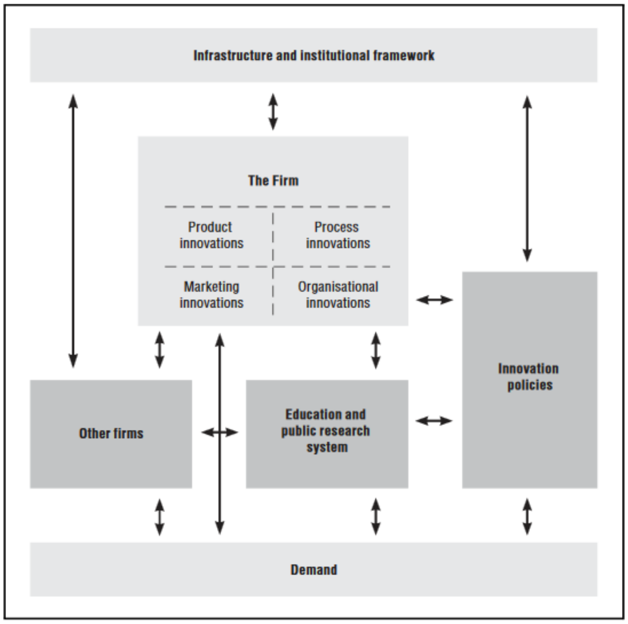

Figure 1 Place of Extraordinary Event, Source: Oslo Manual, 2006.

The framework used in the Manu al thus represents an integration of insights from various firm-based theories of innovation with those of approaches that view innovation as a system. The main characteristics of the framework described are (Oslo Manual, 2006):

- Innovation in the firm.

- Linkages with other firms and public research institutions.
- The institutional framework in which firms operate.
- The role of demand.

The guidelines contained in Oslo Manual can identify motives and obstacles to innovation, changes in the way firms operate, the kinds of innovation activity that they engage in, and the types of innovations that they implement. In terms of the innovation process as a system, innovation surveys can provide information on firms' linkages with other actors in the economy and on the methods they use to protect their innovations.

3 Intelligence Agent

It is assumed that in the contemporary reality agent is an entity that performs a specific activity in a fixed environment. He is aware of emerging changes in the environment and can respond to them (Poole, Mackworth, 2010). The concept of an agent in terms of information system dates to 1970s, when research was conducted on programs determined as "intelligent". Carl Hewitt presented in 1977 the concept of an autonomous object - an interactive actor (Hewitt, 1977). Lasting until about 1990 works in this area led to the introduction of software agents and upgrade of expanding typology and classification. This trend focused on the development of theory and modeling of the architecture of individual types of agents and on the improvement of tools and environments that enable communication of such systems. During this period, one developed, among other things, works on intelligent agents, or software executing specific tasks in a given environment. Their actions can be described as "sending for the task execution" for the purpose of analysis of the collected data, finding the desired information and, after examination reporting the action to the user.

With the characteristics of the essence and function of intelligent agents, one should refer to their architecture and components that create them. As a rule, among the main components of the architecture of intelligent agents there is knowledge base and the inference mechanism (Fig. 2). Extended architecture model of intelligent agents includes:

- input sensors (receptors) allowing perception of the environment,

- knowledge base and the inference mechanism, which allows to update the memory and execute functions of selection of the best solution,
- output sensors (effectors) that allow to take act within the environment.
- Introduction of new products.
- Introduction of new methods of production.

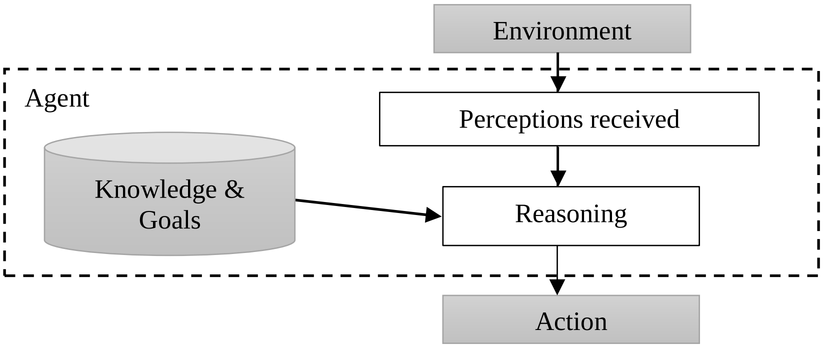

Figure 2. Place of Extraordinary Event, Basic schema of an Intelligent agent. Source: (Zacarias, Valente de Oliveira, 2012).

Initially, when building an agent system, it was assumed that it will consist of a single intelligent agent (Agent-Base system). It is worth noting that usually intelligent agents are rarely equipped with a full set of capabilities. This is due, inter alia, the difficulty and complexity of the design of this type of application, which further results in their difficult use. The solution to this problem is to replace the complex single intelligent agent with several specialized units, which have demonstrated the ability of mutual cooperation. In this way, systems are built that form a network of interacting intelligent agents. Such solutions are referred to as multi-agent systems (MAS). It is defined as a network of concluding agents (the problem solvers) and co-operating ones, communicating and negotiating in order to carry out the task, which cannot be performed by a single agent. MAS is essentially a system that is organized as a set of agents, adapting their behavior to changing conditions in their environment (Weyns, 2010). A prime example of the combined activity of agents within the MAS is teamwork, in which a group of autonomous agents cooperates, both in the aspirations to develop their own individual goals, and for the good of the whole system (Ferber, 1999; Lesser, 2007; Bellifemine, Caire, Greenwood, 2007).

4 Concept of a computer system to support the innovation enterprise

Preliminary identification of intelligent agents suggests that the use of this technology in business can be broad (Bartuś, 2015; Olszak, Bartuś, 2013; Bartuś, 2010). The intelligent agents are characterized by autonomy, proactivity and adaptability, and personalization, they are particularly useful in the Internet, which is rich in different types of information (about the competition, customers, suppliers, patents, open innovation, scientific publications, the labor market). Analyzing the possible application of intelligent agents from the point of view of this article, the abilities of intelligent agents in the area of simulation of economy seem interesting. Research conducted in the field of agent-based simulation are called Agents Computational Economics (ACE). Artificial economy includes three main types of agents: (1) artificial workers and consumers, (2) artificial enterprises, and (3) artificial markets (Tesfatsion, Judd, 2006; Kordon, 2010).

Enterprise innovation entails reaching for new knowledge or its new applications, or a combination of existing knowledge. Gaining new knowledge or the combination of existing knowledge requires investment of work, time and financial resources. In this area, one mainly sees the use of intelligent agents for support of enterprise innovation. It is proposed that in the area of knowledge the individual intelligent agents should act as brokers of knowledge supporting the enterprise in the area of innovation.

In the conducted research works, one has attempted to develop a preliminary model of supporting enterprise innovation using intelligent agents. Using the results of a critical analysis of source literature, one has constructed a novel version of the model of this issue, which is shown in the fig. 3.

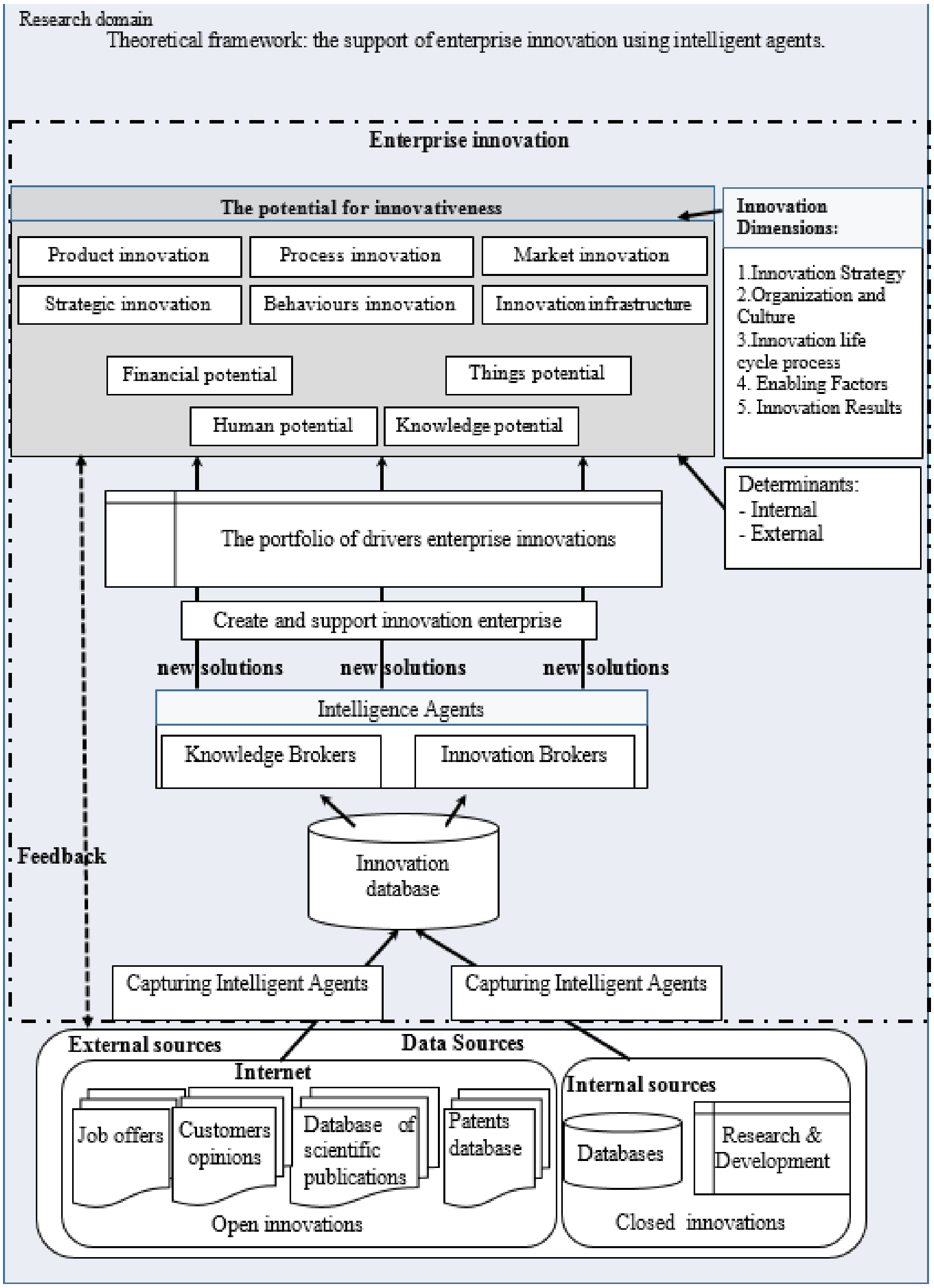

Figure 3. A framework based on intelligence agent approach for innovation enterprise support.

The shown in the above figure model includes four main categories. They are: (1) innovation company (as the main object support), (2) a portfolio of stocks, which are carrier and stimulator of innovation enterprises, (3) intelligent agents (including brokers knowledge and brokers innovation) and (4) potential for innovation, dimensions innovation with determinants.

From the innovative point of view, interesting looks the way and level of impact of intelligent agents on supporting research trends, namely enterprise innovation (considered from the perspective of strategic management, new approach to the resources of the enterprise and dynamic ability of the enterprise) and the concept of intelligent agents (system supporting enterprise innovation), directed to: (1) support of enterprise innovation in many of its areas, including by identifying and supporting portfolio of enterprise resource, (2) the identification and acquisition of strategic information resources (mainly from professional web sources), (3) their collection and transformation into the form required by the enterprise innovation (e.g. classic databases, knowledge bases, but also databases of patents, good practice databases, open innovation portfolios), sharing of discovered knowledge in the enterprise through an advanced personalization and visualization of information distribution with the ability of its evaluation and commenting by the interested stakeholders.

Conclusion

The main conclusion of this study is reflected in the statement that intelligence agent approach is an interesting and useful method for innovation enterprise support system design. The paper contributes new approach to innovation enterprise and computer support. It provides some interesting information on using an intelligence agent for designing of innovation enterprise support systems. The findings should be enriching the scientific achievements in the field of economic sciences in the scope of organization management and information technology management, as it will fill the information gap on supporting enterprise innovation using intelligent agents.

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Information system for calculating the workload of judges in Bulgaria - one year later: goals and results

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Abstract. Judicial reform in Bulgaria is unconditionally associated with one of the main elements of the concept of e-governance - the introduction of e-Justice. A large part of the developed and implemented information systems from the group of "IS assisting the judicial processes" is the result of meeting the European Commission's recommendations and indicators for progress or resolving an organizational or public problem.

In April 2016, the "System for calculating the workload of judges" was introduced, in connection with judicial reform and the optimization of the staff and the movement of staff in the judiciary. The so called weighting coefficients of cases were introduced, which determine the individual workload and the limits of the normal workload of the judges in the regional, district, military, administrative, specialized criminal and appellate courts. Because of the specifics, criteria and targeting, there are no analogous products developed on the Bulgarian market for software systems, which leads to the inability to compare with other developed systems.

The report analyzes the functioning of the implemented "System for calculating the workload of judges" during the last one-year period, the problems that have arisen, analyzes the accuracy of the objective measures for the legal and factual complexity of the court cases.

Keywords: Judicial system, e-justice, Web portal of the judicial system, e-government, information systems of public authorities.

JEL Classification: please select appropriate classification (predefined style "JEL")

1 Introduction

Informatization of judicial bodies is manageable conceptual process aimed at maximizing the potential of modern ICT (Nenkov, N.V., Petrova M.M. and Dyachenko, Y., 2016; Nenkov, N. et al, 2016).

The use of IT in the judiciary improves the transparency of the administration of justice, accelerates the procedures for bringing cases, and

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aims to continue the process of integrating information systems and ensuring their full applicability in the courts, prosecution and investigations.

Increasing openness and accessibility must not increase the workload of judges and judicial staff. The proper organization of work, the elaboration of uniform and clear rules should reduce their workload at the expense of automated document flow. (Petrova, 2017)

Information systems supporting legal proceedings have been developed and implemented as a result of the implementation of the recommendations and progress indicators of the European Commission.

Why a "System for calculating the workload of judges" (SCWJ) is needed?

The individual workload of judges and the workload of individual courts are issues that are of integral importance to the administration of the judiciary and the quality of justice. SCWJ is a priority in the work of the current Supreme Judicial Council (SJC), in relation to the reform of the court card and the optimization and movement of the staff in the judiciary. The aim is to ensure a fair and equitable workload on judges, objectively taking account of their workload in the framework of the attestation procedures and disciplinary proceedings to assess their activities.

The case weighting systems (also known as load balancing and weighted load evaluation models) are currently used in more than 30 US states (including Alabama, California, Florida, Michigan, Minnesota, Texas, Wisconsin and Virginia) , as well as in some countries in Europe, including Austria, Germany, the Netherlands and Switzerland. (Kleinmann, M. and Bryan J. Ostrom, 2015)

2 System for calculating the workload of judges – basic features and functions

The system is developed and implemented as a means of measuring the workload of judges, the purpose of which is to reflect both the factual and legal complexity of the various cases by measuring the time required to carry out the procedural stages inherent in the judiciary.

In order for the statistics gathered by the SJC to give the most accurate information on the actual and average workload, the system is built as a complex assessment method, which, besides the existing criterion - number of cases, also takes into account their complexity or the necessary time to consider them.

The implementation is regulated by the "Rules for Assessing the Workload of Judges" adopted by the SJC by Decision No. 62 / 16.12.2015, amended and supplemented by Protocol No. 15 / 24.03.2016, amended and supplemented by a decision of the SC of SJC under Protocol No. 23 / 08.11.2016, amended and supplemented by Protocol No. 29 / 20.12.2016.

"System for calculating the workload of judges" is a decision-making management information system with a formalized structure. Based on the management principles, it is a strategic system with staff functionality. It is characterized by a centralized processing of information, in the sphere of justice and security, implemented as database management system (DBMS). The technologies used in "Smart Systems 2010" Ltd. in the development of the system are Microsoft - Visual Studio .Net, MS SQL, MS IIS.

The system is designed to work with an Internet Explorer browser. The version must be at least 8, for best results when viewing the pages, Internet Explorer version 10 and Internet Explorer version 11 must be used. To work with the system, the WEB-Host must be added to TrustedSites on IE, and the settings for TrustedSites to be set by default. The system is also compatible with the Mozilla Firefox browser. Access to the system is provided by the Supreme Judicial Council.

Users of SCWJ are: 1. Administrative heads of courts; 2. System administrators of courts supporting system settings; 3. System administrators of the SJC administering the overall system.

In order to assess the workload of the judges, an objective primary indicator is introduced - the necessary inherent time to examine and complete cases of different types, according to a pre-formulated classifier of groups of cases. The value of this indicator is in hours and includes and takes into account the various aspects of the factual and legal complexity of the case, it is regulated in the "Rules for Assessing the Workload of Judges", i.e. these are coefficients for the weight of the cases.

The "Rules for Assessment of the Workload of the Judges" regulate the procedure for determining the individual workload and the limits of the normal workload of the judges in the regional, district, military, administrative, specialized criminal and appellate courts. These rules are the regulatory basis of the "System for calculating the workload of judges".

The determination of the judge's workload is considered as an assessment of the time needed for the examination and settlement of court cases as well as an assessment of the time required for the judge to perform all other activities related to the proper administration of justice.

The cumulative coefficient is calculated by the following formula:

$$(k1 + k2 + ... + kn) - (n - 1) \tag{1}$$

where ***k1, k2 … kn*** are the values of the determined correction coefficients for the applicable reasons, ***n*** is the number of the applicable grounds (Georgiev, G. et. al. 2015).

SCWJ is a self-operating system integrated with the Centralized Random Case Distribution System. For the purpose of generating and determining the load factor for a case, the Centralized Random Case Distribution System is initially used, and the cases are automatically transferred to SCWJ. The Case menu shows all cases in a chronological order of creating and filing with the possibility of a filtered search by a specific feature: case code, case number, case year, input number or specific cipher.

SCWJ maintains two assessments for each case:

- *Initial,* which is determined by the type of court (Regional Court, District Court, Court of Appeal, etc.), the code and the case group, and for each possible combination of court type, code and group there is a specified coefficient;
- Final – the correction coefficients are applied to the initial assessment

For each case, if necessary, the group and the cipher can be corrected by the complexity coefficient, i.e. add / change the parameters that characterize the case and form its weight.

With the correction made and the final result of the case (decided or terminated), the coefficients included give the final estimate of the judge's workload, which is reflected in his individual workload account.

Each judge has the right of authorized access to his / her individual workload account, a submenu "Reference for a Judge", with the opportunity to review his individual reference data. They provide the judge with information on his workload index, which is the sum of the individual assessments of the cases examined and completed and the additional activities included in the lawsuit process.

Table 1 Workload Index, Source: Rules for Assessing the Workload of Judges

Level	Case count (X)	Judge workload
1	50 > X	very lightly loaded judge
2	50 < X <= 70	lightly loaded
3	70 < X <= 130	normally loaded
4	130 < X <= 180	highly loaded
5	X >180	extremely high loaded

The workload rating model assigns a basis value for the annual workload of a judge, assuming that he has 252 working days or 1,600 working hours per year, equal to 100 points.

3 SCWJ one Year Later

As of 01.04.2017. one year has passed since the start of the SCWJ, but it is not possible to assess the advantages and disadvantages of the "System for calculating the workload of judges" over other developed systems: due to the specificity, criteria and target orientation, no analogous products have been developed on the Bulgarian market for software systems.

During this period, the system was researched by examining and analyzing the expert opinions of system administrators and other persons responsible for proper functioning.

Despite the accumulated operational information that is the basis for many adjustments and changes, the system continues to be the cornerstone of the SJC's work. The ideology behind the creation of the information system radically contradicts the real activity of the magistrates. For example, Article 36 (2) of the Rules for Assessing the Workload of Judges regulates the inclusion of the "Case termination" option. This regulation is not yet included in the SCWJ and although it appears to be minor, it is a determining factor in the calculation of the weighting coefficient of the workload of judges. By including it in the system and choosing the "Case termination" option, it will automatically exclude the weighting coefficients with the status "Terminated" from the magistrates' aggregate judicial and individual workload, i.e. the possibility to artificially increase the workload of magistrates.

Another issue that has not yet been resolved is court cases where a magistrate or magistrates are dismissed: the activity of the judge in administering, examining and dismissing from a case is not counted in the system. The magistrate, who decides or terminates the case, gets the weighting coefficient. Litigation by dismissed magistrates is not counted, and sometimes they are hours of work and familiarization with case files.

The system includes the possibility of merging claims in a single court case, but for over three or more objectively and subjectively merged claims, i.e. the merging of up to three claims in one case automatically reduces the weighting coefficient and the workload of the magistrate, which is in contradiction with the real situation. These proceedings are in fact continuing, with the judge receiving only one weighting load factor, with increased court action.

An important omission in SCWJ is the limited reporting when examining a case only in a three-year term of court proceedings (according to Article 36 (1) of the Rules for Assessing the Workload of Judges). If the case lasts for 4 years or more, the magistrate will not receive a workload coefficient for the fourth and subsequent years, i.e. has not worked on this court case. Examples of cases lasting more than three years are civil cases with the subject of "Distribution".

The most important problem in our opinion, or more accurately fault in the system at this moment, is the ideology. Overall, the system is designed and programmed as a quantitative and time-based measure of the workload of judges. This concept is, in our opinion, entirely wrong, because in the work of the judges, apart from the quick court proceedings, the quality of the judicial acts is also important. The quality of the acts and the well-written motives in making a reasoned decision by the magistrate is the main factor for the recovery of the so-called "Sense of Justice" in civil society. *An accurate indicator and a measure of quality are the indices of revoked or amended judicial acts.*

These indicators are in no way laid down in the "Rules for Assessing the Workload of Judges" and SCWJ. Litigation actions are not a production enterprise to account for only quantitative and time indices. The main change to be made in the future is a change in the concept and methodology of the "System for calculating the workload of judges" to *include qualitative indicator in magistrates' court proceedings.*

The past one year of SCWJ work can be described as transient or experimental. This conclusion highlights the numerous changes made to the weighting coefficients and the multiple changes made to the "Rules for

Assessing the Workload of Judges". The accumulated system information of the past year could by no means determine the workload of judges precisely because of the lack of a qualitative measure. For this reason, with protocol No 29 / 20.12.2016., the SJC Judge's College decided: "The annual report on the workload of judges becomes part of the annual report of the courts as of 2017", i.e. the period 01.04.2016 - 31.12.2016 is declared transient and the accumulated information will be of a reference nature only.

4 Discusion

It is obvious that judicial authorities in Bulgaria are trying to meet the European model of ICT development and participate fully in the online exchange of data and information in the EU. (Petrova, 2017)

The analysis, however, complements the observed trend of drastic falling behind in the development of e-justice in the Republic of Bulgaria compared to the European model. This situation is due to the many factors accumulated over time in the implementation of the e-government and e-justice system in Bulgaria. Individual activities and partial decisions on the development of e-government, respectively e-justice, undertaken by heads of state agencies predominate.

The creation and development of e-government in Bulgaria is the shortest way to overcome the electronic divide with Europe and integrate into the common European information society policy.

5 Conclusion

E-Justice is compulsory for better judicial management, quality justice, counteracting corruption in the judiciary.

The introduction of e-Justice requires a lot more time, resources, political will. The introduction of e-Government in the Justice sector ensures increased confidence in the sector, maximum transparency of work, high quality of e-services provided and equal access to justice.

The "System for calculating the workload of judges" shows that, in its current form and concept, it is not enough to make informed judgments on judiciary reform concerning the Judicial Card and e-Justice.

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Information Technology in Waste Management

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Abstract. The article deals with using information technology (IT) in the waste management. The aim of the authors is to compare the ways of waste disposal in the past and at present in the Czech Republic as well as in other European countries. They point out how IT consequently becomes a part of the whole waste disposal process. IT plays a significant role in the field of municipal waste where it is used, for example, to optimize GIS waste collection routes or to monitor the utilization of containers for cost optimization during waste collection. The article introduces the Smart Waste Collection System, which is part of the Smart cities concept.

Keywords: information technology, waste management, municipal waste, Smart cities.

JEL Classification: Q56, M15, O32

1 Introduction

Information technologies are gradually becoming a part of almost all spheres of human being, and waste management is no exception. Together with the effort to reduce the amount of waste, especially mixed waste, this means looking for ways to improve it. As it turns out information technology already has its place in the whole waste management process. According to Act No. 185/2001 Coll., On waste, waste management includes the following five activities: waste prevention, preparation for re-use, waste recycling, other waste recovery and waste disposal. In accordance with the law, it is necessary to carry out the above-mentioned activities exactly in that order, i.e. to first try to prevent waste and to consider waste disposal to be an extreme possibility of dealing with waste. Using IT can be achieved both by improving these individual parts of the waste management process and by reducing costs (Baránková, 2013). Optimal use of information technology in this area is the

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concept of Smart cities, which includes, for example, a Smart Waste Collection System.

2 History of waste management

As the Waste collection predecessor can be considered collection of unneeded or damaged bronze products in a time that is named according to the alloy, i.e. Bronze Age. In this period people have discovered that bronze can be re-melted and used again to make new things. The English people in antiquity had similar idea and by melting glass they made new glass jars. Meanwhile in Greece and especially in Rome the first waste dumps were created. (Siegl.cz, 2017). However, the first waste incinerator was built only in 1870 in London. In years 1876 – 1877 the incinerators spread to other British cities, such as Leeds, Manchester and Birmingham. In 1892 the first waste incinerator was opened in Brussels, Belgium. In the Czech Republic, the first incinerator was built in 1905 in Brno and twenty-eight years later in Prague (1933). (Pašek, Purmová)

In the second half of the 20th century it appears that landfilling and incineration will not solve the problem of increasing waste in the long run. Following the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, the concept of sustainable development is at the forefront, and states are beginning to look for more efficient and environmentally sound ways of waste management. Of particular importance is the sorting of waste. In Czechoslovakia, metals, paper and glass were sorted by way of purchase. The present form has been classified in the Czech Republic since 1997, when the packaging company EKO-KOM, a.s. was established (Recycling-wordpress.com, 2015). The history of waste management in terms of legislation dates back to 1972 when the first European law related to this field was issued in Germany. The subsequent development of laws on waste in individual European countries depends above all on state systems as well as the fact whether the given country has been a member of the European Union. In post-socialist countries, laws on waste were created after the change of political system whereas in Western countries much earlier. For instance, in France the valid law on waste passed in 1975 (Act No. 75-633 of 15 July 1975 on waste disposal and re-use of waste material). (Haltofová, 2013). On the contrary in the Czech Republic the first law on waste was approved in 1991 and in Poland even 7 years later. (Golebiewska, 2017). After joining the European Union, the state is obliged to incorporate EU legislation into its legal order. In the case of waste and waste management, this concerns, in particular, Directive 2008/98 / EC of the European Parliament and of the Council of 19 November 2008 on waste and cancelling certain directives. That means that all twenty-eight Member States have legislation regarding waste management (Kozel, 2015).

3 The use of information technology in waste management

At present, there are a number of possibilities for the use of information technology in waste management process. These solutions benefit not only waste processors, but also municipalities and their inhabitants (Hančlová, 2013). The main aim of IT application in waste management is cost optimization, faster and easier data retrieval within reporting and ultimately reduction of ecological footprint (Janovská, 2015).

There is a set of information systems for activities managed by the Ministry of Environment, which aims, through accessible and high quality information, at streamlining the decision-making and implementation of environmental policy instruments. In total, this system, referred to as the Shared Environmental Information System (SEIS), has twenty-five subsystems. These include, for example, the Air Pollution Information System, The CITES Registers, the Raw Materials Information System or the Nature Conservation Information System. In the field of waste management, there are e.g. the Waste Management Information System and its module Car Wrecks, resp. Integrated Environmental Pollution Register (IRZ). The Waste Management Information System collects data on waste production and waste treatment, facilities for treatment, recovery and disposal of waste. Obligation to report such data results from the Act no. 185/2001 Coll. Part of the IS are the Waste Management Public Information System (VISOH), List of Producers of Electrical Equipment, Register of Electrical and Electronic Equipment, Register of Equipment and Files, List of Carriers and the above-mentioned Wreck Module.

In the field of waste recycling and disposal, information technology is used, for example, to optimize collection routes and check how full individual containers are (Kozel, 2014). Managing these two activities leads towards cost reduction, in particular for fuel, which in turn leads to the decrease of carbon dioxide emissions into the air (Vilamová, 2016).

The geographic information systems (GIS) and global positioning system (GPS) are used to optimize waste collection routes. For instance, Sahoo dealt with this issue in 2005. The outcome was that in GIS we can track the location of individual clients and so choose the optimal route for waste collection and therefore the number of waste collection vehicles, which causes reducing the total journey time and thus the cost of the collection vehicle. In the Czech Republic, for example, Heisig (2014) from the Department of Geo-informatics of the Palacký University in Olomouc solved the optimization of the waste collection. His aim was to create a model and its application within the waste management of the regional city of Olomouc.

In the area of waste management, the use of RID chips is mentioned by, for example, Saar and Thomas (2003). The RFID chips are mostly used in stores for goods recognition. Saar and Thomas state that this technology may also be used when dealing with hazardous waste where this chip contains information on how and where we can dispose of the waste.

RFID chips can also be used for optimizing waste collection. These chips would be installed in individual containers and contain information such as GPS of that particular container, its colour, last maintenance and most of all how full it is at the moment. More information on RFID chips is described in the following chapter.

Information technology can also be implemented in the consequent sorting of the waste on sorting lines (Ministr & Pitner, 2014). For example, the Norwegian company TiTech has created a sorting line that uses an optical recognition device based on NIR (Near InfraRed) spectroscopy. (Šťastná, 2007).

4 Smart cities

Smart Cities is a concept of strategic city or region management based on the principles of sustainable development. This concept, also referred to as the concept of smart or intelligent cities aims at the use of information and communication technologies to create a technical and social infrastructure that facilitate the sustainable economic growth. Emphasis is also placed on reducing energy intensity and impact on the environment, improving the quality of life in the city. The concept includes three elements: smart mobility, intelligent energy and services, and information and communication technologies. (Slavík, 2012)

This concept also includes a Smart Waste Collection System, which utilizes the aforementioned RFID chips. The aim of this system is to optimize the collection routes with the help of information technology, thus reducing the costs of transport and environmental impact.

The main difference between the Smart Waste Collection System (SWCS) and the usual waste collection system, where municipalities are divided into several similarly large districts and collection takes place in prearranged regular cycles (e.g. once a week), is that the SWCS creates the routes according to needs of specific collection points. The usual waste collection does not take into account how full individual containers are, so very often the vehicle collects half-empty container, or worse, the capacity of the container is greatly exceeded and the waste is lying around it. This phenomenon can be avoided in the context of smart waste collection.

Smart waste collection works with sorted waste bins fitted with RFID chips and so-called smart or intelligent bins. By the use of GRPS data these containers send data on how full they are to the collection company headquarters. Data obtained this way are evaluated and serve as a basis for creating optimal collection route using GIS. It is important to create these routes so the collection vehicles only collect full bins and do not spend their time and fuel on half-empty containers.

It is also possible to send data from these containers to tablets placed in individual collection vehicles so the drivers can change their route accordingly.

Thanks to these data, companies have an overview of how many individual streets or parts of municipalities produce waste and how efficiently people sort it. Such information may serve as groundwork for creating various benefits that can help motivate people to sort waste in the whole municipality (Bárta, 2016).

In the case of companies that collect waste from several municipalities the RFID chips can ease the calculation of cost for collection in a particular municipality based on data obtained from these chips.

For reasons of safety, individual containers can also be equipped with a fire alarm system that detects smoke and in such case calls a fire brigade. It can also alert the headquarters that the container is being tampered with.

RFID chips may also be advantageous for the citizens; for instance, handicapped people could have their own chip, which would be able to communicate with the chip in the container and open the lit for them. These chips could also be used for individual households. Based on using the chips there would be a record on how the households sort their waste and that could result in fines for those not complying with this obligation and lower fees for those who do. Similar system is already used in several cities for households with their own bins, i.e. people living in family houses. However, this is only mixed waste, as sorted waste is usually collected in containers managed by the municipality. However, it is clear that this activity would need to be elaborated in detail.

The Smart Waste Collection System also works with the already mentioned smart bins or in other words Bigbelly. These bins that unlike the containers have the chips already build in during their manufacturing, operate on solar-powered basis and are completely self-sufficient. Similarly as in the first case the chip informs the headquarters that the container is full. However, another advantage of this system is that it contains a sensor, which compresses the contents when the container is full, thus providing space for another waste. This type of bins can be used in places with high concentration of people. The undisputable advantage of these bins is that thanks to them it is easier to maintain clean streets of towns and villages. BigBelly bins are used in over fifty countries and the Czech Republic is no exception. Though at the moment there are only few of them.

5 Conclusion

Information technology is becoming an increasingly important area of waste management. The development is mainly recorded in the field of sorting and waste collection, where above all the RFID chips, GIS and GPS are used.

The biggest advantage of using information technology in waste management is the optimization of collection routes, which goes hand in hand with reduction of costs for collection vehicles and the consequent impact on environment. These savings are managed by shortening collection routes that affect the amount of used fuel and therefore lower the amount of carbon dioxide emissions into the air. Information technology also helps to satisfy both, the waste collection companies, which have a greater overview of their costs and the amount of collected waste, as well as the municipalities, which, for example, by using the smart bins can maintain even the busiest parts of their town clean. And ultimately that also satisfies the citizens.

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Synthesis of models of educational processes implemented on the base of the application of IT technologies

Sergey Yablochnikov[1], Mikhail Kuptsov[2], Irina Yablochnikova[3]

Abstract. To effectively manage educational processes implemented with the use of modern information technologies, it is necessary to synthesize a set of mathematical models. The creation of such models, at due time, was devoted to their research by a number of scientists from different countries. These models sufficiently adequately reflect the analyzed processes and allow planning management actions aimed at achieving the educational goal. Information technology contributes to the intensification of learning processes and their role in achieving the goal of the pedagogical process should be appropriately evaluated. The above mentioned conditions, formulated by the authors, made it possible to implement in practice effective pedagogical technologies and teaching aids, including software. In the article, the authors suggested a number of models for managing learning processes based on the theory of automata and systems of Kolmogorov linear inhomogeneous differential equations.

Keywords: Management of educational processes, application of information technologies, mathematical modeling, optimization of learning.

JEL Classification: C02, C31

1 Modeling of educational processes

There was time when scientists of many countries paid attention to the management of social systems, including the founders of cybernetic ideas N. Wiener, W. Ashby, W. Forrester, A. Berg, V. Glushkov. Education is an integral part of society. The implemented of socio-economic processes and their effectiveness are important for society, they largely determine its future. In the scientific literature, there are many examples of modeling the "behavior" of the elements of educational systems and predicting the implementation of

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pedagogical processes. In particular, these are models developed by H. Frank, L. Thurstone, H. Gulliksen, R. Atkinson, R. Bush, F. Mosteller, U. Estes, K. Hall, V. Prisnyakov, V. Trapeznikov, V. Glushkov, M. Novikov, L. Itelson. The authors of this article also synthesized a number of mathematical models, such as the two-product dynamic model of the management of the pedagogical system (Yablochnikov, 2010) and the learning process model based on the Moore automaton (Yablochnikov, Kuptsov, Yablochnikova, 2016).

Most of the models mentioned above are deterministic. However, such mathematical models of pedagogical processes in most cases give the same result with equivalent initial data. And this concerns not only the volume, but also the speed (intensity) of mastering the learning material or acquiring skills. This situation weakly correlates with reality, since the implementation of real educational processes with equivalent initial data (the initial level of knowledge, skills, cognitive abilities of those who study, etc.) in practice almost never leads to the same learning outcomes.

In this publication, the authors attempted to adapt previously known mathematical models of the implementation of pedagogical processes to the real conditions of the functioning of the educational sphere. This is quite important in conditions of wide application of modern information technologies with the purpose of intensification of the teaching process.

In our opinion, the adequacy of deterministic models of educational processes can be improved by introducing new auxiliary variables that significantly affect the achievement of the learning goal. In particular, such variables can be: the intellectual level of students, the degree of their motivation to implement the training, the state of physical health, the perception of certain methods of teaching and pedagogical technologies, social environment; the possibility of continuous use of modern technical means and so on. Most of the governing characteristics, pedagogical conditions, personal and social properties that determine the final result are difficult to formalize. Therefore, the authors consider it expedient in this case to apply the principles of stochastic modeling.

In work (Yablochnikov, Kuptsov, Yablochnikova, 2016) the authors of this publication synthesized and analyzed the model of learning process formalized in the form of Markov random process with a finite number of discrete states of the system considered in a continuous time interval.

First of all we have to analyze the system of learning with two discrete conditions: S_1, S_2. Constant positive parameter λ indicates intensification of transition from initial condition S_1 to the final S_2. In other words, the system describes marked out graph of conditions which is illustrated in *Figure* 1.

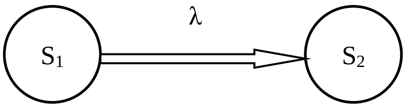

Figure 1 A System f learning with 2 discrete conditions and constant parameter λ. Source: Author´s own processing

Then, as for relativity p_1 and p_2, which characterize the dynamic of process of learning in each moment of time t, the equations are true:

$$\begin{cases} \dot{p}_1 = -\lambda \cdot p_1, \\ p_1 + p_2 = 1. \end{cases} \tag{1}$$

Such model was analyzed from a different point of view in previous publications. (Novikov, 1968), (Antamonov, 1968). We have to mention that system equation solution (1) with initial condition $p_1(0) = 1$ (or the initial system condition– S_1) will be function of $p_2(t) = 1 - e^{-\lambda \cdot t}$. That means, after some time theoretically any learner can achieve condition S_2, completely acquiring the educational program. Apparently, such situation is possible only for elementary basic actions where everyone is learning. The introduction of equation system instead of constant parameter λ doesn't change the main principle of immanency of learning condition. Actually, if we take the following system of equation into consideration (2)

$$\begin{cases} \dot{p}_1 = \dfrac{-2t}{t^2 + 1} \cdot p_1, \\ p_1 + p_2 = 1, \end{cases} \tag{2}$$

then the solution of that system will be function $p_2(t) = 1 - e^{-\lambda \cdot t}$ where the following formula $\lim\limits_{t \to +\infty} p_2(t) = 1$ is valid. Consequently, the above mentioned models (1) and (2) don't describe the process of learning relatively.

2 Specification of the conditions for modeling educational processes

Next, we will describe the situation when it is necessary to analyze the models considering three or more discrete conditions. These extra (transit) conditions reflect not complete but vice versa excessive acquisition of learners` curriculum (for instance, the intermediate level of acquisition of advanced).

The system of learning is described by the graph of conditions depicted in the *Figure 2*.

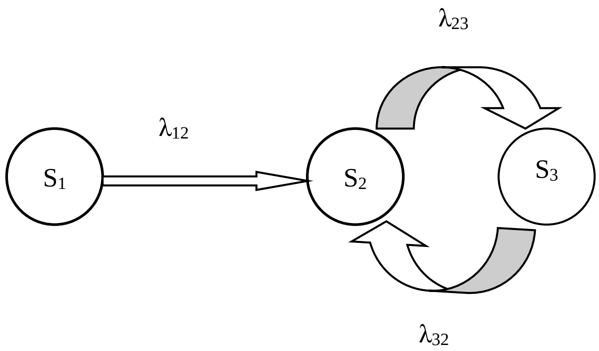

Figure 2 Schematic model considering three discrete conditions for educational processes. Source: Author´s own processing.

Then the dynamics of relativity condition change and mutual transition from one into another one can be depicted with the help of Kholmogorov`s equations.

$$\begin{cases} \dot{p}_1 = -\lambda_{12} \cdot p_1, \\ \dot{p}_2 = (\lambda_{12} - \lambda_{32}) \cdot p_1 - (\lambda_{23} + \lambda_{32}) \cdot p_2 + \lambda_{32}, \\ p_1 + p_2 + p_3 = 1. \end{cases} \tag{3}$$

Presumably, the relativity at the beginning stage of learning satisfies the conditions $p_1(0) = 1, \quad p_2(0) = 0$, then it is the solution of equation system (3) in the following functions:

$$\begin{cases} p_1 = e^{-\lambda_{12}\cdot t}, \\ p_2 = \dfrac{\lambda_{32}}{\lambda_{23}+\lambda_{32}} + \dfrac{\lambda_{12}-\lambda_{32}}{\lambda_{23}+\lambda_{32}-\lambda_{12}} \cdot e^{-\lambda_{12}\cdot t} - \dfrac{\lambda_{12}\cdot\lambda_{23}}{(\lambda_{23}+\lambda_{32})\cdot(\lambda_{23}+\lambda_{32}-\lambda_{12})} \cdot e^{-(\lambda_{23}+\lambda_{32})\cdot t}, \\ p_3 = 1 - p_1 - p_2. \end{cases}$$

Consequently, if $t \to +\infty$ then $p_1(t) \to 0, p_2(t) \to \dfrac{\lambda_{32}}{\lambda_{23}+\lambda_{32}},\ p_3(t) \to \dfrac{\lambda_{23}}{\lambda_{23}+\lambda_{32}}$.

In other words, there is always a probability that the system will will not transmit to condition S_3, (for example, a learner will acquire some educational program partially but on a acceptable level (S_2). The higher probability the more intensity of λ_{32}.

Carrying out the transition to the general math problem and correspondingly to n model conditions S_i ($i=1,\dots,n$), we get heteronomous linear system of non-homogeneous differential equations of Kholmogorov (Wenzel, 1988), which index generally will depend not only on time but also on some controlling parameters $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_k$.

Introducing the designating $\varepsilon = colon(\varepsilon_1, \varepsilon_2, \dots, \varepsilon_k),\ p = colon(p_1, p_2, \dots, p_{n-1})$, the system of Kholmogorov will be written:

$$\dot{p} = \Lambda(t,\varepsilon)\cdot p + L(t,\varepsilon), \tag{4}$$

where $\Lambda(t,\varepsilon) - (n-1)\times(n-1)$ is a matrix of coefficients, $L(t,\varepsilon) = colon(0,0,\dots,0,l(t,\varepsilon)),$ where $l(t,\varepsilon)$ is scalar-valued function.

Components of vectorial parameter ε may reflect not only its characteristics of educational structure (such as parameters of its control), but also characteristics of some learners group such as individual characteristics of each participant of such a group.

If there is some meaning of parameter $\varepsilon = \varepsilon^*$ then it is

$$l(t,\varepsilon) = 0, \tag{5}$$

If it is $\varepsilon = \varepsilon^*$ it becomes a trivial solution $p=0$, or $p_n=1$ (probability of such program acquisition is equal to 1), as a matter of practice most likely it`s not possible to achieve. Nevertheless, it is necessary to emphasize Kolmogorov`s system (4) near the solution $\varepsilon = \varepsilon^*$ bifurcation equation (5), there is a possibility of completely new curves for real meanings of parameter.

A natural generalization of the previously proposed model is the Markov process, which is continuous with respect to the time and states of the system being modeled. It is assumed that for the description of the above-mentioned model it is useful to use stochastic differential equations of a fairly general form

$$d\xi(t) = a(\xi(t),t) \cdot dt + \sigma(\xi(t),t) \cdot d\omega(t)\,, \tag{6}$$

where $\omega(t)$ is a Wiener random process, the function $a(\xi,t)$ is called the transfer coefficient, and $\sigma(\xi,t)$ is the diffusion coefficient. In the fulfillment of a number of additional restrictions, these coefficients $a(\xi,t)$ and $\sigma(\xi,t)$ completely determine the random process we are considering, and the Markov transition functions and the probability distribution density satisfy the Kolmogorov and Kolmogorov-Fokker-Planck differential equations in partial derivatives (Risken, 1984). In this case, the above mentioned transfer and diffusion coefficients (functions) can be interpreted accordingly as functions that formalize the dynamics of the intensity of the processes of forming the competencies of students and their integration into the educational process and the information educational space.

The authors propose a specific approach to the synthesis of models, which consists in evaluating the mathematical expectation and variance of the final results of the random educational process studied by the researchers $\xi(t)$. Here and below, we will treat $\xi(t)$ as a the term "the success of mastering the content of an educational program" as some of the theoretical knowledge, skills and (or the totality of competences) generated by the trainee from the total volume planned by the corresponding program. We will express this quantity in relative units. Thus, the set of values of a random process $\xi(t)$ is the interval of values [0; 1].

It should be noted, however, that the criteria for the success of mastering the educational program is ambiguous. As a rule, this criterion is the arithmetic mean (or sum) of subjective assessments of experts (practitioners in this field, teachers, employers, where trainees undergo training, etc.). In this paper, to objectify these criteria, we propose to use not only the ordinal expert assessments, but also the index of the level of education that is given in a particular educational institution. For this purpose, the ratings of educational institutions (national or international), the percentage of unemployed graduates and their average wages can be used. Moreover, in our opinion, an important indicator of the adaptability of education is subjective assessments of graduates of their satisfaction in the education received. To determine the level of satisfaction with education, we developed a questionnaire in which each respondent in five grades assesses his education from three positions: how much education helps in work, in self-education and in achieving the desired social status.

Thus, most of the considered indicators, to some extent assessing the received level of education, refer to the ordinal scale of measurements. Moreover, many of them are crossed, and, therefore, to add and average them is not completely correct. Therefore, we propose an approach for evaluating the success of the education obtained on the basis of the theory of fuzzy sets.

3 Practical application of synthesized mathematical models

As an example of the practical application of mathematical models synthesized by the authors, including the formation of the above membership functions, let us consider the situation regarding the implementation of pedagogical processes where the success of mastering the curriculum by students is estimated on a ten-point scale. Such a rating system exists in a number of leading higher education institutions of such countries as Belarus, Georgia, Iceland, Latvia, Russia, Romania, Finland. In this particular case, we will use the distribution of relative frequencies (shown in *Figure* 3) and a list of subjects studied by second-year students at one of the most prestigious technical universities in Russia - the Moscow Institute of Physics and Technology (major - "Applied Mathematics and Physics"). The corresponding data are presented by the authors in *Table* 2.

Table 1 Member functions. Source: Author´s own processing.

$\mu_1(x) = \exp\left(-10{,}13(x-1)^2\right)$	$\mu_2(x) = \exp\left(-4{,}5(x-2)^2\right)$	$\mu_3(x) = \exp\left(-3{,}96(x-3)^2\right)$
$\mu_4(x) = \exp\left(-2{,}3(x-4)^2\right)$	$\mu_5(x) = \exp\left(-5{,}17(x-5)^2\right)$	$\mu_6(x) = \exp\left(-15{,}82(x-6)^2\right)$
$\mu_7(x) = \exp\left(-20{,}66(x-7)^2\right)$	$\mu_8(x) = \exp\left(-28{,}13(x-8)^2\right)$	$\mu_9(x) = \exp\left(-40{,}5(x-9)^2\right)$
$\mu_{10}(x) = \exp\left(-28{,}13(x-10)^2\right)$		

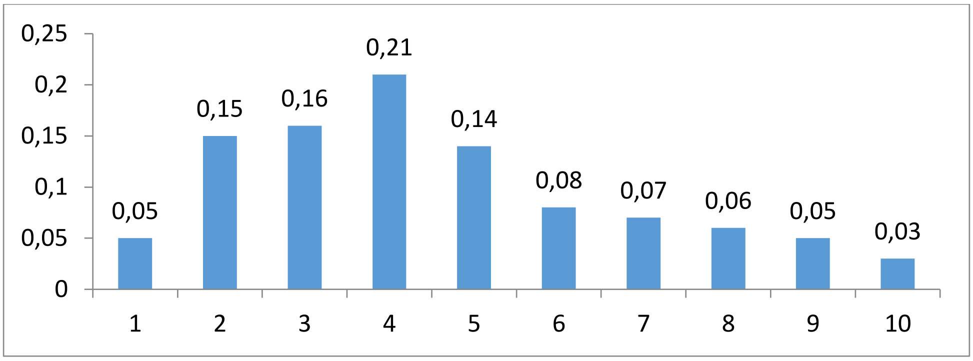

Figure 3 Distribution of relative frequencies of expert assessments of students' knowledge.Source: Author´s own processing.

The membership functions (see *Table* 1, *Figure* 4) are constructed for each of the fuzzy sets $\{1\},\{2\},\ldots,\{10\}$ as $\mu_i(x)=\exp\left(-\frac{(x-i)^2}{2\sigma_i^{\ 2}}\right)$,where $i=\overline{1{,}10}$, σ_i is determined on the basis of the "three sigma" rule, based on the actual distribution of estimates (see *Figure* 4).

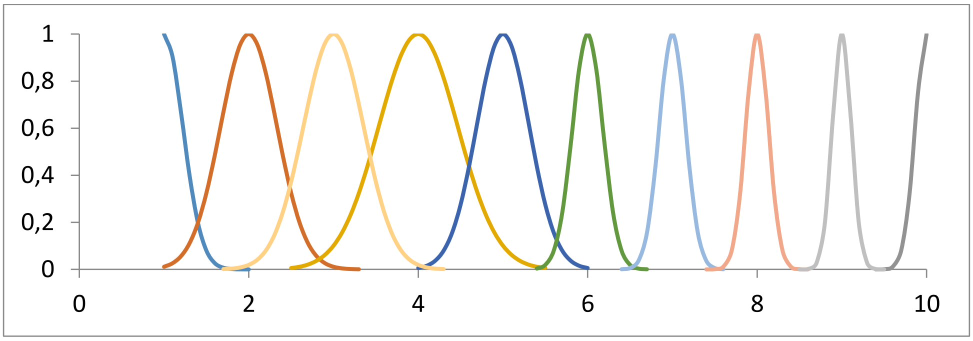

Figure 4 Figure 4 Charts of membership functions. Source: Author´s own processing.

Individual profile (*IP*) of the learner is obtained by composing a linear combination of membership functions and finding its maximum: $IP=\max\limits_{x\in[1;10]}\{\alpha_1\mu_{i_1}(x)+\alpha_2\mu_{i_2}(x)+\ldots+\alpha_n\mu_{i_n}(x)\}$. Weighted coefficients α_i are determined for each academic discipline depending on the credits and forms of control (see *Table* 2).

Table 2 Determination of the weight coefficient of educational disciplines. Source: Author´s own processing

Subject	Credit Ratio	Form of control	Weight assignment	Expert estimation	Member ship function
Difference equation	5	exam	0,15	7	$\mu_7(x)$
Computer technology	4	exam	0,12	5	$\mu_5(x)$
Theoretical mechanics	4	exam	0,12	5	$\mu_5(x)$
Economics	3	exam	0,1	6	$\mu_6(x)$
General physics: optics	5	exam	0,15	6	$\mu_6(x)$
Harmonic analysis	4	exam	0,12	10	$\mu_{10}(x)$
Introduction to electronics	3	pass-fail exam	0,08	7	$\mu_7(x)$
General physics: lab. course	3	pass-fail exam	0,08	9	$\mu_9(x)$
The English language	3	pass-fail exam	0,08	7	$\mu_7(x)$

Then for the expert estimates given in Table. 2, we obtain $IP = \max\limits_{x\in[1;10]}\{(0{,}12+0{,}12)\mu_5(x)+(0{,}1+0{,}15)\mu_6(x)+(0{,}08+0{,}08+0{,}15)\mu_7(x)+0{,}08\mu_9(x)+0{,}12\mu_{10}(x)\}$ that means $IP \approx 0{,}31$. See *Figure* 5).

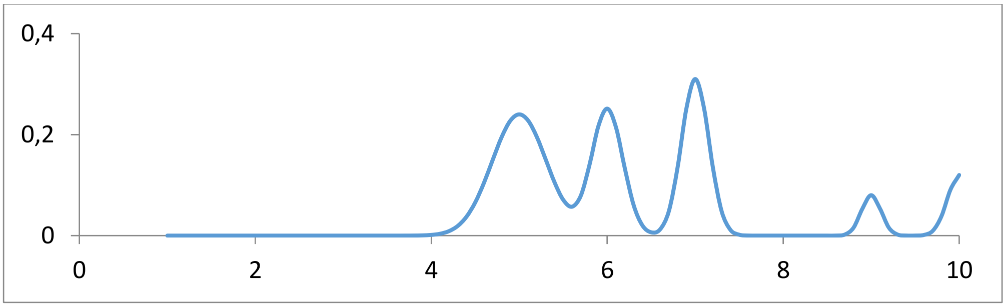

Figure 5 Figure 5 Individual profile (IP) of the learner is obtained by composing a linear combination of membership functions. See text for details. Source: Author´s own processing.

Now it is necessary to take into account the international and Russian ratings of MIPT (see, for example, timeshighereducation.com, raexpert.ru and students.superjob.ru) and the results of a survey of satisfaction with the education of graduates. Since the average rating for MIPT in Russia is the second (the lowering factor is 0,99), the first (the decreasing factor - 1) for the graduates' salaries and the satisfaction index was 0,95, then the overall decreasing factor will be 0,98. So, in this case, after two years of study at MIPT, the individual level of success in mastering the content of the educational program turned out to be equal to $\xi(2) = 0{,}98 \cdot 0{,}5 \cdot 0{,}31 = 0{,}1519$.

Here, the coefficient 0,5 is introduced, as the study of half of the educational program (two years out of four) is completed.

One of the aspects of implementing the modeling of educational processes implemented using modern information technologies was considered by the authors in the report prepared for the international conference IDIMT-2017 (Yablochnikov, Kuptsov, Yablochnikova, 2017). In this publication, in particular, it was concluded that the correspondence between the growth rate of the average assimilation of the educational material (the formation of the trainee's professional competences) and the corresponding values of variances is one of the fundamental patterns of the realization of a random educational process $\xi(t)$. This is largely due to the differences in the requirements for learning by the students of the educational program in individual higher education institutions and the adaptation of pedagogical techniques in accordance with these requirements. Due to the above mentioned fact, the task of effective management of the educational process can be formulated as ensuring the possibility of forming a set of relevant competencies in the shortest possible time.

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