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Edited by
Jan Ministr
Milena Tvrdíková

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FOREWORD

Conference on Information Technology for Practice 2015

Welcome to the 18th "Information Technology for Practice", held at Faculty of Economics VŠB-Technical University Ostrava. This conference (many years with international participation) has become a traditional meeting of IT experts coming from the practice and academic spheres. Providers and users of IT meet at the conference not only each other but also with IT students.

The conference is organized by Department of Applied Informatics of Faculty of Economics VŠB-TUO in cooperation with Czech Branch European University Information Systems (EUNIS-CZ) and Czech Society for System Integration (ČSSI), in collaboration with Karel Engliš Foundation.

In accordance with the development of the whole society and the rapid progress in information technology, this year's conference focuses on the following topics:

- IT Management
- Information Society and Trends in IT Education
- Information Security
- Process Management and its Support

We believe that you will find many papers interesting for you and also find opportunities to discuss these topics during the conference.

We wish you success in solving the problems connected with changes in the IT world and making new useful professional contacts.

On behalf of organizers,

Milena Tvrdíková October 2015

C O N T E N T S

IT MANAGEMET

Polish SMEs as Intelligent Organizations - Conditions of the ICT Support

Piotr Adamczewski[1]

Abstract. An active sector of small and medium enterprises (SME) in Poland is a prerequisite of a properly functioning market economy. This sector encompasses various companies. The ICT (Information and Communication Technology) can help even the odds. We have conducted a questionnaire-based survey to identify how polish SMEs perceive this phenomenon of Intelligent Organizations.

Keywords: Business Intelligence, ERP, ICT, Information Society, Intelligent Organizations, SME

JEL Classification: A23

1 Introduction

Over the last decades, information and communication technologies (ICT) have been the enabling factor in organizational change and innovation, and there is now evidence on their impact on industrial value chains. Organizations today strive to become agile and to operate profitably in an increasingly competitive environment of continuously and unpredictably changing markets. The digital age is different from the industrial age in various ways. For example, today ICT represent a substantial – and increasing – part of the added value of products and services.

Degree of popularization of practical application of ICT in all areas of human activity allows for assertion that we deal with a new stage of information technology support of enterprise functioning. According to the theory of American futurologist Alvin Toffler, evolution of humanity may be framed in the so-called three waves [Aydin, 2008], [Waltz, 2003]:

- first wave – agricultural revolution,
- second wave – industrial revolution,
- third wave – information revolution, were building of information technology society was initiated, and whose essence in the area of economic activity performed in the convention of e-business is constituted by e-companies.

[1] The Poznan High School of Banking PL, adamczewski@wsb.poznan.pl

The term „information technology society" refers to the society which not only possesses developed means of information processing and communication, but also those means are the basis for generating national income and provide sources of maintenance for the majority of society. Its characteristics may be presented in the following way (Adamczewski, 2010), (Dudycz, 2008), (Koronios, 2010):

- information becomes basic economic resource, means of income growth and accumulation as well as competitiveness (digital product),
- information, to a growing extent becomes a factor of social and political life,
- people absorb more and more information as consumers,
- the growing role of information is forced by fast development of the sector of communication means and services; political and economic entities-subjects use more and more information, which in turn forces expansion of this sector. Economic and social aspects of information technology society may be synthetically defined as:
- society is characterized not only by development of new technologies (particularly information technologies), but also new ways of labor management and organization, new professions,
- information sector in economy may be divided into subsectors, coping with, respectively: generating, processing and distribution of information,
- a basic dimension of economic changes in association with development of means of communication is globalization process; it is due to them that „shrinking" of time and space could occur, as the essence of globalization;
- information technology society is characterized by de-ranking of economic structures, which, among others, means moving away from Fordism and Taylorism,
- process of production and management decentralization takes place,
- virtual enterprises occur, banks for instance,
- network economy develops; logic of network has become an important element of now economy, characterized by ability to generate knowledge, transfer and manage information, and on its basis to undertake actions in real time on a global scale,

- network as a form of economic organization concentrates on executing specific business projects; the unit of production process is not a company, but a business project,
- logic of network refers also to the area of political activities, social relationships, human contacts (the so-called network individualism).

State of saturation with ICT solutions and advancement of construction of information technology society in Poland is illustrated by the list of indicators below (The Global Information Technology Report, 2015):

- 97% of Polish companies use computers in their activity and 95% of those have Internet access (of which 46% is broadband connection),
- 100% companies of financial sector use Internet in their business on daily basis,
- 84% of big companies apply wireless connections,
- more than 91% companies contact all authorities via Internet,
- 47% companies are provided with goods and services through e-commerce, but only 39% companies conducted e-sales.

2 Intelligent Organization in Information Society

An intelligent organization is the one, the activity philosophy of which is based on knowledge management (Adamczewski, 2014), (Kumar, 2007), (Quinn, 1992). This term was popularized in the 1990s due to growing development of ICT, dynamically changing economic surroundings and the growth in market competition. One may talk about a intelligent organization when it is a learning organization, having the capacity for creating, gaining, organizing and sharing knowledge and using the knowledge for the purpose of increasing the operation effectiveness and increasing competitiveness on the global market. The idea of such an organization meets the system approach to the organization, namely treating it as a complex organism based on existing structures and implemented processes, with particular emphasis on the role of knowledge. In this approach - called by P. Senge the "fifth discipline" owing to knowledge and relevant tools, all components of the organization and its staff are able to cooperate skilfully to implement defined objectives. Owing to this, the whole organization operates as an intelligent, well-functioning organism in competitive surroundings. He clarifies mutual relations among the methods of achieving goals, understanding them,

the methods of problem solving and internal as well as external communication.

The most important attributes characterizing intelligent organizations include, among others (Adamczewski, 2014), (Kumar, 2007):

- fastness and flexibility of operation,
- the ability to observe the environment,
- the ability to diagnose market signals early and react to changes he environment,
- the ability to implement new solutions based on knowledge quickly and, owing to this, to achieve economic benefits.

The growing volume of information used in an intelligent organization matches the increase in its importance. Peter Drucker already indicated that traditional production factors: ground, work, capital are losing importance to the benefit of the key resource, which in creative functioning of the organization is the knowledge; it constitutes intangible resources connected with human action, the application of which may be the grounds for gaining competitive advantage (Waltz, 2003). Knowledge may be treated as information placed in organizational context and the ability of its effective use in the organization's operation. This means that knowledge resources include data on customers, products, processes, environment etc. in a formalized form (documents, databases) and non-codified (the employees' knowledge).

In practical terms the fulfilment of effective cooperation of these elements means the necessity of the use of advanced telecommunication and ICT solutions within the framework of e-logistics. It uses both technical, technological and organizational innovations appearing over the recent years. They comprise nearly all areas of logistics activity, from the development of the means of transport and equipment, through the organization and management of material and raw material flow to the development of structures of systems performing logistics processes. The area of their operation is the implementation of virtual processes in the environment of extensive telecommunication and ICT networks (most frequently the Internet is the technological platform) aimed at the coordination and integration of business partners in the supply chain.

3 Activity of small and middle enterprises (SMEs)s

The activity of in an essential way was bound by the additional influence, as a result of central planned system transformation in a considered region, on systems of free-market economy. Although several years lasted from transformation processes being in Central and Eastern Europe, certain phenomena, called post-transformation phenomena, can still be observed, the results of which come down to increase the decisions uncertainty in post-transformation conditions, in relation to similar decisions in countries with developed economics.

Analysis of specific forming problems in all Central and Eastern European countries showed the importance of forming the following (Michna, 2006):

- rate of unemployment,
- extent of cooperation with other countries of considered region:
  - foreign trade with other countries of considered region,
  - scale of import from other countries of considered region,
  - scale of export to other countries of considered region,
  - scale of outlay on scientific researches,
  - scale of so-called 'grey sphere',
  - private property share in economy,
  - scale of country subsidies for economic actions.

According to experts, the sector of European SMEs is characterized by the absence of any vision or reflection over using analytical tools in business effectively or regarding information and knowledge as strategic and competitive assets. To improve this situation, ITC needs to be integrated with business, beginning with identification of business information needs.

The environment of SMEs can be described from the aspect of ICT investment, level of business organization and scope of strategic planning. These features are extremely important for setting the background basis for strategy, methods and tools for implementation of the enterprise information system. With regard to this, some important findings are described below [McGinnis, 2007], [Wang, 2007]:

- start-up investment is used for financing basic activities for market development and short-term business continuity management with the lowest margin possible. Planning horizon is low because

of a small-scale startup investment and applied production strategy. Business is done on the basis of short-termed forecasts,

- integrated enterprise information system is not implemented – a non-homogenous environment of different business applications, supporting individual business segments might cause data redundancy and threaten its integrity. Both could induce a risk of wrong or late information, needed for decision making,
- low margin strategy determines the way of doing daily business. Top priority is to remove short-term risks – all resources are involved in fulfillment of sales objectives, rather than cost reduction, which is the primary goal of business ICT applications,
- Less but more flexible workforce is capable of quickly adapting to business process re-engineering deliverables,
- web-based marketing and e-commerce practices are often applied, because they are less demanding regarding investments and workforce, unlike in the conventional marketing and sales activities. This approach enables the company to adapt quickly to web-based business process management, and particularly, B2B activities,
- lack of strategic risk management approach, caused by focused identification and resolution of short-term risks lowers the level of coordination towards fulfillment of business plan objectives.

4 ICT in knowledge management of intelligent organizations

Companies often use ERP (*Enterprise Resource Planning*) and knowledge management (KM) systems to facilitate company-wide business process improvement and innovation (Adamczewski, 2009), (Griffins, 2007). They mine, analyze, and package global best practices in ERP and KM databases, thinking it will be easy and efficient to share the information across their organization. It's not. Best practices almost always have to be adapted to local conditions, and data captured in ERP and KM systems rarely reflect these nuances.

Knowledge is considered as an enterprise's invisible assets. Surviving in today's highly competitive and ever expanding global economy requires

efficiently managing corporate knowledge. Increasing requirements for extended enterprises have stimulated the integration of knowledge management function into ERP systems for knowledge asset management. So far enterprise information systems such as ERP systems are developed and implemented for mainly managing physical assets of an enterprise since 1990s. Due to the fact that both types of assets need to be properly managed, the integration of KM and ERP becomes a strategic initiative for providing competitive advantages to enterprises.

Among many definitions of KM – knowledge management, for the needs of this study we shall adopt proposals put forward by the company Arthur Andersen and American Centre for Productivity and Quality. According to them, it is a process of identification, acquisition and application of knowledge, aiming at improvement of a competitive position of a company, supported by four factors: leadership, organization culture, technology and measurement system.

We may speak about five dimensions of knowledge (Magnier-Watanabe, 2009):

- know why – knowledge concerning strategy of a company, structure of its business processes and partnership associations,
- know what – knowledge concerning portfolio of products and enterprises executing key changes,
- know how – knowledge concerning portfolio of base technologies, level of their application in a company, architecture of the most important solutions and development trends,
- know when - main milestones showing a scenario of events in first three areas (why, what, how),
- know who – knowledge about resources associated with execution of scenarios in the area "what", includes both application of existing resources and a plan of creating new ones.

It maintains full reference to business knowledge, which consists of previously mentioned triad: data – information – knowledge in terms of applied resources and executed business processes in an enterprise.

Intelligent organizations, as economic system applying advanced information technology infrastructure in its internal organization and communication – also external – presently constitutes the essence

of functioning of information technology society in business areas. It practically means support of basic enterprise structures and execution of now economy concept in on-line mode with information technology, including [Hakkinen, 2008], [Wang, 2007]:

- level of technical (equipment) infrastructure,
- level of system and communication infrastructure,
- level of application software,
- level of business processes integration with external contractors of the enterprise.

Specific information technology ecosystem of an intelligent organization must be based on advanced solutions of ERP. Traditionally understood ERP systems as solutions of the enterprise integrating information technology infrastructure are not sufficient anymore. Their basic functionality has been enriched with Customer Relationship Management systems (CRM), Supplier Relationship Management systems (SRM), Supply Chain Management systems (SCM), and Product Lifecycle Management systems (PLM) (Adamczewski, 2009), (Dudycz, 2008).

Simultaneously, development of ERP systems aroused demand for information technology solutions defined as Business Intelligence. They mean no less than effective support of decision processes based on the so-called Business Analytics. It involves tools and applications for analyzing, monitoring, modeling, presenting and reporting data supporting decision making. To this purpose data warehouses, operational analyses of supply chains, analytical CRM and SRM systems, financial analyses and enterprise efficiency indicators are used. The users of such solutions are strategic levels of companies, based on certain data aggregates.

Application on a mass scale of Internet technologies in information systems has strengthened mechanisms of globalization of economic activities and integration of association chains between business partners. It is accompanied by information revolution in progress, whose task is to provide information necessary for effective support of corporation decisions. Those challenges may be matched only by the systems of ERP II class, with highly broadened functionality in comparison to ERP class. Business processes executed within their framework much exceed area of functioning of a single enterprise. They combine information flows

in the scope of integrated economic areas, involving business partners, financial and insurance institutions, science and research institutes and other links of the organization surroundings, applying internet technologies to this purpose, as well as electronic market mechanisms (among others internet auctions and exchanges) (Hakkien and Hilmola, 2008).

ERP II systems allow for expansion and deepening scopes and functionality of integrated solutions and for focusing on tasks which are strategically important for activities of an enterprise. They apply new business information technologies and categories of solutions, including: data warehouses and Business Intelligence class solutions (OLAP - OnLine Analytical Processing), Knowledge Management (KM), Advanced Planning and Scheduling techniques (APS), methods of assessment of Corporate Performance Management (CPM), Balanced ScoreCard (BSC) (Adamczewski, 2009), (Waltz, 2003).

Range of popularization of ERP systems in terms of information technology support of modern organizations allows for a thesis that they are perceived as an element of information technology architecture, which practically constitutes a condition of their effective functioning. ERP systems are subject to evolution, among others, under influence of new business demands, changes in information solution technologies and technical infrastructure. They are characterized by strong orientation towards building relations with clients and business partners and so-called system intelligence.

The scale of popularization of this class of information technology solutions in Poland is characterized by 14 per cent dynamics in scale of last two years, and prognoses in this scope are also optimistic, as ERP systems became a distinguishing factor of modern functioning of global economy organizations. This phenomenon can be also noticed in small and medium enterprises sector. They prove, in terms of quality, a new stage of informatization of Polish companies, where highly processed data (information) constitute a basis for knowledge management system. It mainly refers to ERP class and Business Intelligence solutions, which are applied in the framework of modern management methods in competitive market.

In the beginning of 2014 the author conducted a pilot questionnaire study in terms of degree of application of ICT technology SMEs of Wielkopolskie

(Province in Poland). The structure of registered total of more than 341 thousand enterprises in Wielkopolska is the following:

- 322 thousand (94,45%) of enterprises employing up to 9 people (micro enterprises),
- 15,5 thousand (4,54%) employing 10-49 people (small),
- 3 thousand (0,88%) employing 50-249 people (medium)[1]

Collected research material (in total 754[2] responses) allows for the following general conclusions:

- 98% enterprises have a permanent Internet access.
- type of Internet connection – nearly 52% use DSL connection, 23% – ADSL, 10% – ISDN, 9% – wireless connection, 6% – telephone modem,
- collocation is applied by 45% enterprises, and hosting – 28%,
- main areas of Internet application are marketing – 75%, business catalogues – 70%, partner programs – 55%,
- most frequently applied application software includes financial and accountancy domains, human resources, CRM, warehouses and fixed assets; in 34% ERP class systems are applied, and 5% of respondents admit to applying Business Intelligence class solutions,
- 82% enterprises apply e-supplies, a 50% – e-sales of their products and services,
- 38% enterprises indicated positive experience in terms of application of mobile systems (particularly in the sales area).

Quoted study results indicate a growing share of advanced information technology solutions in support of operational and tactical level of management of small and medium enterprises sector in Wielkopolska, including particularly ERP class systems. It also confirms strategies of the suppliers of those solutions, which imply offering pre-configured solutions in the scope of particular businesses. It is worth emphasizing that among main investment plans in terms of ICT the following were mentioned: ERP systems with elements of SCM (Supply Chain Management),

[1] There were 429 large companies in Wielkopolska, employing more than 250 people, which constituted 0,13% of total registered entities.
[2] Micro enterprises 399 (52,9%), small 254 (33,7%) and medium 101 (13,4%).

solutions of Business Intelligence Class, knowledge management and mobile systems.

5 Directions of ICT development in SMEs

Growing demands of competition in the sector of small and medium enterprises force companies to reach, to a growing extent, to more advanced information technology solutions, where ERP systems take a prominent place. Analysis of evolution of these systems indicates main directions of functional spread in construction of business processes in the framework of the entire logistic chain. This spread includes in the first place intelligent support of complex customer service and support of partner relationships in this chain. In order to execute those objectives the most modern information technology solutions are applied, which also involve wireless remote access to data bases and data warehouses of ERP base system.

Growing demands aimed at ERP systems generally result from functioning of real time enterprise (RTE), which is most fully executed on the ground of e-business solutions. Main development tendencies, which are already clearly outlined on the ground of solutions of this class, may be defined following:

- ever broader range of business services,
- full IT support of virtual structures,
- popularization of internet technologies (including corporate portals, network services and Web browsers as basic interface to ERP systems),
- broader application of mobile solutions, which shall enable access, for authorized users, to company information resources via medium of choice,
- switching to the component architecture,
- deepening functional and technological integration,
- automatic system configuration with its significant parameterization, which has impact on shortening of implementation process,
- broader application of data warehouses necessary for quick obtaining management information and knowledge management systems,
- complete openness to other segment solutions through integration with CAD/CAM systems, industrial automatics, GIS, GPS and other systems,

- fuller information technology outsourcing (including mainly ASP model and data centers).

ERP systems are subject to evolution under influence of, among others, new business demands, technological changes of ICT solutions, dynamic evolution of technical infrastructure. It is projected to ever more expanding functional structure of solutions. Modules from the scope of sales and distribution are expanded to the level of Customer Relationship Management (CRM), Supplier Relationship Management (SRM), and supply and manufacturing logistics becomes integrated in terms of Supply Chain Management (SCM).

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Since Internet network forces companies to build deeper relationships with customers, suppliers and partners, ERP systems become an attractive strategy both from the point of view of business itself and selection of used application software. It means necessity of gradual migration of ERP systems to ERP II,

and, at the same time – increase in adaptation abilities of companies exploiting them. Simultaneously, functionality of these solutions is expanded with BI applications, whose development tendencies are defined by:

- simplicity of application of these tools by the users, who are not ICT specialists,
- compliance of solutions with functioning strategy of a company, illustrating specific indicators in the form of the so-called manager cockpits,
- confidence in sources of data origin, and their streams (metadata) in the framework of entire information chain,
- innovation construed as ability to find new areas of application in terms of support of business decisions.

Evolving business needs and development of ICT technologies have greatest impact on development of information structure of intelligent organizations. Current economic situation, sharp competition between suppliers of these solutions and growing organization and information culture among management level also have influence on the shape of these solutions. It is even bigger, as more advanced ERP class systems are integrated with Business Intelligence solutions. It is directly projected to more effective information and decision processes, which constitute basis for now economy concept, which on the ground of modernly functioning companies is reflected by achieving and strengthening competitive advantage (Kumar, 2007).

Economic transformations and evolution of business relations cause devaluation of traditional sources of competitive advantage, such as capital, infrastructure, access to the market or quality of offered products and services. Intelligent organizations, in order to effectively compete on the market must assign crucial significance to flexibility of an organization and its ability to implement innovative business models and process reorganization. Examples of many Polish companies indicate that vision of a business managed in a modern way entered a dynamic execution stage, and, ultimately, effective knowledge management in intelligent organizations grows to the rank of a paradigm (Adamczewski, 2008), (Michna, 2006).

6 Conclusion

Pragmatics of implementation and exploitation of ICT in the sector of SMEs in Poland and performed deliberations allow for drawing the following general conclusions:

- building advanced ICT solutions becomes a distinguishing factor of intelligent organization,
- ERP systems constitute a key element in enterprise architecture of intelligent organization as a specific information technology ecosystem,
- dynamic evolution of ERP systems expands their functionality with SRM, PLM, CRM, SCM and BI modules,
- ERP create a basis of integrated information technology systems with advanced Business Intelligence (BI), which constitute a basis of ultimate knowledge management system in intelligent organization,
- ICT solutions cannot be based only on appropriate information technologies („hard" factors), but they also must take into account „soft" factors (organization culture, intellectual potential of personnel and their creativity), which, placed in rational organizational structures and effectively organized business processes constitute a condition of obtaining a desired synergy effect,
- increase in interest of companies in information technology solutions offered in SaaS models is clearly noticeable.

Statistics from the last year unequivocally confirm growing indicators of ICT solutions implementation in the sector of small and medium enterprises, which gives fair promise to Polish enterprises for their operations on global markets.

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References

Adamczewski, P. (2014) 'Functional Infrastructure of E-Logistics in Smart Organizations', *Proceedings of the IT for Practice 2014 - 17th International Conference on Information technology for Practice*, Ostrava, pp. 7-16.

Adamczewski, P. (2010) 'Rozwinięte systemy klasy ERP w inżynierii wiedzy', *Wiedza i komunikacja w innowacyjnych organizacjach. Systemy ekspertowe – wczoraj, dziś, jutro, pod red. J.Gołuchowskiego i B.Filipczyk.* Katowice, , pp. 232-238.

Adamczewski, P. (2009) 'Evolution in ERP – expanding functionality by BI-modules in Knowledge-based Management Systems'. *Information Management ICIM'09*. Gdansk, pp. 78-99.

Adamczewski, P. (2008) 'ICT in enterprise architecture of e-companies in light of studies on the sector of SME in Wielkopolska'. *AITM'08*. Research Papers, No. 35, Wroclaw: Wroclaw University of Economics, pp. 9-16.

Aydin, M.N. and Bakker, M.E. (2008) 'Analyzing IT maintenance outsourcing decision from a knowledge management perspective'. *Information Systems Frontiers*, Vol. 10.

Dudycz, H. (2008) 'Analysis of information systems in Polish companies and the realization of the business intelligence concept'. *AITM'07. Research Papers*, No. 8 (1208), Wroclaw: Wroclaw University of Economics, pp. 40-49.

Griffin, J. (2007) 'BI and ERP integration: Five critical questions'. *DM Review*, No. 17(5), 6-6. Retrieved August, pp.34-44.

Hakkinen, L. and Hilmola, O. (2008) 'Life after ERP Implementation'. *Journal of Enterprise Information Management*, Vol. 21, pp.67-88.

Design and Evaluation of Competency Model in the Purchase Department

Blanka Bazsová[1]

Abstract. This paper aims to establish the competency model of the purchase officer and to determine importance of individual groups of competencies represented in this model. Current practice requirements show that competency models are increasingly becoming part of evaluating the work of employees and significantly contribute to the objectification of the remuneration system and human resource management in the organization. Modern trends in human resource management progressively press for a comprehensive assessment of employees based on the networking the performance model with the competency model. Using Saaty´s matrix, the importance of each group of competencies represented in this model is determined and the competency models of the individual employees of the purchase department is performed are evaluated.

Keywords: Competency model, organization, purchase officer, weight

JEL Classification: M54, L25

1 Introduction

The organization currently faces the challenge to create a comprehensive model of performance evaluation based on performance indicators balance and competency models. These indicators create assumptions for achieving the strategic objectives of the company.

Contemporary modern trends of the employees evaluation indicate the necessity to take into account not only efficiency but also competence when evaluating the employee (Ministr, 2013). Evaluation of the employee is mostly performed by the superior. The performance of the employee is affected by several factors. These include working conditions, including salary or wages, management style, communication level, shared values, motivation, computer competences, experiences and others. For objectification of the performance evaluation it is important to have created transparent, uniform and proven performance measurement system. Performance in manufacturing organizations is demonstrable. Each organization has it set

[1] VŠB-Technical University of Ostrava/Deaprtment of Systems Engineering, 17.listopadu 15, 708 33 Ostrava-Poruba, blanka.bazsova@vsb.cz.

to suit the specific conditions and rules in force and valid in the organization. The most common forms of evaluation include assessment by the supervisor. Performance evaluation is closely linked to remuneration. In previous years, a huge debate ran about how to measure and evaluate the staff performance not only in organizations that provide products or services, but also in state and public organizations. The effort to standardize the criteria for measuring the performance of individual professions arose. Based on Government Regulation No. 222/2010, the so called catalogue of works valid for public services and administration was created, in which qualifying standards and evaluation standards required for the performance of a particular job are determined. For each position, a certain level of knowledge based on a numerical scale required. In addition, there is a list of authorized persons who may perform.

There is no uniform classification of competencies in the literature. Many authors (Hroník, Koubek, Wagnerová, etc.) distinguish general, expertise and specific competences. To hold a certain position it is important to have a choice from these three categories. The unique combination of these sub-competencies creates the so-called competency model. Competency model for a specific position should be written. Developing of the employees competences also becomes an opportunity for the personal and professional growth and development of the employee. Wagnerová (2008) provides the skills, knowledge, experience and motivation as the so-called "*personal determinants of performance*". The unique combination of competencies forms the culture of an organization that promotes learning and education deemed as an important business process by the top-level and line managers that are committed to it and that are permanently engaged in it (Armstrong, 2009).

Competence expresses suitability for a particular performance. This is the sort of assumption that the employee can perform the work at a specific position (Hroník, 2006). In addition to assessing by superiors, self-assessment is performed as well in many organizations. Koubek (2004) pointed out that it is necessary to be based on certain criteria for performance evaluation. These criteria contribute to the objectification of the evaluation and remuneration system. Competency model is important for creating the preconditions for the company competitiveness. It is based on permanent monitoring of capabilities, experience and skills of the employees. Together with

the performance model, it creates an integral part of the comprehensive evaluation of the employee performance. Managers and supervisors need to have an overview of the level and condition of these competencies for creating a corporate strategy that could affect the real possibility of its achievement. Competency models are a means to implement the strategy and its continuous verification. In order to enable the employees to realize the performance, they must have such prerequisites. Employees in matrix organization report their results to one functional manager (Řeháček, 2015).

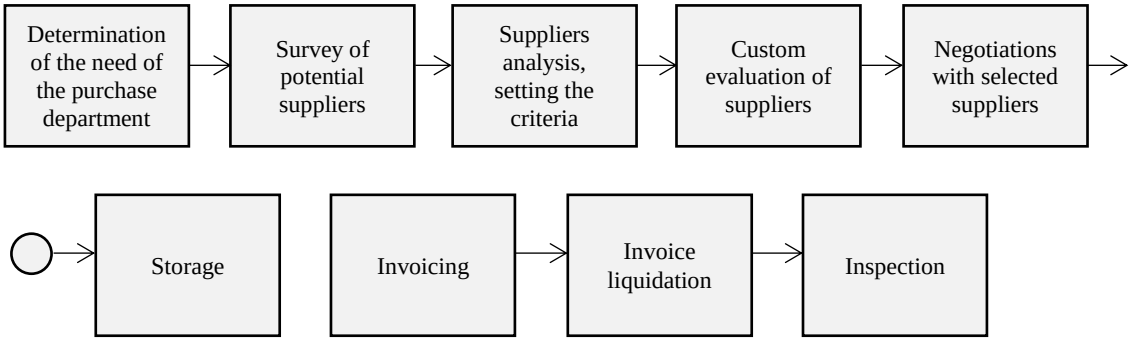

Figure 1 The process of material purchase

The following tasks are important for the purchase officer who ensures the purchase process:

- Ensuring the selection of suitable suppliers and providing optimal contract terms;
- Implementation of purchase with regard to stocks so that their condition was optimal and ensured the process of production;
- Management of complaints to suppliers;
- Obtaining current competing bids, following the development of competitive pricing;
- Timely implementation of data to the Information System;
- Ensuring the traffic conditions;
- Processing purchase contracts based on orders;
- Implementation of the evaluation of suppliers;

Figure 1 shows that, for the purchase officer, set of professional activities aimed to obtain information on suppliers of materials, semi-finished products

and products plays a key role, including their evaluation and negotiations with the suppliers.

2. Saaty´s matrix

Saatyś matrix is useful tool. It supports the evaluation of preferences among criteria. The criteria reflect the way how to solve problems which means the way of goal achievement. This matrix consists of preferences of a maker´s decision. The criteria can be expressed qualitatively and quantitatively (Fiala, Jablonský and Maňas, 1994). We compare preferences of criteria with each other. We can get information about preferences and criteria´s weight.

Saaty´s matrix is the quadrat matrix, $S = \{s_{ij}\}$, where i, j = 1, 2, …, n (Saaty and Vargas, 2001).

$$\begin{array}{c|cccc} & c_1 & c_2 & c_3 & c_n \\ c_1 & 1 & s_{12} & s_{13} & s_{1n} \\ c_2 & 1/s_{12} & 1 & s_{22} & s_{2n} \\ c_3 & 1/s_{13} & 1/s_{23} & 1 & s_{3n} \\ c_n & 1/s_{1n} & 1/s_{2n} & 1/s_{3n} & 1 \end{array} \quad (1)$$

We compare criteria each other and determine the preferences (Bazsová, 2015). The element of the matrix s_{ij} expresses the weights of i-th and j-th criterion. On the diagonal are displayed notes 1.

$$s_{ij} \approx \frac{w_i}{w_j}, \quad (2)$$

where w_i is weight of i-th criterion and w_j is weight of j-th criterion

Saaty uses the 9-escalate scale of the criteria evaluation (see table 1) (Saaty and Vargas, 2001).

Table 1 Saaty´s criteria evaluation

Value	Criteria Evaluation
1	Criteria are equaly significant
3	The first criteria is slightly more important than second criteria
5	The first criteria is strongly more important than the second criteria
7	The first criteria is very much greater important than the second criteria
9	The extreme importance of the first criteria than the second criteria

The Saaty´s matrix has 2 main attributes – reciprocity and consistency. The condition of reciprocity is considered as

$$s_{ij} = \frac{1}{s_{ji}} \tag{3}$$

Consistency is evaluated by ratio of consistency (CR). The value of the consistency must be CR ≤ 0,1, where

$$CR = \frac{CI}{RI} \ , \tag{4}$$

where RI is the random index.

When

$$CI = \frac{\lambda_{max} - n}{n-1} \approx \frac{w_i}{w_j} \ , \tag{5}$$

where λ_{max} is the own number and n is number of criteria.

We determine the weight of each criterion according to the geometric mean

$$w_i = \frac{\left(\prod_{j=1}^{n} s_{ij}\right)^{1/n}}{\sum_{j=1}^{n} (s_{ij})^{1/n}} \tag{6}$$

Saaty´s matrix is a part of the analytical hierarchical process (AHP). It is used in the strategic decision making very often. Hierarchical structure is a special type of the system, which is based on the assumption, that elements which are identified, are possible to group into a disjunction set, where elements of one group influence elements of another group and they themselves are influenced by elements of other group (Ramík and Perzina, 2008).

The focus of this paper is the set of competences the employee in the purchase department should have, and the importance assigned to each significance. On the basis of an expert assessment of the purchase manager, the importance for each group of competences and also within each group was determined. Also, calculation of the significance and evaluation of three employees of the purchase department was determined by the Saaty´s matrix.

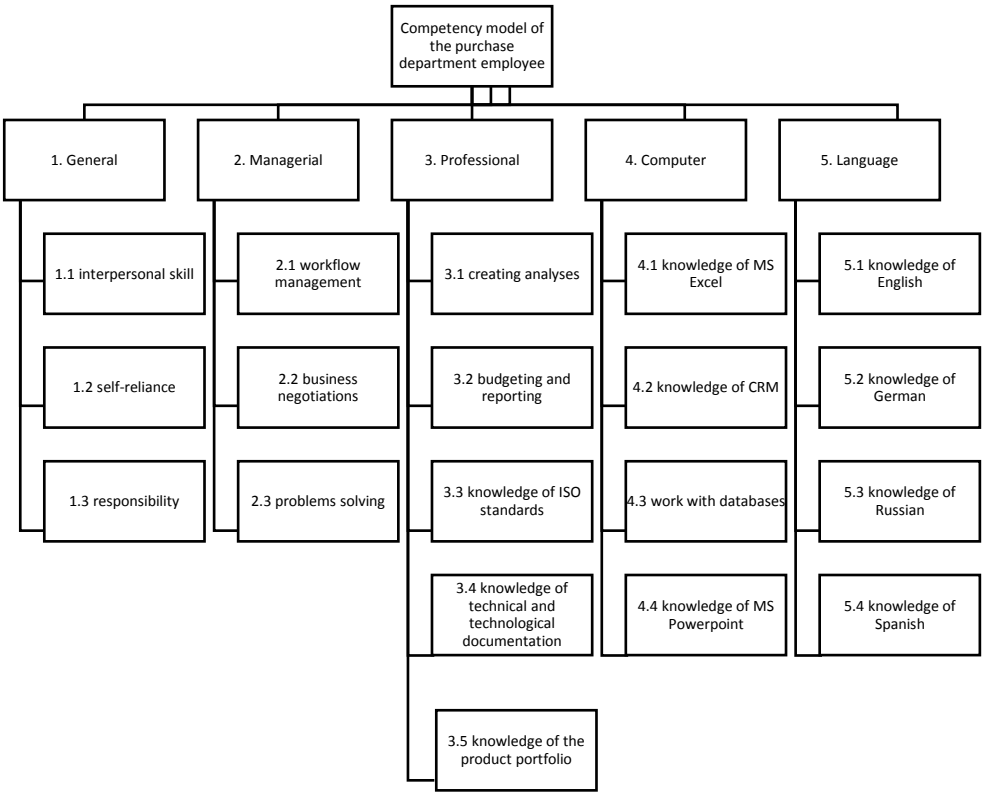

Figure 2 Design of the competency model of the purchase officer

3. Results and Discussion

Competences are divided into professional, managerial, general, computer and language groups. For the purchase officer the professional competences are very important, i.e. the competences for approving purchase contracts, purchase orders, contracts for work and invoices, change sheets. It is not enough just to name the competence, but it is necessary to determine its importance. For this purpose, the so-called competency model serves. The level of importance is adapted to the needs and requirements of each organization. The evaluation of criterions by Saaty´s matrix have been done by immediate superior – purchase manager (see table 2, 3, 4, 5, 6, 7, 8, 9).

Table 2 Main Groups of competences

Main groups of competences	General	Managerial	Professional	Computer	Language	Percentage	Weight
General	1	3	1/7	1/5	1/3	0.488	0.063
Managerial	1/3	1	1/7	1/5	1/3	0.314	0.040
Professional	7	7	1	7	5	4.435	0.570
Computer	5	5	1/7	1	3	1.600	0.206
Language	3	3	1/5	1/3	1	0.942	0.121

Table 3 General Competences

General competences	1.1	1.2	1.3	Percentage	Weight
1.1	1	7	5	3.27	0.7857
1.2	1/7	1	3	0.754	0.1812
1.3	1/5	1/3	1	0.138	0.0332

Table 4 Managerial competences

Managerial competences	2.1	2.2	2.3	Percentage	Weight
2.1	1	5	1/7	0.8939	0.2203
2.2	1/5	1	1/3	0.4055	0.0999
2.3	7	3	1	2.7589	0.6798

Table 5 Professional competences

Professional competencies	3.1	3.2	3.3	3.4	3.5	Percentage	Weight
3.1	1	3	5	7	5	3.4997	0.4913
3.2	1/3	1	5	3	3	1.7188	0.2413
3.3	1/5	1/5	1	1/3	1/5	0.3056	0.0429
3.4	1/7	1/3	3	1	1/5	0.4911	0.0690
3.5	1/5	1/3	5	5	1	1.1076	0.1555

Table 6 Computer Competences

Computer competences	4.1	4.2	4.3	4.4	Percentage	Weight
4.1	1	3	5	7	3.2011	0.5518
4.2	1/3	1	5	5	1.6990	0.2929
4.3	1/5	1/5	1	3	0.5886	0.1015
4.4	1/7	1/5	1/3	1	0.3124	0.0539

Table 7 Language competences

Language competences	5.1	5.2	5.3	5.4	Percentage	Weight
5.1	1	3	5	7	3.2011	0.5585
5.2	1/3	1	3	5	1.4953	0.2609
5.3	1/5	1/3	1	5	0.7598	0.1326
5.4	1/7	1/5	1/5	1	0.2749	0.0480

Table 8 Evaluation of main groups of competences

Groups of competences	Weight	Option 1	Option 2	Option 3	MAX
General	0.063	6.3	6.3	5.04	6.3
Managerial	0.04	1.6	2.4	4	4
Professional	0.57	25.65	45.6	57	57
Computer	0.206	17.51	14.42	20.6	20.6
Language	0.121	8.47	12.1	9.68	12.1
Total		59.53	80.82	96.32	100
Percentage		59.53%	80.82%	96.32%	

Table 9 Professional competences - evaluation

Professional competences	Weight	Option 1	Option 2	Option 3	MAX
3.1	0.4913	29.478	39.304	49.13	49.13
3.2	0.2413	9.652	24.13	14.478	24.13
3.3	0.0429	1.9305	3.432	4.29	4.29
3.4	0.069	6.9	4.83	6.21	6.9
3.5	0.1555	10.885	15.55	12.44	15.55
Total		58.8455	87.246	86.548	100
Percentage		58.85%	87.25%	86.55%	

The competency model of the purchase officer was created. It consists of five groups of competencies - general, managerial, professional, computer and language. To determine the significances of the competences, the Saaty´s matrix was used. From the selected spectrum of competences in the competency model, professional competences were selected and evaluated by the senior executive as the most important. Within the professional competences we can see the most.

4. Conclusion

The results of the evaluation using the Saaty´s matrix and multi-criteria decision show that for the manager is important that the purchase officer are competent in the area of analysis creating, knowledge of technical and technological documentation and the competences related to the knowledge of the product portfolio of the company. We can see, that the best competences were reached by employee no. 3 (see tab. 8). The best professional competences has employee no. 2 (see tab. 9). We can get the similar comparison for the purchase officer in the subordinated groups of competences.

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References

Armstrong, M. (2007) *Řízení lidských zdrojů. Nejnovější trendy a postupy*, 10th ed., Praha: Grada Publishing.

Bazsová, B. (2015) Use of Saatyś Matrix by Performance Employee Measuring at the University Department, *Proceedings of the 10th International Conference of Strategic Management and its Support by Information Systems.* Uherské Hradiště, pp.25 – 35.

Fiala, P., Jablonský J. and Maňas, M. (1994) *Vícekriteriální rozhodování*, Praha: VŠE v Praze.

Hroník, F. (2006). Hodnocení pracovníků, Praha: Grada Publishing.

Koubek, J. (1998) *Řízení lidských zdrojů. Základy moderní personalistiky*, 2nd ed., Praha: Management Press.

Ministr, J. (2013) The Influence of Human Resources on the IT Service Management. *In ITI 2013: proceedings of the ITI 2013: 35th International Conference on Information Technology Interfaces. Cavtat, Dubrovnik, Croatia*., pp. 323-328.

Ramík, J. and Perzina, R. (2008) *Moderní metody hodnocení a rozhodování*. Karviná: Slezská univerzita v Opavě.

Řeháček, P. (2015) ´Matrix Organization for Project Management ´, *Proceedings of the 10th International Conference of Strategic Management and its Support by Information Systems.* Uherské Hradiště, pp. 160-165.

Saaty, T. L. and Vargas, L. G. (2001) *Models, Methods, Concepts & Applications of the Analytic Hierarchy process*, Boston: Kluwer Academic Publishers.

Wagnerová, I. (2008) *Hodnocení a řízení výkonnosti*, Praha: Grada Publishing.

Analysis of Czech actors' cooperation network using Gephi

Josef Daňa[1], Jaroslav Ráček [2]

Abstract. Presented paper illustrates the possibility of constructing and analyzing properties of complex cooperation networks created from semi-structured data gathered from the internet. Additionally, basic concepts of network centralities as well as the usage of Gephi software are explained on the example of Czech actors' cooperation network.

Keywords: social network analysis, complex networks, cooperation, Gephi.

JEL Classification: C65, C88, D85

1 Introduction

Social network analysis is becoming increasingly popular technique for analyzing properties of various aspects of human "ecosystems", i.e. interaction of non-trivial amount of person in some environment (Ministr & Pitner, 2014). During recent years, studying such dynamic interaction on networks formed a basis for new interdisciplinary scientific discipline called Network Science or Complex Networks. In this paper, we would like to present an alternative approach to classic social network analysis and demonstrate the possibilities of Gephi tool widely used for analyzing complex networks.

In our last paper (Ráček, Daňa, Frištik, 2015), we presented the ARIO software and functionality of its modules allowing to analyze unstructured data and recognize personal relationships out of these data. Such software can be used, e.g., by police for security purposes – detecting network of persons participating in or cooperating on illegal activity. However, a network constructed this way can be further analyzed and visualized in order to obtain deeper understanding about the structure of the network and importance of its particular nods.

[1] Masaryk University Brno, Faculty of Informatics,
Department of Computer Systems and Communications, Botanická 68a, 602 00 Brno,
jdana@mail.muni.cz
[2] Masaryk University Brno, Faculty of Informatics,
Department of Computer Systems and Communications, Botanická 68a, 602 00 Brno,
racek@mail.muni.cz

2 Network centrality measures

When analyzing network structure, several measures regarding the nod importance are calculated. Given the fact that importance in the network is related to the measure of how many other nods are related to the particular nod of interest, the importance is therefore called centrality measure. The more important the nod is, the highest values of centrality measures it exhibits.

There are several network centrality measures that can be used for complex network analysis. Nevertheless, the most frequently used centralities (and those used for purposes of our analysis to be presented below) are degree centrality and betweenness centrality (Borgatti, 2005).

2.1 Degree centrality

Degree centrality is considered to be robust measure of network topology (Albert & Barabási, 2002). Degree of the nod refers to the amount of links with other nods – the more links, the higher value of degree. Intuitively, the degree centrality refers to the importance of the nod regarding its connectivity, e.g. a "social capital" when describing person and number of its connections to other person (Ministr, 2013).

In a directed network (i.e. we can identify a direction of the network flow – e.g. who is sending an email to whom), degree centrality measure can be distinguished into in-degree and out-degree. In-degree refers to the number of other nods pointing to the nod of our interest, e.g. when analyzing social network, high in-degree may refer to a person that is being contacted by a lot of other people. On the other hand, out-degree represents a number of other nod that the nod of our interest is pointing on, i.e. a person that is distributing or contacting many other people. Differentiating in-degree and out-degree may provide additional insight on the behavior inside a directed network.

2.2 Betweenness centrality

Betweenness centrality is a measure referring to the amount of shortest links from one part of the network connected to the other part of the network through the nod of our interest, see Figure 1 below:

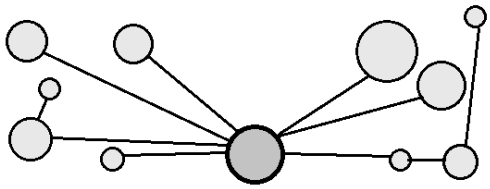

Figure 1 Illustration of nod with high value of betweenness centrality.

High values of betweenness centrality usually refer to a nod that bridges two (or more) otherwise unconnected or not directly connected parts of the network. In a social network, nods with high betweenness represent mediators or middlemen.

3 Gephi software

Gephi is an open source software tool for analysis and visualization of complex networks. It is able to calculate various centrality measures and visualize overall structure of the network, list of connections between nods being the only input.

When considering the network structure and properties, the overall appearance of the network is being weighted up, apart from centrality measures of important nods. Gephi uses several default algorithms for visualization of the network, while Force Atlas is the most commonly used. This algorithm is not deterministic, however, the overall appearance of the network can be often very similar when two or more instances of visualization are created. This is because distribution of nods in space follows simple, gravity like rules – nods repulse and edges attract, i.e. the more connections are between two nods, the closer they are to each other (Jacomy, Venturini, Heymann, Bastian, 2014). Therefore, multiple visualization of the same dataset produce similar results as the physical properties of the network remain the same.

Apart from visualizing structure, the Gephi tool is also able to represent datasets including time label and, consequently, analyze dynamics of evolving networks (Gephi.org, 2015).

4 Czech actors' cooperation network analysis

As a dataset used for purposes of complex network analysis demonstration using Gephi, we obtained information about Czech actors' co-occurrence in Czech movies from the ČSFD (Česko-Slovenská Filmová Databáze – Czecho-Slovak Movie Database), a Czech version of IMDB (The International Movie Database).

4.1. Gathering data

On ČSFR server, the data about movies and actors are already semi-structured into categories. For purpose of this analysis, we selected only movies of Czech/Czechoslovak origin from three time periods: 1930-1959, 1959-1989, and 1989-2015. Moreover, only 50 best rated movies according to ČSFD community from given period were taken into the calculation. As a result, we obtained four datasets: one from each of three above mentioned time periods and one overall dataset including all 150 movies from year 1930 to 2015.

For means of simplification, we concluded that all actors participating on a particular movie cooperated with each other, i.e. they created a fully connected graph, although they may not appear together in one scene during the movie.

In order to analyze data in Gephi, we had to create a list of unidirectional links from one node to another, if there was a connection. For that purpose, we took a list of actors appearing in given movie, create a fully connected graph out of them, and generated all links existing in this graph. Cumulating these links, we obtained a network of all actors appearing in movies of given time period.

4.2. Analyzing data and results

Each dataset was imported into the Gephi. Degree and betweenness centralities were calculated, and Force Atlas algorithm was used so that the overall structure and appearance of the network was generated.

The overall network consisted of $N = 1785$ nods, $E = 43453$ links, and average degree of a nod was $k = 24.34$. Structure of the network is displayed on the Figure 2 below, where diameter of the nod refers

to the degree centrality and hue of the nod refers to betweenness centrality (darker = higher value).

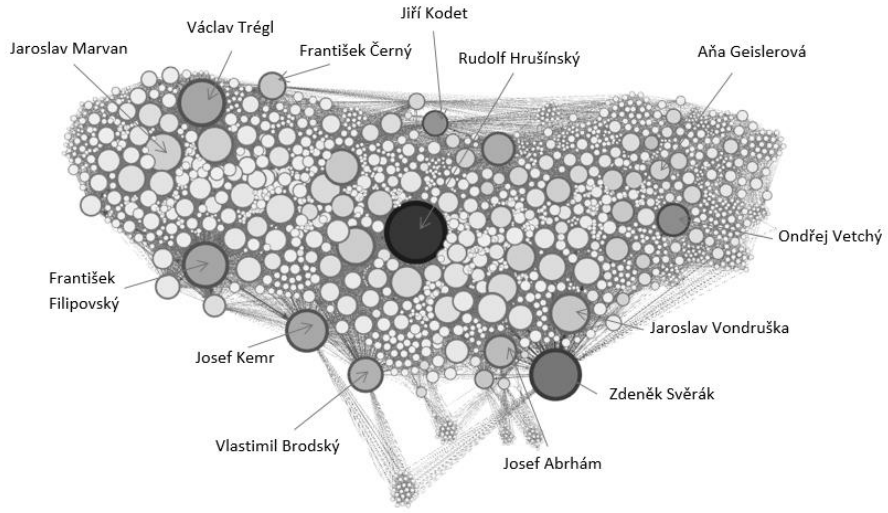

Figure 2 Overall structure of the actors' cooperation network with important nodes highlighted, Source: own.

In order to illustrate how cooperation network differs in structure and appearance, we present three network samples according to three time periods of movie history. Attributes that distinguish these networks are, e.g., density, structure, compactness, number of detached subgraphs or proximity of important nods (Figure 3).

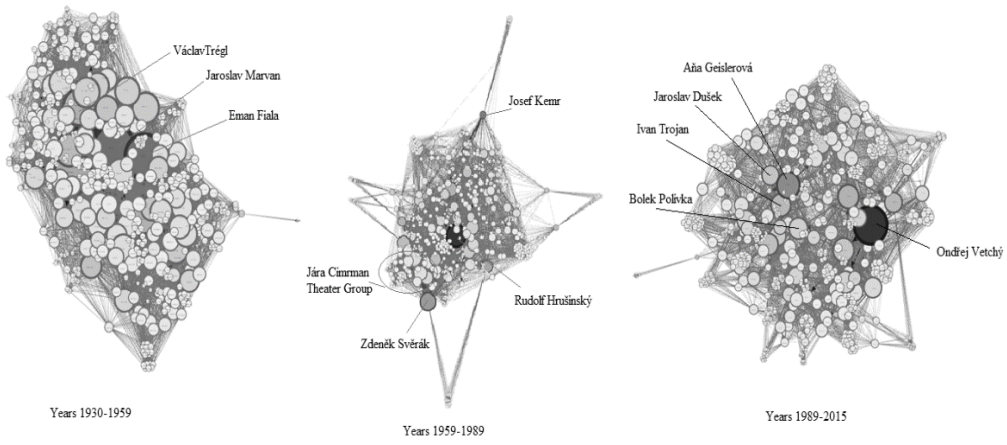

Figure 3 Network samples according to 3 time periods of movie history, Source: own.

5 Conclusion

Complex networks analysis is becoming widely acknowledged as powerful approach to studying structure and properties of systems, where there are numerous interacting agents in time. Gephi is suitable and frequently used tool for visualization of these networks and, as such, may provide additional layer of social network analysis.

As many of real life systems around us may be perceived as complex networks, recently emerging interdisciplinary field of network science and tools like Gephi may extend the possibilities of analyzing interacting networks. Network centralities are measures that highlight important nods in the network and, therefore, provide us with deeper insight about its properties and allow us to influence the network in a knowledgeable way.

References

Albert, R., Barabási, A-L. (2002). 'Statistical Mechanics of Complex Networks.' *Reviews of modern physics*. Vol. 74. pp 47-94.

Borgatii, S.P. (2005). 'Centrality and network flow.' *Social Networks*. Vol 27, Issue 1. pp 55-71.

Gephi.org (2015). 'Gephi. The Open Graph Viz Platform.' [Online], Available: http://gephi.github.io/

Jacomy, M., Venturini, T., Heymann, S., Bastian, M. (2014). 'ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software.' PLoS ONE 9(6): e98679. doi:10.1371/journal.pone.0098679

Ministr, J. (2013). 'The influence of human resources on the IT service management'. In *Proceedings of the International Conference on Information Technology Interfaces, ITI 2013*. Cavtat / Dubrovnik; Croatia, Czech Republic, pp. 323-328.

Ministr, J., Pitner, T. (2014). 'Towards an Ecosystem for Academic-Industrial Cooperation'. In *IDIMT-2014: Networking Societies - Cooperation and Conflict: 22nd Interdisciplinary Information Management Talks.* Poděbrady, Czech Republic. pp. 71-78.

Ráček, J., Daňa, J., Frištik, M. (2015). 'Personal Relationships Identification in Unstructured Data.*' Proceedings of the 11th international conference on Strategic Management and its Support by Information Systems 2015*. Uherske Hradiste, pp. 478-483.

SAP HANA, BIG DATA and In Memory Computing

Igor Kollár[1], Bohuslav Martiško[2]

Abstract. Main aim of the article is to explain basics of In Memory Computing and Big Data using SAP HANA platform. It is expected that these new technologies together with mobile technologies will improve management of a company in real time. Data returns back to operating memory, where they can be very fast and simple used by different applications, no need to move from hard disk to operating memory and therefore also programing processes will be changed. This speeds up data processing and enables manage enterprise in real time.

Keywords: In Memory Computing, SAP Hana, Big Data, Real time, Mobile technologies, Business processes.

JEL Classification: O33

1 Introduction

At the beginning of use of computer technology in everyday business practice in the second half of the 20th century data and programs was stored together in operating memory of PC. Capacity of operating memory was small and therefore programing was realized in machine code. Computing operations were relatively fast, because no mechanical units were used for data storage.

But the amount of data was increasing and operating memory was too small to store program and data together, therefore external storage units like magnetic tapes began to be used. External storage units had very large capacity (almost unlimited using sets of magnetic tapes) but were very slow. Data ware stored sequential, so that data access was very tedious. If a file was stored at more magnetic tapes, it was necessary to go through several magnetic tapes. These problems were solved with new storage unit – magnetic disc which is used to present day. It turned out that magnetic disc solved these problems only for "a certain time".

[1] Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Tajovského 10, 974 01 Banská Bystrica, igor.kollar@umb.sk
[2] Matej Bel University in Banská Bystrica, Faculty of Economics, Department of Quantitative Methods and Information Systems, Tajovského 10, 974 01 Banská Bystrica, bohuslav.martisko@umb.sk

At present magnetic discs seems to be “very slow” and it hinders real time data processing. Using new technologies the operating memory can be expanded up to several hundred terabytes. Thanks to this, we can go back to the beginning so data and programs can be stored together in operating memory. Using “old principle” and new technologies we can process big amount of data in real time.

2 IT in practice – current state

Currently are information systems in practice used “classic” way. Basic components of software platform of an information system are: operation system, database system, application server.

Important changes happened in hardware platform using virtualization. Information systems are not already running on a physical machines but a virtual one. We can say that every business area (BA), which management decides to automate requires implementation of a specific information system. This radically increases the number of software and hardware systems used in an enterprise, because every IS has its own operating and database system. Thanks to virtualization and centralization amount of HW systems can be reduced using one (or a few) high performance HW system.

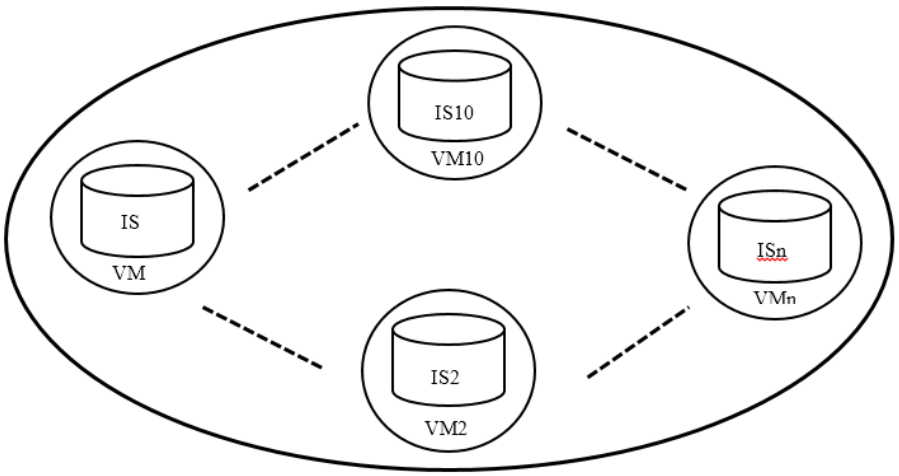

Figure 1 Large number of SW systems in an enterprise, Source: Own elaboration, 2015.

Figure 1 schematically shows the number of software systems in the enterprise. We can say that the higher is degree of automation within an enterprise, the higher is amount of SW and HW systems.

2.1 Big amount of information systems – big problem

To ensure functionality of such a big amount of information systems in enterprise datacenter requires not only high number of specialized staff but also other costs such as: software licenses, systems (processes) integration, security policy, specialized trainings, maintenance of HW and SW, development of HW and SW.

2.2 IS integration

Integration of processes and information systems is an essential requirement of the present time. Large software companies offer integration platforms. But in practice the number of SW and HW systems is rising, because there are also old information systems which cannot be integrated using integration platforms. The way out of this situation is a disturbance of specialized systems and replace them with specialized functionalities of one large complex information system.

Requirement No. 1 – consolidation of information systems

2.3 OLTP and OLAP as independent systems

Due to large amount of data, there are two groups of information systems: OLTP and OLAP. OLTP is used by standard user as a productive system and OLAP is analytical system used by management. Each of these systems has own source of data. Current relationship between transaction and analytical system displays Figure 2.

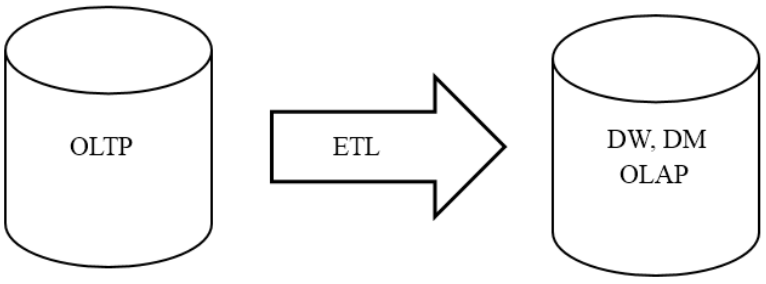

Figure 2 OLTP and OLAP, Source: Own elaboration, 2015.

OLAP contains mostly data from enterprise OLTP systems, sometimes also data from external sources are included. Data migration from internal and external information systems to multidimensional OLAP system is realized in batches, mostly during night. In a constantly accelerating business environment also one day old data can be considered as "historical". Therefore, only one up-to-data data source is required in practice. This data source should contains all company data, data from external sources, structured or unstructured. Database systems used so far did not allow collecting and processing in one system heterogeneous data that actually exist in an enterprise. ETL logic during transport of data from OLTP to OLAP automatically "add" for example missing dimensions. This in some cases reduced information value of original data.

Requirement No. 2 – one universal up-to-date data source (structured and unstructured data)

2.4 Disk drives – limits of mechanical systems

The speed of data save, read, search and processing has always been a very important issue, dealing mainly fundamental scientific disciplines such as physics and mathematics. Informatics then dealt with the technical implementation of their proposals. In the past magnetic tapes were replaced by hard drives and it brings great progress in IT, mainly fast access to data. But currently are hard drives speed to slow, and cannot be increased due to the limits of mechanical components. New discoveries in physics and thought patterns in mathematics currently allow us to use new technologies in practice. Capacity of operating memory can be increased up to the level of disk arrays and this affords opportunity to process all data in memory.

Requirement No. 3 – data in operation memory, hard drives backup

2.5 The challenge - management of selected business processes in real time

The business environment is significantly dynamic, processes ongoing in the company and its surroundings are radically faster. Therefore, the internal processes must follow these trends. The number of processes that should be managed in real time is increasing. Speed requirements for decision making in business processes is close to the speed of decision making in technological

processes. In many cases, the decision must be made immediately, if not then it is too late for any decision. Because of this increasing number of business processes must be managed in real time.

Requirement No. 4 – management of selected business processes in real time

3 New trends in IT practice

Information technology offers an answer to the above requirements in the form of "new trends" - BIG DATA, In Memory Computing and mobile technologies.

3.1 BIG DATA – universal data storage

Big Data offers opportunity for integration of many information systems used within an enterprise. There will be only one universal data storage and all information systems will access to required data. Structured and unstructured data (texts, photos, pictures, videos...) can be stored together (Mayer-Schönberger and Cukier, 2014).

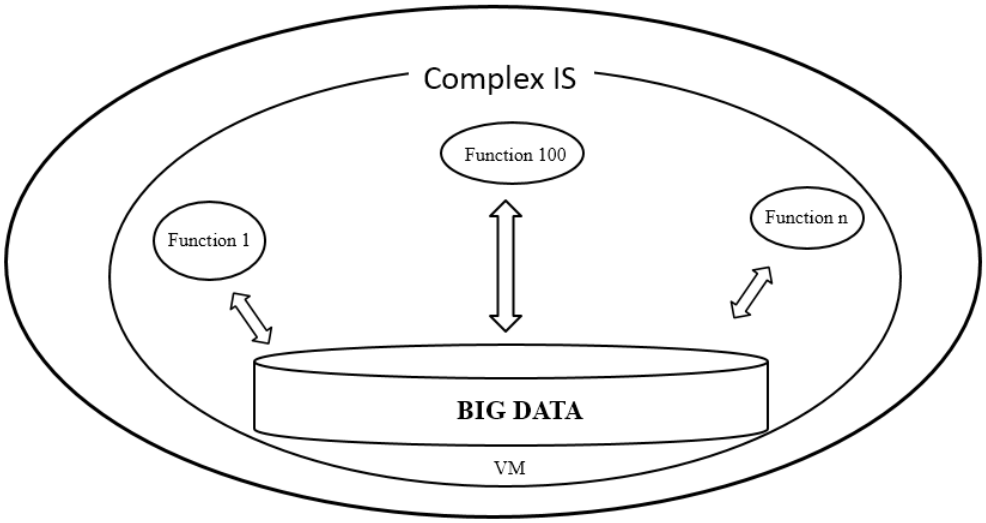

Figure 3 Big Data and unlimited amount of functionalities in complex IS, Source: Own elaboration, 2015.

Also a small enterprise can have big amount of data, depending on industry and automation of processes. Such a data structure is currently called BIG DATA. Integration of processes in an enterprise will be realized

using one complex information system with all required functionalities using one universal data storage. It means that only one dataset (structured and unstructured data) will be used, without data redundancy.

3.2 In Memory Computing

Big Data can be stored in operating memory, which significantly speed up processing of tasks, especially those with frequent data (disc) access (Select statement). Capacity of operating memory can be increased up to the level of disk arrays (up to several hundred terabytes). Data will be stored in operating memory in column-oriented database system. In details it is explained by Harizopoulos, Abadi and Boncz, (2009).

3.3 Mobile technologies

Already now we can see growing importance of mobile technologies in business processes. In the future we can expect even higher importance of mobile devices for management of an enterprise in real time. As static technology can be considered terminals (PCs) connected to the complex IS using fixed cable connection. This type of connection is mainly used today and will be used also in the future for typical office processes. But business processes should be implemented by means of mobile devices and real time data processing.

4 SAP solution and project at the Faculty of Economics, Matej Bel University

Each of the major hardware and software companies (IBM, ORACLE, Microsoft, HP, SAP, etc.) responds to current technological challenges and offers own solution for processing of Big Data in real time.

4.1 SAP S/4 HANA

SAP already introduced new complex information system SAP S/4 HANA, as a successor of the legendary SAP R/3. Functionalities of the IS are expanded not only by SAP, but also by partner companies. The transition from SAP ERP to SAP S/4 HANA will be gradual, divided into phases. Authors Plattner and Leukert (2016) describes the next generation of business applications in the innovative new SAP Business Suite 4 SAP HANA (SAP S/4HANA),

exploiting the revolutionary capabilities of the SAP HANA in-memory database. Up-to-date information about SAP S/4 HANA are available at official SAP HANA website (SAP, 2015).

4.2 Project at the Faculty of Economics, Matej Bel University

The aim of applied research conducted at Faculty of Economics, Matej Bel University in cooperation with companies will be to verify and to compare:

- Methodology of installation of SAP S/4 HANA,
- Migration of data from SAP ERP to SAP S/4 HANA,
- Compare outputs and response times for both systems,
- Additional test according to requirements of each company.

To solve those tasks, companies will participate during research. Research teams will be set for each task individually composed of company employees, students and teachers. Team size will be related to the complexity of the issue.

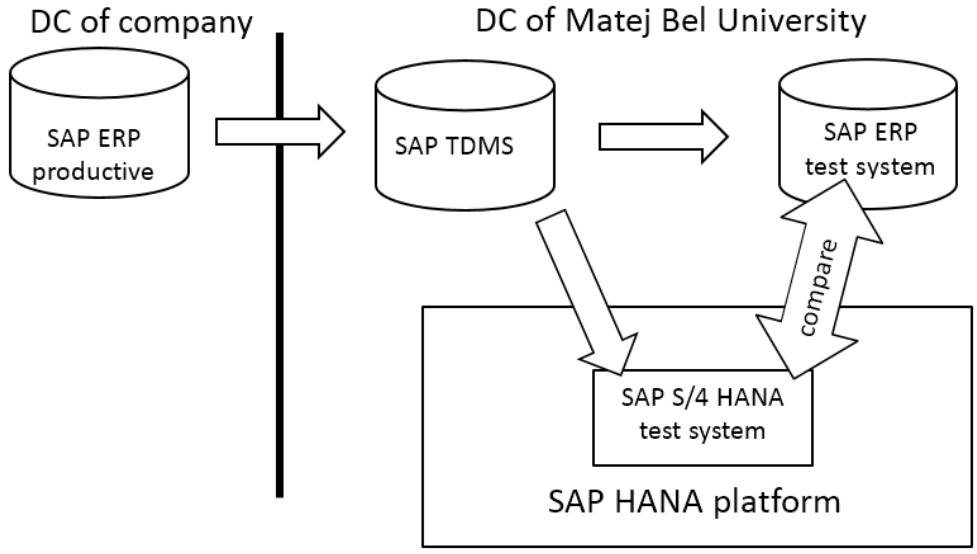

Figure 4 Project at Faculty of Economics, Source: Own elaboration, 2015.

5 Conclusion

In conclusion, we can state that the "old fashion is back." This phrase applies also in the field of IT, but only on principle, not on the technology. Data returns back to operating memory, where they can be very fast and simple used

by different applications. Data is no longer need to move from hard disk to operating memory and therefore also programing processes will be changed. This speeds up data processing and enables manage enterprise in real time.

Universal data storage which will hold all enterprise data (Big Data), structured and unstructured, allows to make better ad-hoc analysis and predictions in real time. In many solutions we have used inaccurate statistical methods, now we will be able to process quickly all data relate to specific task.

Widespread use of mobile technology allows us to be in touch with our company and to solve business problems in real time, even when we're on another continent.

References

Mayer-Schönberger, V. and Cukier K. (2014) *Big Data – Revoluce, která změní zpusob, jak žijeme, pracujeme a myslíne*, Brno: Computer press.

Harizopoulos, S., Abadi, D. and Boncz, P. (2009). *Column-Oriented Database Systems*, [Online], Available: http://www.cs.yale.edu/homes/dna/talks/Column_Store_Tutorial_VLDB09.pdf . [16 Sept 2015.]

Plattner, H. and Leukert, B. (2016) *The In-Memory Revolution - How SAP HANA Enables Business of the Future*, Springer International Publishing.

SAP (2015). *SAP Hana* [Online], http://hana.sap.com/abouthana.html. [16 Sept 2015.]

Accessing Databases from R for a Purpose of Data Mining

Jan Manďák[1]

Abstract. Nowadays companies are storing huge amount of data in databases. But unfortunately only a few of them are leveraging this "company welfare" to improve their processes or identifying new market opportunities. Data mining is a comprehensive and still growing subfield of computer science involving methods at the intersection of artificial intelligence, statistics, machine learning and database systems. The goal of the Data Mining is extracting information from data sets and transforming it into an understandable structure for further use. Probably the most used programming language for Data Mining among researchers and also professionals is R. The aim of this paper is to show the easiness of integration of databases and R statistical programming environment for the purpose of finding useful knowledge for improving companies' efficiency

Keywords: Data Mining, R, Databases, SQL, Clustering.

JEL Classification: C81

1 Introduction

It is known that SQL has limited numerical and statistical features. For example, it has no least squares fitting procedures. Also, the wide range of data types may have drawbacks when it comes to performing arithmetic calculations across a row, as some of the conversions from one numeric type to another may produce unexpected truncation and rounding. For these reasons, it may be desirable or even necessary to perform a statistical analysis in a statistical package rather than in the database. One possibility is to use Microsoft SQL Server 2016 (Eldersveld, 2015), because R is incorporated directly into SQL Server. But the drawback of this solution is the prize of MS SQL Server. Another way to do this is to extract the data from the database and import it into statistical software. If you are using e.g. free MySQL database, this paper should help you to utilize your data stored in your database and perform statistical/data mining analysis.

[1] VŠB-TU Ostrava/Faculty of Economics, Department of Systems Engineering, Sokolská třída 33, 701 21 Ostrava 1, jan.mandak.st@vsb.cz

The structure of the paper is as follows: firstly the data mining (process of solving data mining problems, frequent use cases) and R statistical programming language are briefly described. Secondly the process of integration of R and databases using package RODBC is introduced with examples of R scripts. Finally one data mining task - clustering - is applied to artificial data set.

2 Data mining using R

Data mining, interdisciplinary subfield of computer science, is the computational process of discovering patterns in data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems (Lantz, 2013). The purpose of the data mining process is to extract information from a data set and transform it into an understandable structure for further use. According to Cross Industry Standard Process for Data Mining (CRISP-DM), there are six phases of solving data mining problems (Shearer, 2000):

1) Business Understanding,
2) Data Understanding,
3) Data Preparation,
4) Modelling,
5) Evaluation,
6) Deployment.

It is necessary to pay attention to all steps of data mining project. In some cases, data pre-processing could take over 50% of the time of the entire data mining process.

Data mining is a huge field with applications to all sectors of economy. Among the most known data mining use cases belong (Zhao, 2013):

- clustering - segmentation of customers,
- classification - churn prediction,
- regression - prediction of continuous variable
- association rules - market basket analysis,
- time series prediction - forecasting of key performance indicators,
- text mining - sentiment analysis of social networks,
- anomaly detection - fraud detection,
- recommendation systems - next best offer.

As mentioned in the introductory section, one of the most used tool for data mining is R. R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. R language and environment was developed at Bell Laboratories (formerly AT&T, now Lucent Technologies) by John Chambers and colleagues. R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, etc.) and graphical techniques, and is highly extensible. The main advantages of R are the fact that R is freeware and that there is a lot of help available online. It is possible to use R as it is, but it is preferred to use R in combination with the RStudio interface (also freeware), which has an organized layout and several extra options.

3 Integration of databases and R

Why one should use relational database with R? You can use R to explore data and build predictive models. Relational database servers are designed to handle large amounts of data. Because data is usually stored in a normalized fashion in relational databases, you will likely need to recall some of your SQL skills to join the relevant attributes across multiple tables to perform your exploratory data analysis (EDA) tasks. You could also create some read-only views that would speed up the initial data analysis tasks. By default, R will read all of the data into memory before performing any analysis. Now let's show some R code how to connect to database from R and retrieve data to R. Please note that all the data are artificial.

In the following chunk of R code firstly RODBC package (Ripley and Lapsley, 2015) is loaded and then connection to the database is created. Using the connection we have just created, we can find out which tables are available. Finally we can read table from database and put the data to data frame.

```
# Install and load RODBC package

install.packages("RODBC")
library(RODBC)


# Create a connection to the database called "channel"

channel <- odbcConnect("DATABASE", uid="USERNAME", pwd="PASSWORD")
# Find out what tables are available (Optional)
```

```
Tables <- sqlTables(channel, schema="SCHEMA")


# Query the database and put the results into the data frame "dataframe"
dataframe <- sqlFetch(my_conn, "TableName")
```

If we don't want to select all data from a given table, we can use sqlQuery function to retrieve results of an SQL query to the database.

```
# Query the database and put the results into the data frame "df"
df <- sqlQuery(my_conn,
"SELECT StudentName, Subject, GradeLevel
FROM SCHEMA.Table1 t1
JOIN SCHEMA.Table2 t2
ON t1.StID = t2.StID
WHERE t2.SchoolYear = 2015
ORDER BY 2, 3")
```

In the RODBC package there is also possibility to create/update tables in databases directly from R using sqlSave/sqlUpdate function.

```
# Create table Table3 in the database
sqlSave(channel=my_conn, dat=data_frame, tablename=Table3, rownames=FALSE)


# Update table Table3 in the database
sqlUpdate(channel=my_conn, dat=data_frame, tablename=Table3, rownames=FALSE)
```

If we don't want longer to be connected to the database, we can close connection using odbcClose function.

```
# Close connection to the database
odbcClose(my_conn)
```

4 Example of data mining task

In this simple example of one of the data mining task - clustering, I have used an artificial set of student's grades from Economy and Statistics created in MS Excel using RANDBETWEEN function. In the script, the data are at first loaded from CSV file into R. Using package NbClust it is possible to determine optimal number of clusters, this package consists of 23 different indexes (Charrad et al., 2015). Because the first column is ID of student, we will use for the analysis only 2nd and 3rd column (grades from Economics and Statistics). Then we can proceed to k-means analysis and visualize the clusters.

```
# Load data from csv file into R
Grades <- read.csv("ittp.csv", header=TRUE, sep=";")

# Check whether the data are loaded correctly
View(Grades)

# Install package NbClust for determining optimal number of clusters
install.packages("NbClust")
library(NbClust)

# Function NbClust recommends us number of clusters according to 23 indexes
NbClust(Grades[,2:3], method="kmeans", min.nc=2, max.nc=5)

# Now we can perform k-means clustering
cluster <- kmeans(Grades[,2:3], centers=3)

# Plot the results in the scatter plot
plot(Grades$Statistics, Grades$Economy, col=cluster$cluster, pch=16,
main="Clusters of students", xlab="Statistics", ylab="Economy",
cex=1.2)

# Add a legend
legend(50, 100, pch=c(16,16,16), col=c("black", "green", "red"),
c("Cluster1", "Cluster2", "Cluster3"), bty="o", box.col="black",
cex=1)
```

The visualization of clusters is in the Figure 1. In this case we have identified 3 groups of students – students, who are good in Economy and Statistics (black points), students, who are very good in statistics, but weak in Economy (red points), and students somewhere in the middle – average in Economy and in Statistics (green points). Clustering can be (and in a lot of companies is) used for segmentation of customers, instead of grades of students one can use monetary value of customer's spending, frequency of purchases and recency of purchases (this analysis is known as RFM analysis). The result of this analysis are segments of customers, which can marketing department use for targeting specific marketing campaigns.

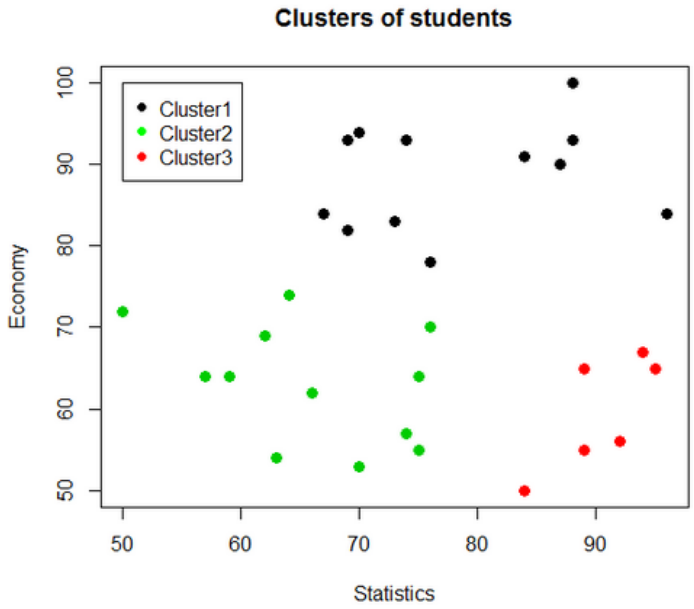

Figure 1 Visualization of clusters

5 Conclusion

The goal of this paper was to present the easiness of integration of databases and R and to present one of data mining use cases - clustering. Companies could find hidden value in their data stored in data warehouses, but it is necessary to perform data mining techniques. One possibility is use of R statistical programming language, which consists of many packages focused on all range of data mining techniques – regression, classification, clustering, time series modelling, association rules mining etc. There are of course different tools for data mining available, e.g. SAS, SPSS, Python

etc., but in my opinion the choice of R has two major advantages – it is free and it is supported by huge community e.g. at stackoverflow.com.

Acknowledgements

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References

Brian Ripley and Michael Lapsley (2015). *RODBC: ODBC Database Access. R package version 1.3-11*. http://CRAN.R-project.org/package=RODBC

Eldersveld, D. (2015) *Blue Granite*, [Online], Available: http://www.blue-granite.com/blog/5-reasons-microsofts-r-integration-in-sql-server-will-be-revolutionary [12 Sep 2015]

Malika Charrad, Nadia Ghazzali, Veronique Boiteau and Azam Niknafs (2014). *NbClust: NbClust package for determining the best number of clusters. R package version 2.0.* http://CRAN.R-project.org/package=NbClust¨

LANTZ, B. (2013) *Machine learning with R*. Birmingham: Packt Publishing.

Shearer, C. (2000) 'The CRISP-DM model: the new blueprint for data mining', *Journal of Data Warehousing*, vol. 5, no. 4, pp. 13—22.

ZHAO, Yanchang. (2013) *R and data mining: examples and case studies*, 1st ed., Boston: Academic Press, an imprint of Elsevier.

RBF Neural Networks for Time Series Modelling and Forecasting

Dusan Marcek[1], Martin Jurasek[2]

Abstract. In this paper the classic and soft radial basis function (RBF) neural networks are modified by Gaussian cloud concept. We concern with learning aspects of granular RBF networks. We also compare the results from the granular network with that from classic and soft RBF networks. As an illustration, we consider the case study related to task of time series forecasting.

Keywords: Forecasting models, machine learning, RBF neural networks, time series analysis and forecasting.

JEL Classification: C13, C45, D81, G32

1 Introduction

In this paper we show how to join together two techniques – fuzzy systems and neural network to estimate input-output function of systems. These techniques seem at first quite different but that in many engineering tasks share the common ability. For instance both estimate functions from sample data. Statistical approaches also estimate functions but they require that we guess how outputs functionally depend on inputs. Neural and fuzzy systems are numerical model-free estimators. Their learning algorithm converts numerical inputs to numerical outputs. The reader is referred to literature Kosko(1992), Marcek (2003) as examples of the above-mentioned approaches. This approach was applied to sales forecasting of a company. A new model of neural networks have been studied with complex (granules) activation (membership) functions which finally resulted in the methodology of granular computing.

The paper is organized as follows. Section 2 briefly present basic notions of fuzzy additive systems and RBF neural networks. Section 3 introduces the architecture of granular networks. Section 4 compares the RBF neural nets with a statistical model applied to wages time series modelling and forecasting. Section 5 concludes the paper.

[1] VŠB-TU Ostrava/Department of Applied Informatics, Sokolská 33, 701 21 Ostrava, Czech Republic, dusan.marcek@vsb.cz
[2] VŠB-TU Ostrava/Department of Applied Informatics, Sokolská 33, 701 21 Ostrava, Czech Republic, martin.jurasek.st@vsb.cz

2 Fuzzy and neural function estimators

Neural networks as well as fuzzy systems can estimate the input-output function of complex systems without requiring a mathematical description of how output functionally depends on the output. Fuzzy systems (see Figure 1) estimate functions with fuzzy sets samples (A_i, B_i). The fuzzy system maps input fuzzy sets A to output fuzzy sets B. The fuzzy inference computes the output fuzzy sets B_i, weights them with the weights w_i, and sums to produce the output fuzzy set B, i.e.

$$B = \sum_i w_i B_i \ . \tag{1}$$

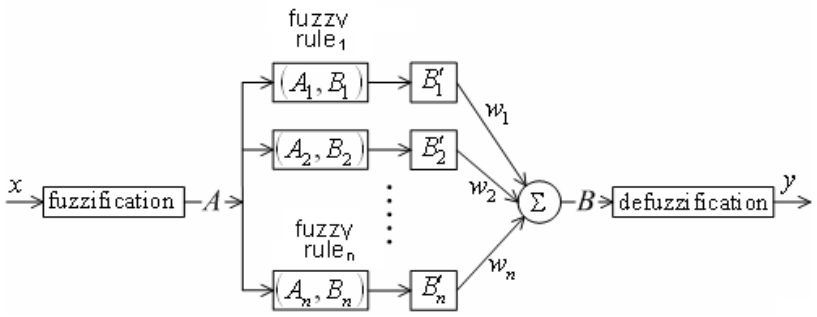


Figure 1 Additive fuzzy system, Source: own.

The fuzzy system is distributed and consists of a series of separate fuzzy rules (relations) of the type of *if* A_i *then* B_i. Centroidal output converts fuzzy sets vector B to a scalar. The most popular centroidal defuzzification technique uses all the information in the fuzzy distribution B to compute the crisp y value as the centroid $\tilde{y}$ or centre of mass of B, i.e. $\tilde{y} = \int_{-\infty}^{\infty} y\mu_B(y)dy \,/\, \int_{-\infty}^{\infty} \mu_B(y)dy$, where μ_B represents the union of all clipped output fuzzy sets. When the output membership functions are singletons, then, in the case of a $\Re^k \to \Re$ function, last formula becomes

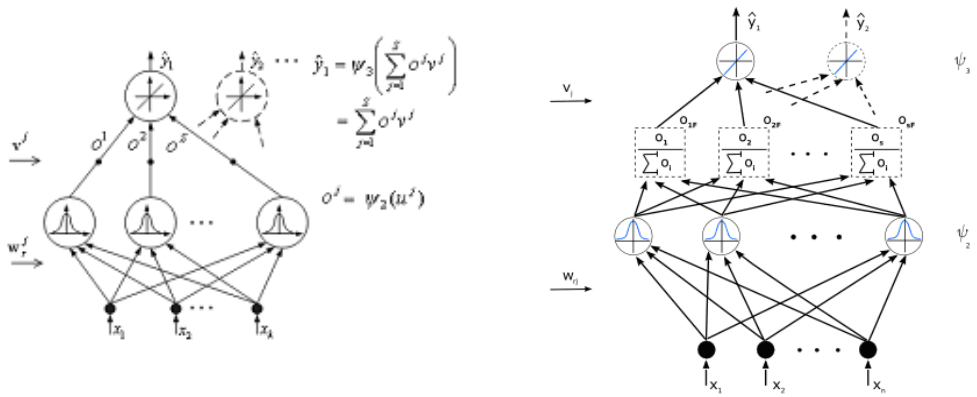
$$\tilde{y} = \sum_{j=1}^{n} y_j \mu_j(x) \,/\, \sum_{j=1}^{n} \mu_j(x) \tag{2}$$

where y_j stands for the centre of gravidity of the *j*th output singleton, the notation μ is used for a membership function and *n* denotes the number of rules.

Soft RBF neural network structures are used to perform fuzzy logic inference for fuzzy systems (see Kosko(1992), Marcek (2007)). We propose the neural architecture according to Figure 2 (b) whereby the a priori knowledge of each rule is embedded directly into the weights of the network.

In classic RBF network (Figure 2 (a)), each circle or node represents the neuron. This neural network consists an input layer with input vector $\mathbf{x}$ and an output layer with the output value $\hat{y}_t$. The layer between the input and output layers is normally referred to as the hidden layer. The output signals of the hidden layer are

$$o_j = \psi_2(\|\mathbf{x} - \mathbf{w}_j\|) \tag{3}$$



(a) **(b)**

Figure 2 Classic (a) and fuzzy logic (soft) (b) RBF neural network architecture, Source: own.

where $\mathbf{x}$ is a *k*-dimensional neural input vector, $\mathbf{w}_j$ represents the hidden layer weights, ψ_2 are radial basis (Gaussian) activation functions. Note that for an RBF network, the hidden layer weights $\mathbf{w}_j$ represent the centres $\mathbf{c}_j$ of activation functions ψ_2. The output layer neuron is linear. The RBF network computes the output data set as

$$\hat{y}_t = G(\mathbf{x}_t, \mathbf{c}, \mathbf{v}) = \sum_{j=1}^{s} v_{j,t}\, \psi_2(\mathbf{x}_t, \mathbf{c}_j) = \sum_{j=1}^{s} v_j o_{j,t}, \qquad t = 1, 2, ..., N \tag{4}$$

where N is the size of data samples, s denotes the number of the hidden layer neurons.

If the scalar output values $o_{j,t}$ from the hidden layer will be normalised, where the normalisation means that the sum of the outputs from the hidden layer is equal to 1, then the RBF network will compute the "normalised" output data set $\hat{y}_t$ as follows

$$\hat{y}_t = G(\mathbf{x}_t, \mathbf{c}, \mathbf{v}) = \sum_{j=1}^{s} v_{j,t} \frac{o_{j,t}}{\sum_{j=1}^{s} o_{j,t}} = \sum_{j=1}^{s} v_{j,t} \frac{\psi_2(x_t, c_j)}{\sum_{j=1}^{s} \psi_2(x_t, c_j)}, \quad t = 1, 2, ..., N \tag{5}$$

The similarity of approximation schemes (5) and (2) is obvious. From these schemes is shown that the weights $v_{j,t}$ in Eq. (5) to be learned correspond to w_i in Eq. (1), and $\psi_2(./.)$ to $\mu_B(y)$ in Eq. (2). Thus, the adaptive fuzzy system uses neural techniques to abstract fuzzy principles and to choose the weights w_i, and gradually refine those principles as the system samples new cases. These properties were firstly recognised by Kecman (2001). In Fig. 1 (b), the network with one hidden layer and normalised output values $o_{j,t}$ is the fuzzy logic model or the soft RBF network.

The frequently used learning technique uses clustering to find a set of centers wich more accurately reflect the distribution of the data points. For example by using K-means clustering algorithm, the member of K centers must be decided in advances. If the estimated output for the single output neuron is $\hat{y}_t$, and the correct output should be y_t, then the error e_t is given by $e_t = y_t - \hat{y}_t$ and learning rule has the form

$$v_{j,t} \leftarrow v_{j,t} + \eta\, o_{j,t}\, e_t, \qquad j = 1, 2, ..., s; \quad t = 1, 2, N \tag{6}$$

where the term η is a constant called the learning rate, $o_{j,t}$ is the normalised output signal from the hidden layer. The supervised learning will by also alternatively realized in a Petri net.

3 Granular RBF network

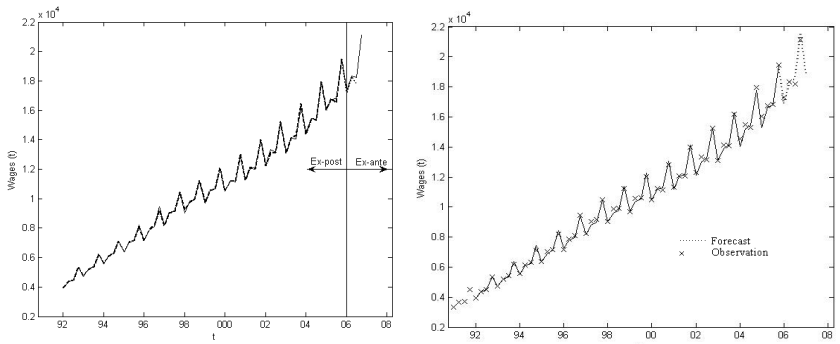
Next, to improve the abstraction ability of soft RBF neural networks with architecture depicted in Fig. 1, we replaced the standard Gaussian activation (membership) function of RBF neurons with functions based on the normal cloud concept Yao (2005), (Li and Du, 2008), (Changyu, 2005). Cloud models are described by three numerical characteristics.Expectation (*Ex*) as most typical sample which represents a qualitative concept, Entropy (*En*) as the uncertainty measurement of the qualitative concept and Hyper Entropy (*He*) which represents the uncertain degree of entropy. Then, in the case of soft RBF network, the Gaussian membership function $\psi_2(./.)$ in Eq. (5) has the form

$$\psi_2(\mathbf{x}_t, \mathbf{c}_j) = \exp\left[-(\mathbf{x}_t - \mathrm{E}(\mathbf{x}_j)/2(En')^2\right] = \exp\left[-(\mathbf{x}_t - \mathbf{c}_j)/2(En')^2\right] \quad (7)$$

where En' is a normally distributed random number with mean En and standard deviation He, E is the expectation operator.

4 Neuronal vs. statistical comparison for time series modelling and forecasting

To illustrate the statistical (econometric) modelling methodology, consider the wages time readings $\{y_t\}$ of the Slovak economy. The quarterly data were collected for the period JAN 1, 1991 to DEC 31, 2006 which provides total of 64 observations (displayed in Fig. 3 (a)). The sample period for analysis y_1, ..., y_{60} and the ex post forecast period (validation data set), y_{61}, ..., y_{64}.



(a) (b)

Figure 3 Nominal average wages (a) (January 1991 - December 2006) and forecasts of wages data (b). See text for details, Source: own.

In the case of statistical (econometric) modelling methodology the following reasonable model

$$y_t = 0.23935 + 1.04044\, y_{t-4} + e_t, \qquad \text{MSE}_A = 0.0026,\ \text{MSE}_E = 0.0033 \quad (8)$$

where e_t are residuals.

In the RBF neural network framework, the non-linear function was estimated according to the expressions (3) and (4). In the case of RBF fuzzy logic network, the non-linear input – output approximation function was estimated according to the formula (6). In the case of granular RBF networks, the non-linear input – output approximation function was estimated according to the formula (7). In Table 1, we give the achieved results of approximation ability in dependence on various number of RBF neurons. The mean square error (*MSE*) was used to measure the approximation ability. As can be seen from Table 1, our empirical results confirm that granular RBF networks have indeed a forecasting power: if anything, it seems that they manage to forecast better than others architectures and better than the B-J (statistical) approach.

Table 1 Out-of training data set forecast performance ex-post prediction results of various RBF´s networks related to the different number of clusters.

Neural network architectures:	Gaussian (classic RBF network)	Gaussian with normalised outputs (soft RBF network)	Gaussian soft RBF (with normal cloud concept – G RBF NN)
Number of RBF neurons	RBF network representation for model (10)		
	MSE_E		
3	2,484	0.380	0.018
5	2.111	0.299	0.008
10	1.688	1.878	0.123
15	1.799	0.180	0.262

5 Concluding remarks

In this article, we have extended RBF neural network methodology to approximate the non-linear time series data using normal cloud models in the role of standard Gaussian activation (membership) function for RBF neurons. To approximate the input-output function of an economic process, the RBF neural network approach was applied on the quarterly data of average

nominal wages of the Slovak economy and compared with an approach based on the statistical procedures. Using the disposable data a very appropriate model is the soft RBF network with activation functions based on the granular concept. It is also interesting to note that the most computationally intensive models, the model based on the Box-Jenkins methodology, is newer considered “best”.

The method may be of real usefulness in practical applications, where the expert usually can not explain linguistically what control actions the process takes or there is no knowledge of the process. In principle a neural network can derive this knowledge from data. In practice this is usually necessary. Although the method has been carried out in the time series modelling field, it is suitable for other applications as data mining systems, information access systems, etc.

Much of the cloud RBF neural networks, we still not understand. For instance, the empirical results suggest that the granular network is indeed capable of discovering the basic structures underlying a set of noisy data. But how precisely does this relate to its sensitiveness to expectation when the number of clusters is increased. We were expecting that the accuracy of ex post forecasts increases when the number of clusters (RBF neurons) increases. This is not truth for Gaussian RBF network with normal cloud concept and soft RBF one with 15 RBF neurons. Does it mean overfitting? Can we find minimal number of RBF neurons (i.e. minimal model complexity) that is able to represent real deterministic structure? This is generally a very hard problem. We shall continue our research in this direction.

Acknowledgements

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References

Changyu, L. (2005) ´*Normal cloud model and their interpretation. Proceedings of Eleventh International Fuzzy Association World Congress – Fuzzy Logic, Soft Computing and Computational Intelligence´*, Beijing, China 25th - 27th July 2005, 1540

Kecman, V. (2001) *Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy logic Models*. Massachusetts Institute of Technology, The MIT Press.

Kosko, B. (1992). *Neural networks and fuzzy systems a dynamic approach to machine intelligence*. Prentice Hall, Inc.

Li, D., and Du, Y. (2008). *Artificial intelligence with uncertainty*. Boca Raton: Chapman & Hall/CRC, Taylor & Francis Group.

Marcek, D. (2003) ´Determination of Fuzzy Relations for Economic Fuzzy Time Series models by Neural Networks´. *Computing and Informatics*, Vol. 22, pp. 457-471.

Marcek, M., Marcek, D. (2007) ´RBF Neural Network Implementation of Fuzzy Systems: Application to Time Series Modeling´. In. *Aijun An et al* Eds.:*RSFDGrC 2007 , LNAI 4482*, Springer Verlag Berlin, pp. 500-507.

Yao, Y.Y. (2005) ´Perspective of Granular Computing´ *Proceedings of IEEE International Conference on Granular Computing*, pp. 85-90.

Corporate Reporting and Corporate Informatics in the Context of Planning Tasks

Milos Maryska[1], Petr Doucek[2]

Abstract. The goal of the article is to provide key information that affects the design and creation of reports in planning tasks in corporate informatics. The article identifies the main planning tasks handled by corporate informatics as well as reports connected with planning. The article describes the basic tasks, the individual phases of the planning process and the entire planning process from the planning perspective. The article identifies the main dimensions that should be taken into consideration in a given report. The entire proposal takes into consideration the needs of the Reference Model of Optimization of Cost Allocation and Profitability (REMONA).

Keywords: Remona, Cost Allocation, Model, Profitability, Business Intelligence, Corporate Performance Management

JEL Classification: M15, M21,

1. Introduction

Many modern organizations perform their activities in an environment that keeps changing and is unstable. If they want to offer their customers interesting products and services both in the short-term and long-term, they must take into account not only their customers' requests but also often very different requests of the owners, managers, suppliers, employees and other entities involved in the functioning of the organization.

In order to actually recognize these requests, it is necessary to correctly understand the expectations and needs of different entities as well as what the organization does to meet these expectations and needs and whether or not the organization does it in a sufficiently good and effective manner.

New disciplines, techniques and approaches – such as managerial accounting, Balanced Scorecard, cost allocation based on activities (Activity Based Costing, Corporate Performance Management – CPM) etc. – were created or further developed in order to better understand the functioning of an organization, to ensure that procedures and activities are performed more

[1] University of Economics, Prague, Department of Information Technologies, W. Churchill sq. 4, Prague, Czech Republic, milos.maryska@vse.cz
[2] University of Economics, Prague, Department of Systems Analysis, W. Churchill sq. 4, Prague, Czech Republic, doucek@vse.cz

effectively and to better satisfy the needs of customers. An increasing complexity of handled tasks and the higher demands, requests and expectations of the entities involved in the functioning and performance of an organization led to higher demands on managers and on the accuracy and correctness of their decisions. This logically also led to higher demands on the quality of information, based on which the decisions of managers are made.

This trend is reflected in the world of information technology as well, specifically in Business Intelligence (BI) that is quickly and dynamically developing and provides organizations with a potentially powerful tool that, besides other things, makes it possible to look at data from different perspectives and at a different level of details. BI can thus provide organizations with needed information and considerably contribute to more effective decision-making, which can fundamentally improve the functioning and running of the entire organization.

Reporting, as a part of BI, represents an imaginary link in the chain that connects the process of data acquisition, processing and transformation on one hand and data analysis and presentation on the other hand. Therefore, reporting tools, their quality and the quality of outputs that can be obtained by reporting tools play a very important role in the entire decision-making process and for this reason, it is important to pay sufficient attention to them.

Reporting represents a part of the solution that can be included in the entire BI architecture, specifically in the layer of analytical tools.

The role of reporting is to provide information for decision-making at all levels of the organizational structure in a suitable form, on time and often on a regular basis (Lacko, 2009) as well as answers to such questions as “What is the situation of the firm or affiliate branch?,” ‘Why is it like this?,” Where is the money?,” “How were the transactions made?,” “What was the result of this step?.”

In a narrow sense, reporting can be considered a set of activities, the purpose of which is to allow creating questions in databases, using standard interfaces. In a broader sense, the purpose of reporting can also be seen as information visualization or as the process of turning data into knowledge.

The key-stone of reporting can thus be characterized as effective communication of relevant information to users and the satisfaction of their

information needs. To achieve this, processed information must be provided to users in a simple and easily understandable form and must be as meaningful as possible.

Reporting, together with questions and other analytical activities, represents a certain base that makes it possible for organizations to create reports. Reports as outputs of these activities represent an organized and formatted presentation of corporate data that help their users to make decisions. Therefore, reporting plays the role of a certain information and communication medium that allows sharing necessary information in a required form across the entire organizational structure and also possibly with external entities (Soljakova, Fibirova, 2010; Machac, 2003).

A correctly setup system of reporting and reporting outputs are crucial for managers to make correct decisions and to make decisions at a strategic, tactical and operational level. Inaccurate, unclear or malfunctioning reporting and its outputs result in company managers, or, as the case may be, external users, making wrong decisions.

A report can be defined as a document that provides information about a company's economic activities in different details. Information is displayed in the form of tables, charts or other graphical elements as of a certain time segment. Reports can be generated ad-hoc or on a regular basis in paper or electronic form.

A dashboard can be defined as a one-page document presenting aggregate information about a company's economic activity and functioning. Dashboard information is displayed in the form of tables, charts or other graphical elements as of a certain time segment. Dashboards are updated on a regular basis in paper or electronic form. A dashboard combines selected key reports, the data of which are aggregated at a needed level of details (Few, 2012).

Corporate reporting covers all areas of interpretation of information necessary for making decisions as part of corporate communication and a communication infrastructure, for instance, the visualization of measurements of a company's operational and strategic goals, the presentation of key metrics and trends, the overview of product and service success, corporate and in-house accounting. Communication that

is understandable to different groups of stakeholders represents the basic principle of reporting (Few, 2012; Hroch, 2008).

Reporting becomes even more important when the first signs of a crisis are identified. In such a situation, it is recommended to increase the frequency of costs, revenues, profit and other metrics reporting from a monthly to e.g. weekly basis, which will provide the company management with sufficient information while creating room for potential changes in original plans and procedures. Reporting should provide both current and historical information. In this context, historical information can be divided into information that compares current values with those in a previous time period (e.g. the same time period of the previous year) and information that compares current values with those in a previous report (e.g. changes during the past week or month).

2. Problem Formulation

Reporting and reporting tools allow for easy and basically routine processing of a large quantity of data, which would be otherwise impossible because of the size of the data, the scope of information needs and the quantity of decision-making tasks of users (Soljakova, Fibirova, 2010).

In order to manage their companies or departments, managers need information about the quality and quantity of products and services provided, about how the demand changes with time, etc. The role of corporate informatics often lies in providing other company departments with a large quantity of relevant data through corporate informatics services but not in finding a solution.

Limited funds usually put pressure on corporate informatics employees to provide more services for less money, while not deteriorating the quality of provided services. Therefore, it means "do more with less." Corporate informatics thus must show results to prove that it fulfills its tasks focused on higher effectiveness and that it makes sense to invest money into the operation and development of corporate informatics. To show results requires performing regular measurements and creating a system of reports providing information to the stakeholders.

One of the key reporting areas, which has not yet been analyzed in detail, is reporting that supports planning. In this article, we identify the individual

types of reports crucial for this area as well as the dimensions of these reports. The reports are always proposed in the context of a specific task. In our proposal, we suggested and identified these tasks and defined the main dimension crucial for a given report. Our proposal and solution is provided in relation to REMONA.

3. Methodology

The proposed REMONA and related planning and planning reporting tasks are based on our research of literature on information technology and especially on areas that do not concern information technology, such as accounting, controlling, economics, etc. An important element of the proposed model is its authors' practical experience obtained from their projects at both an academic and corporate level.

The proposed model, including the reporting part, was tested in selected private companies.

4. Results - Planning Reporting in the Context of REMONA

4.1 Remona

The proposed model identifies key dimensions and indicators and interconnects them into suggested analytical cubes. The goal of REMONA is an easy integration into a company and an easy configuration allowing its quick adaptation to the needs of a specific company.

The goal of the model is to provide a solution for two key corporate tasks – "Cost Allocation" and "Profitability Management." These tasks are inseparable from analysis, especially what-if analysis and planning, tasks.

For both tasks, the model specifies the key "Dimensions," "Metrics," "Drivers" and "Activities" that are in general handled by corporate informatics. Another model requirement is its ability to easily and quickly adapt to the needs of a specific company where it will be implemented. In the case of REMONA, this is achieved by the fact that its logic is implemented as much as possible through suitable links between individual data cubes and the dimensions connected with these cubes.

For the sake of completeness, we would like to add that in the case of specific companies, allocation rules or profitability analyses, we can also include any requested change directly in the actual reference model (solution code) and, as part of system feedback, expand the original model for such new information.

4.2 Planning Task

4.2.1 Basic tasks

In order to define a planning concept, it is necessary to first determine the basic planning tasks carried out in corporate informatics management. The list of tasks is provided in the following comprehensive figure. It covers the basic tasks and identifies some of the main business drivers and forms that can be used to enter data and reporting data. The figure also identifies the key data sources.

The figure also covers the cost allocation areas since planning, cost allocation and other economic tasks in financial management are closely interconnected.

The entire process is focused on the processing of primary and business data (input data) into a form suitable for planning, providing information for cost allocation and determining profitability. All input data must be sufficiently detailed to allow for planning tasks, cost allocation and profitability determination. Input data are usually broken down to G/L account (G/L balance) data, business data, master data, cost data, etc. All input data are then sorted, based on set rules, by group, e.g. center costs, balance sheet, cash flow and other to make it possible to perform set tasks every year with the identical set of data and not to limit their information value due to a different database. The last important part of input data includes parameters that allow adapting the general solution to the needs and characteristics of a specific company and time period. The definition of business drivers is an example of such parameters.

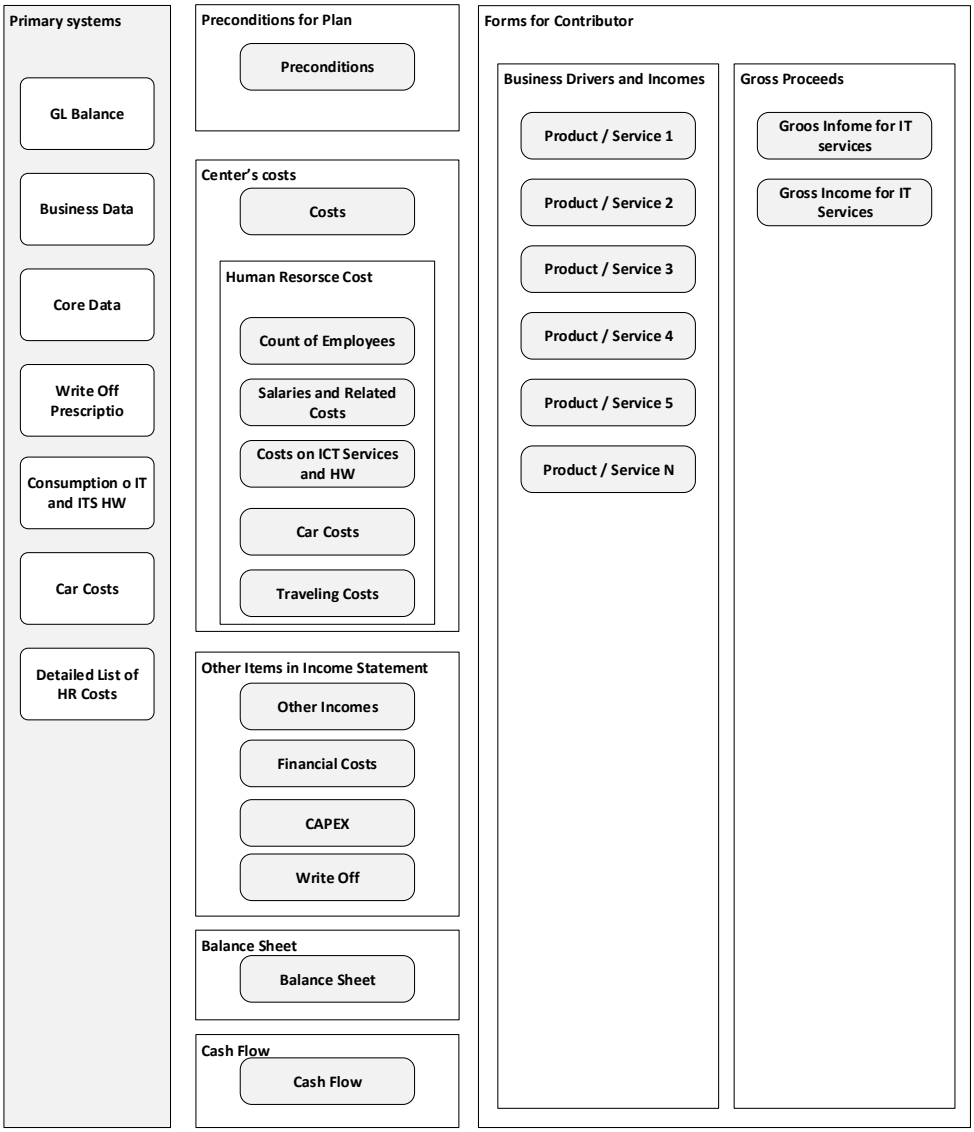

Figure 1 The concept of planning, cost allocation, input forms and data sources in corporate informatics management, Source: author

The authors will not describe in detail the individual steps and areas due to lack of space. The time-limits and their definition are explained e.g. in (Kral, 2011; Maryska, 2014; Maryska, Novotny, 2013; Maryska, Wagner, 2013 and other).

4.2.2 Phases of the planning process

The following chart describing the phases of the planning process indicates that a plan can be made in more than just one version. It is not unusual to prepare several plan versions.

The first plan version is usually prepared for approval by the top management. The top management typically requests some changes. Then the second plan version is opened and the first version is copied into it. The relevant users then modify the second plan version, based on the request of the top management. The second version must be filled in the same forms so that the entire logic would be "functional" and the relationships of the business models would not be corrupted. The second version is then sent to the top management for approval. If the version is approved, it is copied into the "Approved Plan Version for Period XY" and is locked for any changes. If the top management does not approve the version, the process repeats just like in the case of the second version.

From the planning point of view, workflow is a key part of the planning model. In the planning context, workflow is a clearly defined process that takes the user through the planning process.

The basic steps of the planning process are shown in the figure n. 2.

4.3 Planning and cost allocation reporting

During the planning process, it is necessary to provide users with different views of planned data in such a way so that:

- Plan solicitors would be able to analyze the plan data;
- Plan approvers would be able to see the status of the plan of subordinate items;
- The planning (Finance) manager would have access to aggregate overviews of the status of all items.

For these purposes, we identified the views of data that REMONA should provide.

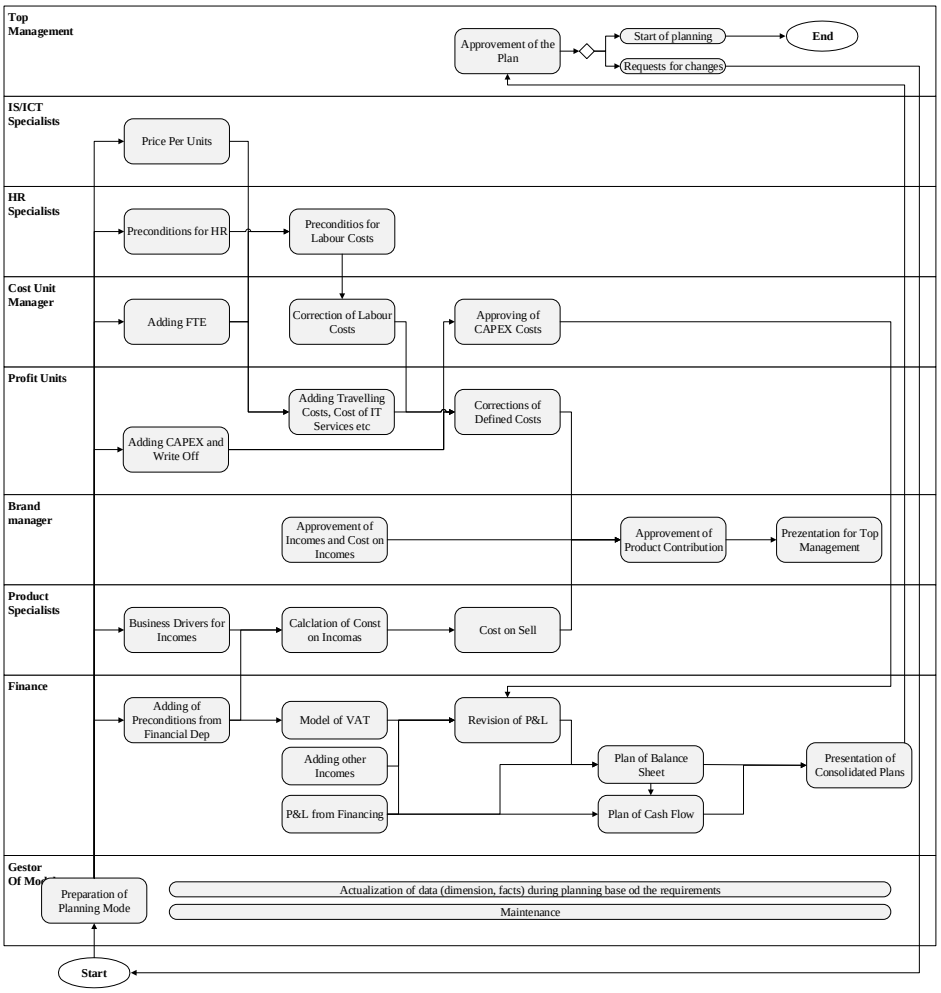

Fig. 2 Planning process, Source: author

4.3.1 Product contribution

Product contribution provides a detailed overview of the contribution of products to the profit and loss account of a company. The report will make it possible to see individual products or product groups. The report structure is derived from the product contribution entry form.

The report is placed above the data cube that will combine: the values entered directly in the product contribution forms (revenues, the cost of revenues, the cost of sale), direct costs entered by centers, including the cost of campaigns, and allocated overhead costs.

The dimensions of this report are as follows: time (the lowest detail (granularity) - weeks), product contribution item, data version, G/L account, product, channel and center (regions).

The key feature of the report is that it allows displaying data at any summary level of each dimension. Therefore, it will be possible to select such combinations as “Total Products,” “Total Channels,” etc.

4.3.2 Profit and loss account - managerial

This report provides a managerial view of profit and loss account items.

The dimensions of this report are as follows: time (the lowest granularity – month), managerial profit and loss account items, data version and center.

4.3.3 Profit and loss account

The structure of this report is similar to that of the managerial profit and loss account. The only difference is in the rules of downloading data to the individual items of the report.

The dimensions of this report are as follows: time (the lowest granularity – month), IFRS profit and loss account item, data version and center.

4.3.4 Revenues

This report provides a comprehensive overview of individual products and services and their contribution to revenues.

The dimensions of this report are as follows: time (the lowest granularity – month), product (including the corresponding hierarchy), data version and center.

4.3.5 Balance sheet

The structure of this report is the same as that of the form for Balance Sheet for Entering and Approval of the Balance Sheet Plan.

The dimensions of this report are as follows: time (the lowest granularity – month), G/L account (including the balance sheet hierarchy) and data version.

4.3.6 Profit and loss account – product breakdown

This report is derived from the managerial profit and loss account report; the only difference is that individual products are shown in individual columns. The report provides a unified view of the contribution of individual products to each item of the profit and loss account.

The dimensions of this report are as follows: time (the lowest granularity – month), product, data version and channel.

4.3.7 Operating costs

This report is derived from the form that is used for entering the operating costs of centers.

The dimensions of this report are as follows: time (the lowest granularity – month), product (including specific items such as: R01, R02 or alternative elements for product groups), data version, G/L account, activity and center (including the relevant hierarchy) (in order to obtain an overview of the costs of all centers, regions, etc.).

4.3.8 Business driver analysis

This report provides data for the individual types of products or services.

The dimensions of this report are as follows: time (the lowest granularity - weeks), report item (business drivers), data version, product, channel and center (regions).

4.3.9 CAPEX

This report provides an overview of in-progress and planned investment projects.

The report items are at the level of individual investment projects in the plan.

The dimensions of this report are as follows: time (the lowest granularity – month), report item (investment project, data version, product and center.

5. Conclusions

Planning and its support with reporting tools is one of the key areas of corporate management and corporate informatics since a well-prepared plan, which is provided to the top management via well-designed reports,

makes it possible to set up the limits and parameters of the corporate informatics budget for the following time periods, based on which it is then possible to set up the bonus goals of corporate informatics management.

In this article, we identified the basic planning tasks of corporate informatics as well as the main reports and the related dimensions that are crucial for the correct setup of corporate informatics reporting. All tasks are identified in relation to REMONA, of which the identified tasks are a part

Correctly prepared reports and the avoidance of the most frequent mistakes, which we also pointed out in this article, represent a separate reporting issue.

References

Soljakova, L., Fibirova, L. (2010). *Reporting. 3*., Praha: Grada, 221 s. Finance (Grada). ISBN 978-80-247-2759-2.

Machac, O. (2003). 'Reporting: jako součást informačního systému podniku'. *IT System* [online]. No. 12 [cit. 2015-03-23]. URL: http://www.systemonline.cz/clanky/reporting.htm

Lacko, L. (2009). 'Business Intelligence v SQL Serveru 2008'. Praha, *Computer Press 2009*. ISBN: 978-80-251-2887-9.

Few, R. (2012). *Information Dashboard Design – The Effective Visual Communication of Data*. USA, O´Reilly. ISBN: 978-0-596-10016-2.

Hroch, L. (2008). 'Proč potřebujete corporate reporting*?', System OnLine*. [online]. 2008. [cit. 2014-01-03]. ISSN 1802-615X. URL: http://www.systemonline.cz/business-intelligence/proc-potrebujete-corporate-reporting-1.htm.

Kral, B. et al., (2012). *Manažerské účetnictví* (3. rozšířené vydání); Praha : Management Press, ISBN: 978-80-7261-217-8.

Maryska, M. (2014). 'Architecture of the Reference Model for Cost Allocation and Profitability Management', *IDIMT 2014*. Linz, pp. 331-338, ISBN: 978-3-99033-340-2.

Maryska, M., Novotny, O. (2013). 'The reference model for managing business informatics economics based on the corporate performance management – proposal and implementation' *Technology Analysis & Strategic Management*. [online]. 2013, Vol. 25/2. ISSN 0953-7325. [cit. 2013-10-16]. URL: http://dx.doi.org/10.1080/09537325.2012.759206. eISSN 1465-3990.

Maryska, Wagner, (2013). Reference model of business informatics economics management. *Journal of Business Economics and Management*, 2013, Vol. 14, No. 4, pp. 1–17. ISSN 1611-1699.

Dependency Injection Containers and Caching

Jiri Matula[1], Frantisek Hunka[2]

Abstract. The technique dependency injection does not only encourages loose decoupling of modules in applications. By passing responsibility of classes for construction of dependent objects is possible to control life cycles of objects and the way of their initialization. Based on this fact, the presented concept encapsulates features of dependency injection container and caching, thereby improves reusability of components and allows to non-intrusively cache instances of objects in applications.

Keywords: dependency injection container, caching, management of dependencies.

JEL Classification: O33

1 Introduction

The dependency injection is a design pattern which is the one of implementations of inversion of control. The idea of dependency injection is passing of a dependency to a client object, whereas dependencies are not founded or built by the client (Fowler, 2004). The dependency injection container facilitates initialization of objects and assembles their dependencies (Potencier, 2009). A role of the container is depicted in the figure below.

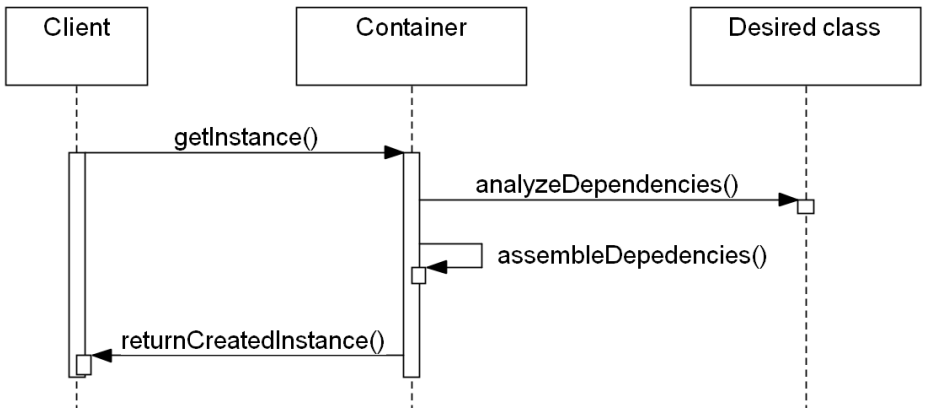

Figure 1 UML sequence diagram of dependency injection container, Source: own.

[1] University of Ostrava, Department of Informatics and Computers, 30. dubna 22, 701 03 Ostrava, matula.jirik@gmail.com.
[2] University of Ostrava, Department of Informatics and Computers, 30. dubna 22, 701 03 Ostrava, Frantisek.Hunka@osu.cz.

2 Caching via Dependency Injection Container

The presented concept extends the dependency container by caching. By passing responsibility of classes for object construction, the container is able to create or retrieve instances of objects from distinct sources. Due to this fact, it is possible to serialize already created instances, store them into cache and reuse when needed. Compared to native implementation, code which handles caching can be removed from classes and delegated to the container in the form of a properly configured dependency. This enables to globally configure which objects will be cached outside of their implementation. The figure below is depicting the presented concept.

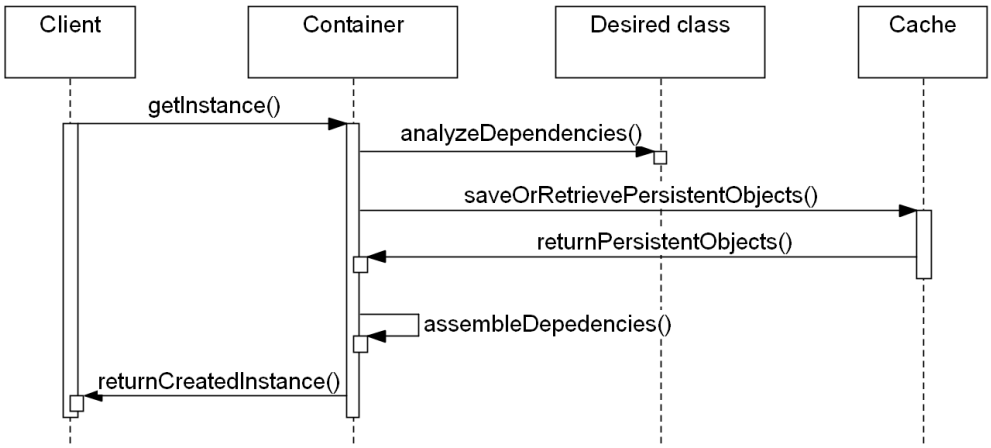

Figure 2 UML sequence diagram of modified dependency injection container, Source: own.

2.1 Benefits

The dependency injection container with the ability of caching offers advantages over native implementations when maintainable and configurable architecture of an application is required. It is a preposition of many long-term projects developed in an agile environment.

Considering this perspective native implementation has the following issues:

1) Hidden dependencies using static scope breakdown modularity.
2) Classes are responsible for construction of dependent objects.
3) Therefore, configurations of classes must be defined along its construction or directly inside a class.

These issues endanger maintainability of applications. Hidden dependencies using static scope does not allow use only interface definition in the class. Thus any change in static scope may lead to a change in dependent classes and a violation of the single responsibility principle (Martin and Micah, 2007). Moreover, changes in configuration leads to changes in source code as well. For a flexible architecture it is essential that changes are not invasive. If we consider above mentioned facts, this condition cannot be fulfilled.

In addition, the presented concept offers the following advantages over native implementation:

1) It leads a programmer to decouple an application into independently functional parts which are easily replaceable by other similar components.
2) These independent parts can be easily cached and reused in an application.
3) Caching of objects eliminates repetitive initializations within an application.

2.2 Demands

All objects which are supposed to be held constantly by a container, let call them persistent. Usage of persistent objects places demands on application architecture which are following:

1) Each persistent object has to allow serialization.
2) Persistent objects must not contain a class member which is not serializable.
3) Static members must not be a part of a persistent object.

Such conditions are quite restrictive, especially for libraries where static class members are used to ensure their proper functionality. Generally, usage of static members is not the best practice. Nevertheless, the dependency injection encourages elimination of static members within classes, which helps to fulfil conditions given above.

3 Experiment

The concept has been verified in the test including the completion of five thousand requests on the index page, which includes initialization

of the framework, the controller and the registration form generation within particular request. The test is comparing application response times between default dependency injection container and its modified version according to the presented concept. All instances of classes possible to serialize which did not contain dynamic content were configured as persistent. The test was executed at five particular concurrency levels, namely 1, 5, 10, 50 and 100.

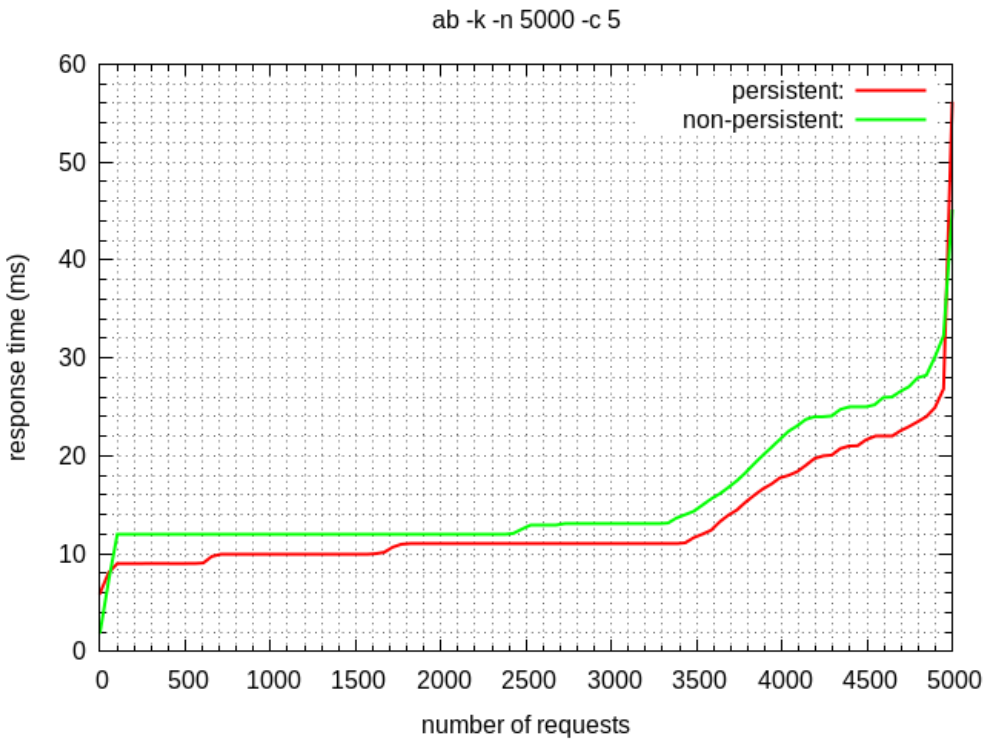

Figure 3 Graph is presenting influence on application response time between native and modified version of container, Source: own.

The graph above shows a noticeable difference between the native and modified version of the dependency injection container. In this case, the concurrency level was set to five. The native version is slower by 3 milliseconds beyond the modified container for more than 98 % of requests. Simultaneously, remaining approximately 2 % of requests increases response time approximately by 20 % compared to unmodified container. This pattern appears through all particular concurrency levels. With the increasing concurrency level response time grows up but the modified version of the container still improves overall performance of the application.

Table 1 Detailed statistics for previous graph, Source: own.

	Using non-persistent objects	Using persistent objects
Time taken for tests	15.586 seconds	13.050 seconds
Complete requests	5 000	5 000
Failed request	0	0
Request per second	320.81	383.15
Time per request (mean)	3.117 milliseconds	2.610 milliseconds
Percentage of the requests served within a certain time (ms)	50 % 13 66 % 13 75 % 18 80 % 22 90 % 25 95 % 27 98 % 30 99 % 32 100 % 45 (longest request)	50 % 11 66 % 11 75 % 15 80 % 18 90 % 22 95 % 23 98 % 25 99 % 27 100 % 56 (longest request)

4 Conclusion

The proposed solution has brought two main positive outcomes. Firstly, thanks to passing responsibility for object instantiation an architecture which has utilized the dependency injection pattern is able to adaptively cache objects via container configuration. At first glance, this minor change in implementation has a strong influence on the consistency of application source code. In addition, it improves maintainability of an application. Secondly, objects configured as persistent eliminate repetitive initialization within scope of running requests. This improves the overall performance of applications. Testing has shown that utilization of the modified dependency injection container is possible even though application architecture is fully designed to utilize abilities of such container. A performance gain is coupled with nature of application, whereas the container prototype was able to shorten time necessary for request completion from 13 to 37 % in the test.

In conclusion, the solution has arisen from combination of the dependency injection container and caching. The concept has been verified and considered as valid tool which saves application performance, improves reusability of components and allows adaptively cache objects in applications.

Acknowledgements

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References

Fowler M. (2004), *Inversion of Control Containers and the Dependency Injection pattern*, [Online], Available: http://www.martinfowler.com/articles/injection.html [25 Aug 2015].

Martin, R. and Micah M. (2007) '*Agile principles, patterns, and practices in C#'*. Upper Saddle River, NJ: Prentice Hall, p. 732.

Potencier, F. (2009) *Do you need a Dependency Injection Container?*, [Online], Available: http://fabien.potencier.org/article/12/do-you-need-a-dependency-injection-container [25 Aug 2015].

The legal minimum for project manager

Zora Říhová[1]

Abstract. The paper discusses the necessary legal awareness for project manager that can significantly affect the course of the project. This relates to the content of the contract, i.e. subject, schedule, labor intensity, cooperation and other aspects, according to will be manage the project. Legal awareness of IT project managers is often too small. In the article are also presented the most common problems of project managers in the legal field of project management.

Keywords: contract, cooperation, legal aspects of project, project, project manager.

JEL Classification: M15

1 Introduction

Legal education of project managers is not common, but the success of the project is required at least a basic knowledge. Greatly simplifies the situation during project implementation.

Mostly legal awareness of project managers is below the average to average level. Common IT project manager is equipped with mainly technical or economic (and IT) education and special certificates (e.g. ITIL). In the field of law is often dependent on cooperation with internal or external lawyers. Therefore, it is quite frequent that part of the project team is often also the person responsible for the legal aspects of project implementation, but not all vendors it cannot afford due to budget. In the papers is specified legal "Ten Commandments" for the project managers and the most common errors that occur in the practice.

2 Methodological background

The contract is a relationship between two or more entities, which defines the rights and obligations of the parties. Defines the object of the contract, time, financial fulfillment and conditions that are related to the contract. The contract should be balanced in the standard rules of business. In project management are handled, although generally accepted project methodology (PMBOX,

[1] University of Economics, Prague, Faculty of Informatics and Statistic, Department of the System Analysis, W. Churchill Sq. 4, Czech Republic, zora.rihova@vse.cz

PRINCE2, Chester, ASAP, ...) regularly used as a set of processes to ensure the smooth progress of work from the beginning to the end. These methodologies are dedicated to best practices in various stages of project implementation, organizational issues, determining the roles, documentation. Neither scientific articles are not engaged in the legal issues (Hodgson and Paton 2015), (Říhová 2004), (Davis 2010).

There are many methodologies and delicious, but usually start with the project started after the signing of the contract or the pre-stage, but does not participate project manager in this part of the project preparation. (Doležal, Máchal and Lacko 2009). Into the knowledges of project managers should include the minimum legal knowledge to help prevent or resolve problems arising from the contractual or regulatory arrangements of the customer.

3 What is essential from a contract for the project manager

The contract has to act as a management tool. It must be precisely balanced and specifically define the obligations of the parties and should not give space for competition lawyers in the interpretation of individual provisions. Often, especially in tenders according to law 137/2010Sb. on public procurement it is very complicated and the contracts are dictated hard in favor of the customer.

The contract should be understood by all who have to manage and implement the project with it. Unilateral disadvantageous contracts also does not constitute a long-term relationship. Contracts must be mutually beneficial. There are also situations where the pressure (e.g. for reasons of time to complete the project) for the accelerated signing of contracts and unsettled some major contractual points, which can then be of great conflict and possibly litigation. In any case, the project manager finds himself in a difficult situation, which was created out of him. Another contractual relationship that may be critical to the project manager - contract with a subcontractor which usually follows the terms of the contract with the customer, but this agreement have to be available to the project manager to manage and control of subcontractors. By subcontractors is also important a quality of consultants, which usually does not know in advance the project manager.

A very important condition is that the project manager had at all opportunity to express to a contract in the preparatory phase. This is not a common practice, especially among large corporations. From the practice shows that it is necessary for the future of project, that project manager has been actively involved in the preparation of bid and contract. It often happens that in order to win the contract, it underestimated the actual laboriousness or the scope of the project. Future project managers often "picked up" in the project until the conclusion of the contract and cannot point to a number of fundamental facts. Preparation of the tender is often charged with "BID manager" who can manage, write and coordinate the preparation of offers, including pricing aspects and often contract preparation.

4 The legal minimum for project manager

In the next text is “Ten Commandments" for legal minimum:

1) Object of the contract. It must be very clearly defined subject of delivery - specifically defined scope and content. It is often a problem point, where the scope of the contract is vaguely defined. There is space for different interpretations in particular from the customer who requires a supply of what is the subject matter disclosed, but the contractor has to know that it belongs to the project. This is why sometimes explicitly specifies what is not included in the contract. Unable to accept the uncertainties in the supply of subject matter - from practice, it is obvious that this often happens.
2) Definitions of license conditions. It must be clear what rights apply to "box-in" software and how to products that are developed under the project. Never be passed on to anyone more rights than I do myself.
3) Timetable of the project in relation to the payment terms. Unable to accept unrealistic deadlines for implementation - underestimated labor intensity leads to problems that is for project manager difficult to handle. It is of course important the quality of consultants, which can affect the resulting labor intensity.
4) Solution design changes. The IT projects often occur to change in the project progresses. It must be clear what can be considered as a change that will fit into a contractual relationship and what kind of change that will require changes in labor input or schedule a supplement to contract. Project manager must be negotiator

of communication and propose solutions to the customer or higher approve of the project's organizational structure.

5) Cooperation. It is a key issue in the case of IT project and its range. This is a crucial aspect of IT projects and must be defined in the contract. Customer key users perform their daily tasks and beyond are now part of the project. The problems arise if they do not have sufficient decision-making powers or are not sufficiently qualified.
6) Acceptance procedure. It should really appreciate the concept of acceptance procedures. Often there are a number of errors in relation to particular penalty. The delay is not only that something was not delivered on time, but also because it is not delivered in the required quality. Acceptance procedures are tied to the financial fulfillment of the customer and therefore, this point is very important.
7) Contractual fines. Importance are also principles of contractual fines and, in this connection, linkage to compensation.
8) Scope and nature of guarantees and support of delivered solutions. Very often confuses the content and character of typical guarantees for the quality of support (maintenance).
9) Premature termination of the contract. It should always be able to assess whether, in the case of premature termination of the contract filling "return" or not. This can have serious effects on costs for both supplier and customer.
10) Regulatory rules of the customer. In addition to the legal provisions in the contract, have to be known and respect the regulatory rules of the customer and the project manager should be acquainted with them on beginning of the project.

If the client is dissatisfied with the fulfillment of contracts, it is necessary for project manager took over the activity, and did not avoid the talks on the problems. The basis must be true analysis of the situation and any defects admit. Solutions must seek both parties together. It is the interest of both parties. In the project is a supplier and customer one team. The problem cannot be ignored, it would certainly occur a chain reaction of other problems and it could completely destroy the project.

5 The most common issues in the legal area in project management

- The bad contents of the contract (inaccurate definition of a contract underestimated labor intensity, unrealistic deadlines, ...).
- Lack of knowledge of the contractual relationship
- Lack of knowledge of subcontractors (if any)
- Misunderstanding or wrong interpretation of the individual parts of the contract
- Failure to observe the contract
- The project manager is not invited to prepare the contract
- Ignorance of legislation
- Lack of knowledge the customer's internal standards.

It is easy under these points something to imagine, so there is no need to analyze in details and so will be describe just briefly some of the typical deficiencies.

Project legal problems resulting mainly out of ignorance contract by the project manager / contractors / subcontractors. Another reason could be misunderstanding and wrong interpretation of sections or failure to observe the contract e.g. at any cost to complete the project. Executive problems in this area may occur as early as the project preparation, the contract is not precisely specified (contract is too general in terms of defining the subject of the project), unrealistic time for processing or not covered important legal requirements – e.g. an obligation arising from the Act 101/2000Sb. on Privacy Policy. Problems can also arise if they are not included in this contract requirements of the Project Manager on labor intensity of project and its staffing. Also, there may be a lack of knowledge of internal standards of the customer.

6 Conclusion

Project manager's duty is to bring the project to a successful conclusion in terms of time, scope and resources. All this is done under contract. Delivered work must accept the customer. It is important that both sides benefited from the work and cooperation. For everyone project managers I recommend a training of minimum of legal, on the basic principles of trade relations and the principles of "licensing rights". It is important e.g. whether

the provision of services or delivery of a comprehensive solution, which has different laws, but also the business context.

In IT projects, it is also very crucial privacy - there is a general awareness of the legal minimum. Assistance to internal and external lawyers are usually no longer relevant for the resolution of inconsistencies or conflicts. It's better to be pre-equipped with a "legal minimum"- was specified in the text "Ten Commandments" of the legal context of influencing the outcome. Errors in contracts suffer project manager.

It is appropriate to organize courses legal minimum for PM, which should lead lawyer that has IT knowledge and understands the specifics of IT area.

References

Davis, B. (2010) ´97 klíčových znalostí projektového manažera´ , Brno Computer Press, ISBN 978-80-251-2854-1.

Doležal, J., Máchal, P., Lacko B. (2009) ´Projektový management podle IPMA´,Grada Publishing, , ISBN 978-80-247-2848-3.

Hodgson, D. E., Paton, S. (2015) ´Understanding the professional project manager: Cosmopolitans, locals and identity work´. *International Journal of Project Management, In Press, Corrected Proof, Available online 3 April 2015*

Říhová, Z. (2004) ´Personální stránka řízení projektů´. *Proceedings Systémové inženýrství – SI '04.* Hradec Králové, Vysoká škola pedagogická.

Zwikael, O. Smyrk, J. (2015) ´Project governance.´*International Journal of project Management, Volume 33, Issue 4, May 2015, Pages 852-862*

Do gender and personality traits (BFI-10) influence self-perceived tech savviness?

František Sudzina[1],[2]

Abstract. Nowadays, it is necessary to use technology in various everyday activities. A certain level of what used to be called high-tech savviness is needed to access certain services. The aim of this paper is to analyze if gender and personality traits (Big Five Inventory-10) influence self-perceived tech savviness. A not so surprising finding is that gender influences self-perceived tech savviness, 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

As Witt, Massman and Jackson (2011) put it, "[t]he benefits of being technologically fluent are obvious, but the liabilities of not being "tech savvy" may be more substantial (e.g., increased isolation from world, local, interpersonal, and personally meaningful events)".

Among others, tech-savyiness can be used, to measure self-identity, as it was done e.g. in (Gimpel, Sudzina and Petrovčiková, 2014).

The aim of this research to investigate the impact of gender and of personality traits according to the Big Five Inventory on tech savviness.

Probably with the exception of adoption of deal sites (Sudzina, 2015) where women were found about twice as likely to use them compared to men, virtually all other studies report either higher technology adoption in men or that there are no statistical differences found between genders. It is also possible that men and women use technology for different things. To sum up, it is possible to hypothesize a higher self-perceived tech savviness in men.

[1] University of Chemical Technology, Department of Economics and Management, Technická 5, 166 28 Praha 6, Czech Republic, Frantisek.Sudzina@vscht.cz.
[2] Aalborg University, Department of Business and Management, Fibigerstræde 2, 9220 Aalborg, Denmark, sudzina@business.aau.dk.

Big Five Inventory became a de facto standard for investigating personality traits in information systems literature. For example in Computers in Human Behavior there are more than 160 articles using the framework.

So far, there was only a limited amount of research targeting the impact of gender and of personality traits according to the Big Five Inventory on tech savviness. A search for

"tech savvy" OR "tech savviness" "big five" OR "big 5"

as a topic within Web of Science did not yield any results. The same query in Google Scholar (full-text search) resulted in reported 146 results of which only 140 were displayed. Of the 140 results, only Witt, Massman and Jackson (2011) investigated the impact of Big Five personality traits (and self-esteem, gender, income, and race) on tech savviness, well, on frequency of use of:

- videogames (e.g. play video games on a computer, and play video games on a console);
- general computer use (e.g. create documents for school, save images/graphics);
- communication (e.g. talk on a cell phone, and instant message with friends).

There are negative aspects of technology use, such as too much time devoted to social media (Pavlíček, 2013) or to mobile phone-related activities (Chiu, 2014). Tech savviness may lead to shodow IT (Silic and Back, 2014), i.e. creating or using IT in an organization without an explicit approval from the top management or the relevant superior. These issues are not considered in this paper.

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 the spring semester 2014 using a broader on-line questionnaire dealing with personality traits. Respondents were students of Aalborg University. Of 186 students who started, 172 (of whom 106 were male and 66 female) fully filled in the questionnaire.

Tech savviness was measured using two statements used in (Gimpel, Sudzina and Petrovčiková, 2014) to measure tech savviness as a part of the self-identity construct. The instruction 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".

A 1-5 Likert scale was used where 1 meant strongly disagrees 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..."

- ... is reserved;
- ... is generally trusting;
- ... tends to be lazy;
- ... is relaxed, handles stress well;
- ... has few artistic interests;
- ... is outgoing, sociable;
- ... tends to find fault with others;
- ... does a thorough job;
- ... gets nervous easily;
- ... has an active imagination.

on a 1-5 Likert scale where 1 meant strongly disagrees and 5 stood for strongly agree. 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.

The questionnaire contained additional questions which were not used in the analysis presented in this paper. This questionnaire was preceded

by another questionnaire, approximately a week before, it contained the same Big Five Inventory-10, and respondents were asked to save the answers and provide then again later. So one of the questions not analyzed here is whether the respondents entered their answers from a week before or they filled in their current answers. Of 172 respondents, 63 personality traits ratings were from previous week, and 109 were recent.

A generalized linear model (GLM) was used to analyze impact of gender and of five personality traits (extraversion, agreeableness, conscientiousness, neuroticism, openness to experience) in three models where the dependent variables were:

1) tech savviness in the eyes of others ("People consider me to be tech savvy");
2) tech savviness in one's own opinion ("I consider myself to be tech savvy");
3) 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.

Table 1 Parameter estimates for model 1, Source: own.

Parameter	B	Std. Error	T	Sig.
Intercept	2.738	.587	4.667	.000
Extraversion	.031	.088	.353	.724
Agreeableness	-.078	.096	-.811	.418
Conscientiousness	-.070	.086	-.810	.419
Neuroticism	-.014	.083	-.166	.869
Openness to experience	.191	.084	2.265	.025
Gender (male)	.201	.130	1.541	.125

The model per se is not significant (p-value = .107), R^2 = .061, R^2_{adj} = .026 and only openness to experience appears to be significant in this model.

Baroudi and Orlikowski (1989) estimated that information systems researchers typically have a 40% chance of not detecting the phenomenon under study, even though it, in fact, may exist. Therefore, submodels were tested to see whether omissions of certain independent variables could improve p-values. Parameter estimates for the best submodel are provided in Table 2.

Table 2 Parameter estimates for streamlined model 1, Source: own.

Parameter	B	Std. Error	T	Sig.
Intercept	2.328	.266	8.754	.000
Openness to experience	.176	.082	2.157	.032
Gender (male)	.230	.122	1.896	.060

The streamlined model is significant (p-value = .011), R^2 = .052, R^2_{adj} = .041 and the significance of gender increased.

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.

Table 3 Parameter estimates for model 2, Source: own.

Parameter	B	Std. Error	T	Sig.
Intercept	2.440	.624	3.911	.000
Extraversion	.113	.094	1.205	.230
Agreeableness	-.099	.102	-.978	.329
Conscientiousness	.015	.092	.160	.873
Neuroticism	.018	.089	.198	.843
Openness to experience	.117	.090	1.308	.193
Gender (male)	.212	.139	1.527	.129

The model per se is not significant (p-value = .277), R^2 = .044, R^2_{adj} = .009) and gender has to lowest p-value.

Several submodels were tested and parameter estimates for the best submodel are provided in Table 4.

Table 4 Parameter estimates for streamlined model 2, Source: own.

Parameter	B	Std. Error	T	Sig.
Intercept	2.939	.101	28.990	.000
Gender (male)	.240	.129	1.857	.065

The streamlined model is borderline significant (p-value = .065), R^2 = .020, R^2_{adj} = .014 and the significance of gender increased.

The correlation coefficient for tech-savviness tech savviness in the eyes of others and tech savviness in one's own opinion is .696, p-value < .001. This translates into Cronbach's alpha of .82, i.e. higher than Nunnally's (1978) threshold of .7.

On average, tech savviness in the eyes of others was lower by .064 from tech savviness in one's own opinion, p-value .186. 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	.298	.480	.621	.535
Extraversion	-.082	.072	-1.135	.258
Agreeableness	.022	.078	.280	.780
Conscientiousness	-.084	.070	-1.199	.232
Neuroticism	-.031	.068	-.460	.646
Openness to experience	.074	.069	1.068	.287
Gender (male)	-.011	.107	-.102	.919

The model per se is not significant (p-value = .625), R^2 = .026, R^2_{adj} = -.010. It was not possible to find a submodel with p-values < .1.

4 Conclusion

The aim of the paper was to analyze impact of gender and of personality traits on self-perceived tech savviness. There were two versions of the dependent variable used - tech savviness in the eyes of others, tech savviness and in one's own opinion.

In both cases, men believed to be more tech savvy than women on average by a bit more than .25 on a 1-5 Likert scale. Respondents more open to experience 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 almost .7) and the difference between the two was not statistically significant.

Further research could investigate if using the 44-item version of the Big Five Inventory questionnaire would give the same results.

References

Baroudi, J. J. and Orlikowski, W. J. (1989) 'The problem of statistical power in MIS research'. *MIS Quarterly*, vol. 13, no. 1, pp. 87-106.

Chiu, S. I. (2014) 'The relationship between life stress and smartphone addiction on taiwanese university student: A mediation model of learning self-Efficacy and social self-Efficacy', *Computers in Human Behavior*, vol. 34, pp. 49-57.

Gimpel, G., Sudzina, F. and Petrovčiková, K. (2014) 'Mobile ICT Acceptance in late adopter countries', *Proceedings of 13th International Conference on Mobile Business 2014*, London.

John, O. P. and Srivastava, S. (1999) 'The Big Five trait taxonomy: History, measurement, and theoretical perspectives', in Pervin, L. A. and John, O. P. (Eds.) *Handbook of personality: Theory and research*, 2nd edition, New York, NY: Guilford Press, pp. 102-138.

Nunnally, J. C. (1978) *Psychometric theory*, 2nd edition, New York, NY: McGraw-Hill.

Pavlíček, A. (2013) 'Social media – the good, the bad, the ugly.', *Proceedings of IDIMT-2015: Information Technology, Human Values, Innovation and Economy: 21st Interdisciplinary Information Management Talks 2013*, Praha, pp. 139-149.

Rammstedt, B. and John, O. P. (2007) 'Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German'. *Journal of Research in Personality*, vol. 41, no. 1, pp. 203-212.

Silic, M. and Back, A. (2014) 'Shadow IT – A view from behind the curtain'. *Computers & Security*, vol. 45, pp. 274-283.

Sudzina, F. (2015) 'Do gender and personality traits influence use of deal sites?', *Proceedings of IDIMT-2015: Information Technology and Society Interaction and Interdependence: 23rd Interdisciplinary Information Management Talks 2015*, Poděbrady, pp. 133-138.

Witt, E. A., Massman, A. J. and Jackson, L. A. (2011) 'Trends in youth's videogame playing, overall computer use, and communication technology use: The impact of self-esteem and the Big Five personality factors'. *Computers in Human Behavior*, vol. 27, no. 2, pp. 763-769.

IT Service Strategy - Within or Beyond IT Strategy

Agnieszka Zając[1]

Abstract. Information Technology Service Management (ITSM) became an everyday practice for many global businesses as well as small and medium enterprises (SMEs). Such frameworks like ITIL, MOF or COBIT standardize most processes concerning IT service development and execution (operation) and provide full some guidance to IT service strategy formulation. It is assumed that strategy itself and IT strategy are well developed topics in many research papers. However, the question is if the guidance related to strategy and IT strategy could be directly implemented for IT service strategy purposes. The goal of the paper is to discuss the relation between IT service strategy and IT strategy.

Keywords: IT strategy, IT service, IT service strategy

JEL Classification: M15

1 Introduction

Information technology service strategy (ITSM) is a quite new practice especially in developing countries. Many companies deal with the problem of IT service strategy selection and formulation. Should they build on their own recourses or outsource IT services?

Strategy itself is an essential topic from the beginning of management discipline. Such models like Mintzberg's 5P's (Mintzberg, 1987), Porter's five-forces (Porter 1980), the value chain model (Porter 1985) or core competency theory (Prahalad and Hamel 1990) are well known and seldom applied in practice.

IT strategy became crucial since 80s (Cash, at al. 1992; Earl, 1989; Rackoff, at al., 1985). Right now IT is the main source of business development and its application is getting more and more complex. ITSM brings not only added values to IT adoption but also some new challenges and questions. ITSM frameworks, such as Information Technology Infrastructure

[1]Cracow University of Economics, Department of Computational Systems, Rakowicka 27, 31-510 Cracow, Poland, zajacaga7777@gmail.com

Library (ITIL - Cabinet Office, 2011), Control Objectives for Information and related Technology (COBIT - COBIT, 2007) or Microsoft Operations Framework (MOF - MOF Overview, 2008) aim at answering these questions and providing good practices of ITSM introduction and execution. Still, in the area of IT service strategy they are too complex or just outline what should be done.

This paper is a preliminary study that is to check on the possibility of creating some sets of strategy methods and models that will suit specific IT service usage scenarios. The first section deals with strategy and IT strategy topic through selecting main approaches and models. The second part discussed the most known ITSM frameworks and theirs approach to the strategy issue. The third section draws circumstances of strategy generation in situation of IT service management. Conclusions concerning new conditions of IT strategic planning applying service oriented approach close the paper.

2 Strategy and IT strategy

IT strategy is a part of the business strategy and together with the increasing role of IT, its importance and scope evolves and becomes more and more indispensable for the company's growth. IT strategy is sometimes called IS or IT/IS strategy and could be seen as:

1) A long term planning for organization's IT sector to utilize IT for organization's long term success (Toolbox, 2015).
2) The discipline that defines how IT will be used to help businesses win in their chosen business context (Gartner, 2015).
3) A comprehensive plan that information technology management professionals use to guide their organizations (Rouse, 2015).

"An IT strategy should cover all facets of technology management, including cost management, human capital management, hardware and software management, vendor management, risk management and all other considerations in the enterprise IT environment. Executing an IT strategy requires strong IT leadership; the chief information officer (CIO) and chief technology officer (CTO) need to work closely with business, budget and legal departments as well as with other user groups within the organization" (Rouse, 2015).

Strategy itself has been a topic of management discipline for almost one century and there are many attempts to structure and define it. Mintzberg (1987, after: Chen and Mocker, 2010) defined strategy as 5P's:

1) plan (consciously intended course of action);
2) ploy (a specific maneuver intended to outperform a competitor);
3) pattern (a stream of realized actions);
4) position (a means of matching between an organization and its external environment);
5) perspective (which is shared among organizational members, and the content of which consists of not just a position, but also a way of perceiving the world).

Information Technology Infrastructure Library (ITIL) for its own purposes defines strategy as "a complex set of planning activities in which an organization seeks to move from one situation to another in response to a number of internal and external variables" (Cabinet Office, 2011, p. 35).

Chen and Mocker (2010) divided the strategy research into three main streams. The first stream encompasses these works which are focused on answering the question 'what is strategy' or 'what constitutes a strategy' where they included such models or theories like Porter's five-forces (Porter 1980) and the value chain model (Porter 1985), core competency theory (Prahalad and Hamel 1990), the resource based view of the firm (Barney 1991; Rivard et al. 2006), and other tools to analyze, develop, and execute the strategy (Hambrick and Fredrickson 2001). The second stream bases on characteristics that distinguish strategic decisions from non-strategic. "Frequently cited characteristics of strategic decisions include their irreversible nature, the expected impact on long-term firm performance, and the directional nature, that give guidance to non-strategic decisions" (Chen and Mocker, 2010, p. 236). The third stream distinguishes role and scope of the strategy in different organizational levels like corporate strategy, business unit strategy or functional strategy.

Besides general strategy models that are extensively applied, also in IT discipline, there is an IT strategy model that should be mentioned in this paper. It shows categories of strategic relevance and impact of existing and future IT application, identifying four different IT environments (see figure 1, cf. Cash at all, 1992).

There are four modes that refer to present and future needs of IT applications. Factory mode shows high need for reliable current IT and low importance of future applications. It stresses maintenance needs and high impact on avoiding the failure of existing IT systems. Support mode refers to low meaning of IT application for organization activities at present as well as in the future. Turnaround mode represents the situation when some circumstances push the company to extensively use IT application in the future. Strategic mode is in the situation when IT plays an important role at present and in the future.

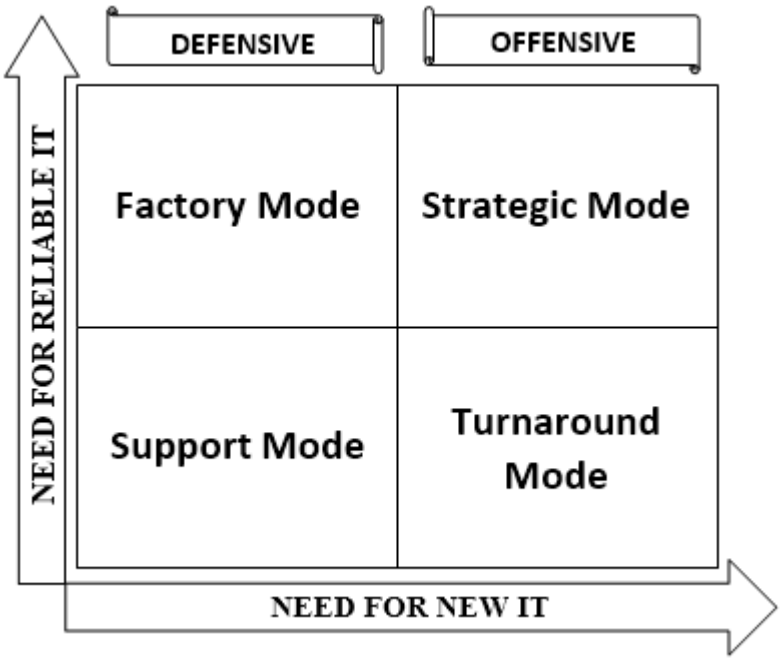

Figure 1 The IT Strategic Impact Grid, Source: based on Nolan, McFarlan, 2005.

Nolan and McFarlan (2005) have assembled four IT strategy modes into two main groups: defensive and offensive. Defensive use of IT allows company to constantly develop and maintain IT systems without time pressure while offensive forces quick and extensive IT changes.

All these definitions and approaches to strategy itself and specifically to IT strategy prove that it is a wide-ranging topic which may also create some problems as to its complexity when defining the company's strategy.

3 IT service strategy according to ITSM frameworks

For many years IT has been seen as a strategic weapon or the factor to competitive advantage but its influence on the organization is particularly visible if we use the service approach. When compared to IT strategy topic, information technology service management (ITSM) is a quite new approach. ITSM is strongly focused on the client needs and business processes. It also introduces service oriented organization of IT units and strongly connects IT budgeting with bringing value to the client. IT service strategy can be seen as an evolution of business strategy that includes purposeful use of IT (IT business alignment).

There are quite many ITSM frameworks used to organize IT processes in the companies. The most recognized is ITIL, which provides good practices to service management and is dedicated to IT departments. ITIL presents the service strategy from the client's perspective: "Service strategy specifically defines how service provider will use services to achieve the business outcomes of its customers, thereby enabling the service provider (whether internal or external) to meet objectives." (Cabinet Office, 2011, p. 35). This definition underlines IT department role as the service provider. It also introduces internal and external sources of technology.

The other well-known framework strongly connected with ITSM but known as IT governance standard is Control Objectives for Information and related Technology (COBIT). COBIT defines a set of universal processes to manage IT. It brings rather audit and monitoring tools to assess IT reliability in the organization than instructions on how to do it. One of the activities among COBIT processes is an IT strategic planning that "is required to manage and direct all IT resources in line with the business strategy and priorities" (COBIT, 2007). COBIT focuses on the function of strategy and strategic planning: "The strategic plan improves key stakeholders' understanding of IT opportunities and limitations, assesses current performance, identifies capacity and human resource requirements, and clarifies the level of investment required. The business strategy and priorities are to be reflected in portfolios and executed by the IT tactical plan(s), which specifies concise objectives, action plans and tasks that are understood and accepted by both business and IT." (COBIT, 2007, p. 29).

Besides the two above mentioned standards that are non-commercial (ITIL designed by public agency and COBIT created by an association), there is a quite well known and applied Microsoft Operations Framework (MOF). "MOF provides question-based guidance that allows you to determine what is needed for your organization now, as well as activities that will keep the IT organization running efficiently and effectively in the future." (MOF Overview, 2008, p. 1). Among four phases of MOF, the first phase called "Plan" deals with strategy generation and IT business alignment. In the business/IT alignment service management function IT service strategy is defined as: "the plan that aligns an organization's objectives, policies, and procedures into a cohesive approach to deliver services that support business strategy" (MOF Business/IT Alignment, 2008, p. 5).

If we compare these three frameworks from the strategy perspective ITIL devotes the most attention to the subject topic, stressing out the importance of bringing business value to service the customer. MOF structures the responsibilities and tasks of specific actors involved in the strategy development and COBIT deals with examining if existing IT service strategy is correctly developed and executed.

4 Circumstances of IT strategy with connection to IT services

The range of service management use in organization depends on many aspect, such as the company's size, area of business activity or scope of IT applications. First of all we can distinguish IT service providers as a special type of organizations for which IT service strategy represents their business strategy. From the perspective of the scope of customers, we can specify several situations of delivery of IT services:

- for own purposes (inside company),
- for various external customers,
- for one external customer,
- for own purposes and external customers.

In all these situations companies may draw on their own resources (under OLA[1]) or buy some or all services outside (using UC[2]), what generates many different possibilities and strategic decisions.

Referring to a grid presented on figure 1, we will have different IT demands that will influence IT service strategy. In such conditions some questions arise. From the perspective of IT reliability is it more rational to outsource IT services or maintain inside the company? If company operates in defensive scenarios, is it better to outsource IT services? Offensive use of IT require constant service development as well as quick IT provision, does it mean that company under such a condition has a limited possibility to buy services outside?

ITSM gives the company much independence in service source selections, flexibility in deciding what to do inside the company and what to outsource. It generates various scenarios of the meaning and scope of IT service strategy. That is why in some cases IT service strategy will mean more than only IT strategy while in other situations it will be just a part of IT strategy.

5 Conclusions

Strategy creation is a complicated process that requires knowledge, experience, vision and creativity. Although literature offers many strategic methods, models and patterns, decision makers have to carefully select appropriate approaches that stay in line with the company's needs and strategic goals. ITSM frameworks and standards organize and structure activities concerning strategy formulation and monitoring to some extend and do it in a rather general way.

Under the conditions of ITSM philosophy, there are some new questions concerning sources, reliability and availability of IT services. The need for IT services is also strongly connected with IT strategic impact on organization's activities. It would be helpful to have a set of selected methods suitable for specific scenario of IT service usage.

[1] Operational Level Agreement is a contract that defines how various IT groups within a company plan to deliver a service or set of services.
[2] Underpinning Contract is an agreement created between the IT Service Provider and an external supplier of services.

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References

Barney, J. B. (1991) 'Firm Resources and Sustained Competitive Advantage', *Journal of Management* (17:1), pp. 99-120.

Cabinet Office (2011) *ITIL Service Strategy*, TSO, London.

Cash, J.I.Jr., McFarlan, F.W., McKenney, J.L., Applegate (1992) *Corporate Information Systems Management: Text and Cases*, 3rd edition. Homewood, Il. -- Boston, Ma.: Irwin

Chen, D. Q. and Mocker, M. (2010) 'Information Systems Strategy: Reconceptualization, Measurement, and Implications'. *MIS Quarterly*. Vol. 34 No. 2, June 2010, pp. 233-259

Earl, M.J. (1989) *Management Strategies for Information Technology*. New York: Prentice Hall.

Gartner (2015) 'IT Strategy', *Gartner IT Glossary*, [Online], Available: http://www.gartner.com/it-glossary/it-strategy [2 Sept 2015]

Hambrick, D. C., and Fredrickson, J. W. (2001) 'Are You Sure You Have a Strategy?', *Academy of Management Executive* (15:4), pp. 48-59.

COBIT (2007*) COBIT 4.1*, IT Governance Institute

Mintzberg, H. (1987) 'The Strategy Concept I: Five Ps for Strategy', *California Management Review* (30:1), pp. 11-24.

MOF Overview (2008) *Microsoft Operations Framework. MOF Overview*, Ver. 4.0, Microsoft Solution Accelerators

MOF Business/IT Alignment (2008), *Microsoft Operations Framework. Business/IT Alignment Service Management Function*, Ver. 4.0, Microsoft Solution Accelerators

Nolan, R. and McFarlan, F.W., (2005) 'Information Strategy and a Board of Directors'. *Harvard Business Review*, October 2005, pp. 96-106

Porter, M. E. (1980) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, New York: Free Press.

Porter, M. E. (1985) *Competitive Advantage*, London: Free Press

Prahalad, C. K., and Hamel, G. (1990) 'The Core Competence of the Organization', *Harvard Business Review* (68:3), pp. 79-93.

Rivard, S., Raymond, L., and Verreault, D. (2006) 'Resource-Based View and Competitive Strategy: An Intended Model of the Contribution of Information Technology to Firm Performance', *Journal of Strategic Information Systems* (15), pp. 29-50.

Rackoff, N., Wiseman, C. and Ullrich, W.A. (1985). 'Information Systems for Competitive Advantage: Implementation of a Planning Process'. *MIS Quarterly* (December 1985).

Rouse, M. (2015) IT strategy (information technology strategy) definition, *Searchcio*, [Online], Available: http://searchcio.techtarget.com/definition/IT-strategy-information-technology-strategy [2 Sept 2015]

Toolbox (2015). 'Definition IT Strategy'. *Toolbox for IT. Wiki*, [Online], Available: http://it.toolbox.com/wiki/index.php/Definition_IT_Strategy [2 Sept 2015]

INFORMATION SOCIETY AND TRENDS IN IT EDUCATION

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Author's project computer support organizational creativity

Kamila Bartuś[1], Thomas Bartuś[2]

Abstract. The article presents the characteristics of it-enabled organizational creativity support. The first to be introduced in the subject of organizational creativity and lists the tools that can support it. Further it proposes and describes the unique concept of a computer system to support the work of the organization. The purpose of this article is characteristic of the architecture and functionality of the proposed system selected computer. The research results may help in the design of computer systems to support the work of the organization.

Keywords: organizational creativity; organizational creativity support.

JEL Classification: C61, L25

1. Introduction

It should be pointed out that a purpose of this project is not to develop a creativity computer/IT/information system (Creativity Systems) which will generate new ideas alone. The purpose is to develop an information system that will support the organizational work at every organizational level (unit / group / organization).

According to many scholars (Gong, Haung and Farh, 2009; Klijn and Tomic, 2010; Choi, Madjar and Yun, 2010; Zhou and Ren, 2012), organizational creativity means the capability to generate new and useful ideas concerning some products, services, processes, managerial practices as well as competitive strategies (Olszak, Lorek, Bartuś, 2015). It might be investigated from many different perspectives. The following approaches are distinguished in literature:

- Creativity as process – process-oriented approach (Woodman, et al., 1993), (Shalley, et al., 2000), (Martins & Terblanche, 2003), (Alvarado, 2006), (Hirst, et al., 2009), (Baer, 2012), (Basadur, et al., 2012),
- Creativity as problem solving (Osborn, 1953),

[1] University of Economics in Katowice, Faculty of Economics, department of Business Informatics, ul. Bogucicka 3, 40-226 Katowice, Poland, kamila.bartus@ue.katowice.pl.
[2] University of Economics in Katowice, Faculty of Economics, department of Business Informatics, ul. Bogucicka 3, 40-226 Katowice, Poland, tomasz.bartus@ue.katowice.pl.

- Creativity as problem finding (Jay & Perkins, 1997),
- Creativity as interaction (Borghini, 2005),
- Creativity as knowledge creation (Huang, 2006),
- Creativity as teamwork and collaboration (Andriopoulos & Dawson, 2014).

Therefore, the range of usability and functionality provided by IT systems supporting organizational creativity is very wide. Usually, ICT tools enable information transfer and communication in organizations. And this favours directly organizational creativity. (Woodman, et al., 1993). In literature related to IT- supported creativity processes there is a set of significant properties that IT/computer systems should have. One of authors claims that IT systems within this domain should (Proctor, 2002):

- Facilitate moving between stages/phases of a process of creative problem solving,
- Provide mechanisms that stimulate thinking, e.g. to collect ideas and/or make maps of relationship between them,
- Provide structure for creative process support, e.g. to facilitate problem classification.

Analyzing IT solutions that correspond to needs of both individual and organizational creativity, it seems that the solutions are not sufficient to solve completely all the needs in this domain. Indeed, they constitute specific groups of IT tools, and each group contributes to a different aspect of creativity support.

The division made by Shneiderman is quite interesting (Shneiderman, 2007). The author specifies particular groups of tools together with examples of solutions they provide. The details are presented in a table below.

Table 1 Groups of creativity- supporting tools with examples, Source: (Shneiderman, 2007).

Tools for individual and group creativity support	
Information visualization tools	Spotfire, SAS JMP, DataDesk, ManyEyes, Digg
Specialized visualization tools : GIS	Google Maps, ArcInfo
Specialized visualization tools: gene expression analysis	GeneSpring, DNASTAR
Mathematical calculations	MatLab, Mathematica
Projects within: engineering, architecture, industry, products	Autocad Inventor, DataCAD, SolidWorks
Simulations	SPICE, Terra
New media environments	Max/MSP, Pd processing
Animation and interaction	Flash, FLEX, OpenLaszlo
Music	Cinescore, Cakewalk Sonar
Video	Premier, Final Cut Pro, Lightworks, iMovie, Windows MovieMaker
Ideas mapping	Inspiration, MindMapper, MindManager, Axon
Tools for group and social creativity support	
Software development	Eclipse, JDeveloper, Visual Studio
Wiki	Wikipedia, Wikia
Social journalism	Blogger, Ohmynews, Slashdot
Media sharing	Flickr, YouTube
Music	Garageband, MacJams

2. Research method

The research involves an attempt to develop and programme an original (proprietary) information system for organizational creativity support. On the basis of results obtained, an attempt to implement the system shall be undertaken.

To do this, a research experiment was conducted consisting in developing a model of computer system. The main task of such the computer system model is to support organizational creativity both at numerous levels (unit, group, entire organization) and particular stages of organizational creativity (data acquisition and analysis, sharing ideas in organizations and further recommendation and application of the ideas).

3. Proposition of architecture of organizational creativity computer support system

A previously conducted evaluation and study of already existing IT systems indicates clearly that they contribute to individual/single (non-integrated) solutions, and their architecture lacks important elements that are crucial from the perspective of organizational creativity. Therefore, when developing architecture of a computer system for organizational creativity support, the following key assumptions are adopted:

- In organizational creativity important are: accessing, transferring, and processing of resources (including information), and discovering new knowledge in terms of creating interesting recommendations and new ideas,
- Input database/resources in the process of organizational creativity are: input and output data, information system managing the data, personalities and other human qualities, group relationship and relationships between group members,
- Continuing interface between system output (recommendations, final ideas) and system input enhances creativity processes,
- In the system, particular intelligent agents are attributed with functions requested from the information/IT system at particular stages of the process (data collecting, knowledge-mining, making recommendations, evaluation and result sharing).

Before developing the complete architecture of the organizational creativity support system, its general framework was made. It is proposed to include the following elements into the framework (see Fig. 1):

1) System input: The system input includes the characteristics describing a creative task as well as a context of the investigated situation;
2) Kernel of the computer system processing data;
3) Creativity system output:
    a) Collection of creative recommendations allowing solving the creative task posed at the beginning;
    b) Sharing the recommendations among organization members and its stakeholders;

4) Tools for distributing and reviewing the results (sharing new recommendations / ideas).

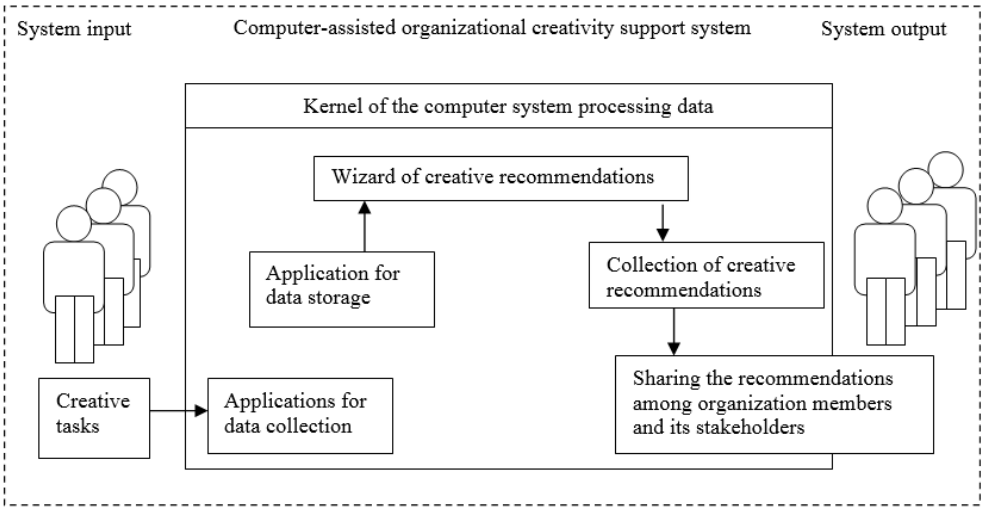

Figure 1 Place of Extraordinary Event, Source: Taha, 2010

Before developing the complete architecture of the organizational creativity support system, its general structure was created (see Fig. 2). The structure consists of the following elements:

1) Source data:
    a) Internal, i.e. saved in information systems of an organization,
    b) External, i.e. saved in information systems of business partners and WWW, with particular interest in price comparison websites, databases of academic research papers, and databases of patents,
2) Organizational creativity:
    a) culture, processes,
    b) society, technology, information systems,
3) Data identifying and collecting/loading:
    c) Monitoring agents that detect and track any changes/modifications of website content,
    d) Capturing agents that acquire data, then filter/clean data and load/collect them from selected WWW,
4) Data repository that captures data collected in the organization as well as data collected by agents from WWW,

5) Knowledge-mining, in order to extend knowledge within particular subject investigated, which leads to creation of interesting recommendations and, consequently, new ideas,
6) Usability and results sharing, including communication and evaluation of results.

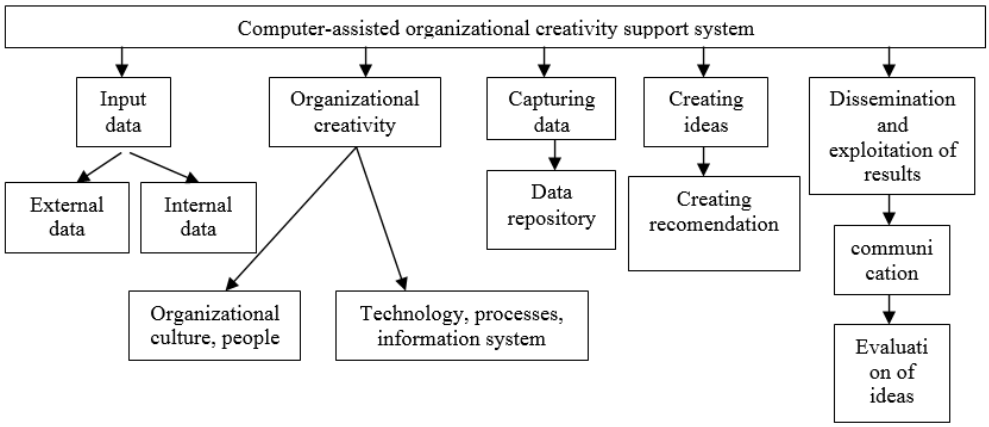

Figure 2 Scheme of structure of organizational creativity support system
Source: Own study

It is assumed that a multi-agent system for automatic acquisition of data from selected resources (mainly external) should consist of the following five modules (Fig. 3):

- Monitoring agents,
- Capturing agents,
- Creative agents, knowledge-mining agents that discover new knowledge and provide recommendations,
- Manager agent,
- Data repository,
- Portal of idea validation and communication.

Monitoring agents

The monitoring agents are responsible for tracking any changes/modifications in selected websites (price comparison websites, databases of academic research papers, and databases of patents), related to selected products and/or services as well as desired content. The purpose of any monitoring agent is to track the changes. In the case of price comparison website, these changes may refer to product features and/or opinions

on the product ("positive", "negative"). Considering databases of academic research papers, the changes may apply to new publications in particular science. And tracking databases of patents may result in finding new patents in various domains.

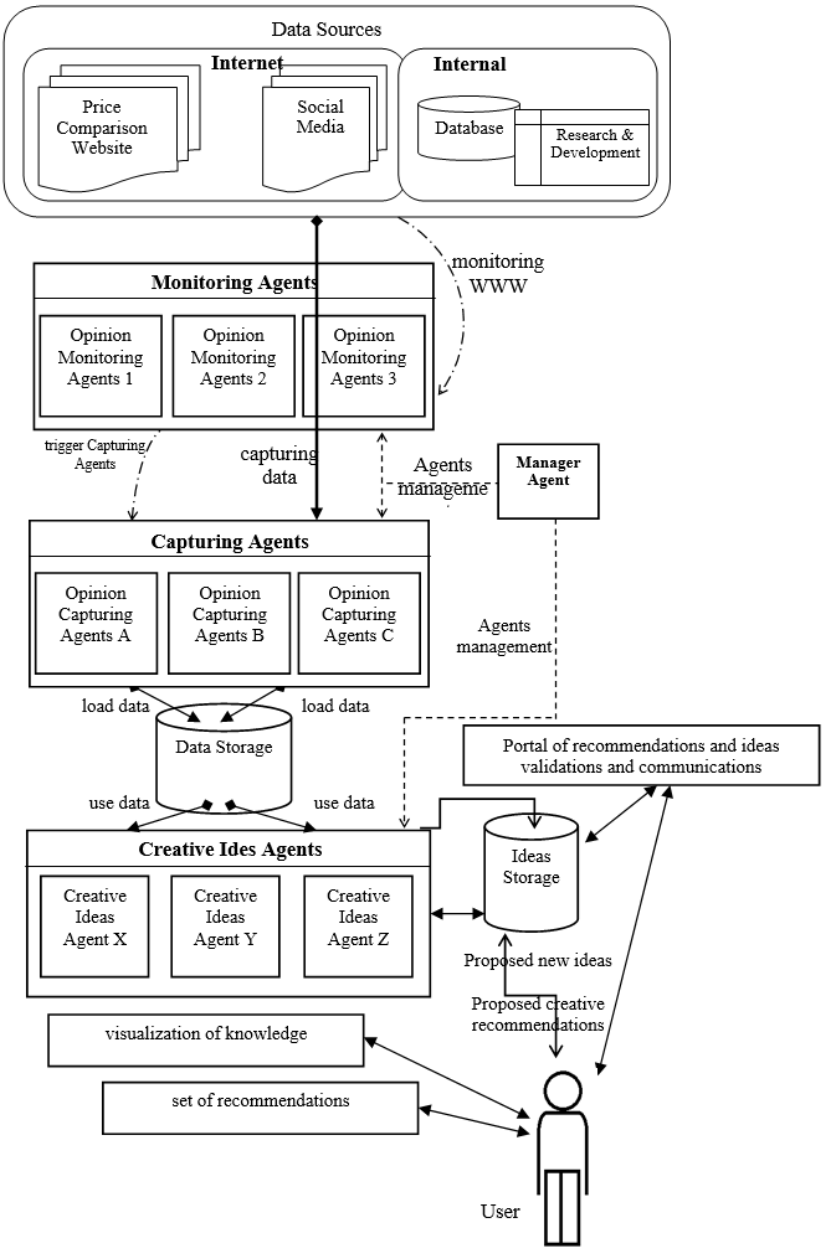

Figure 3 Architecture of computer-assisted organizational creativity support system
Source: Own study based on (Olszak, Bartuś, 2015).

Capturing agent

The purpose of any capturing agent is to collect the desired information on the subject being monitored. Each monitoring agent has own equivalent capturing agent. According to operations of monitoring agents, capturing agents acquire: (1) opinions on the desired product from the selected price comparison website (Fig. 4), (2) academic publications on selected subject/science (Fig. 5), and (3) patents (Fig. 6). Usually, it consists in acquiring particular key words, expressions, or contents. Capturing agents act as a specific interface or integrator of web sources and business data. The data acquired by particular agents are saved in repository system.

```
User;ReviewsNumber;Yes;No
kiss_me2070;1871;fantastic camera, good features/specs, easy to use;few problems with battery \u0026 ca
jjcross;287;Great all rounder of a phone, waterproof, removeab;The LG G3 will be with us soon, some mig
badongism;80;Great camera, innovative features, excellent batte;Build quality not the best, user Interf
AndyJohn83;2;Very good camera (if not a little slow sometimes),;Can be a little slow and unresponsive w
matthew_owens;2;Very nice screen, Quick, Apps run smoothly, finger;Battery life, screen si
Emilio1993;28;Performs very well, great design, high quality cam;Expens
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Figure 4 Example of data collected from price comparison (http://www.ciao.co.uk/), Source: Own study.

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Autor;SN;DO;URL;KW1;KW2;KW3;KW4;KW5;KW6;KW7;KW8;KW9;KW10;KW11;KW12;KW13;KW14;
Ngoasong, Michael Z.Kimbu, Albert N.;0261-5177;http://dx.doi.org/10.1016/j.tourman.2015.07.012;http://www.sciencedirect.com/science/article/pii/S02615177
Yang, XiupeiGao, HuanhuanQian, FanZhao, ChuanLiao, Xiangjun;0731-7085;http://dx.doi.org/10.1016/j.jpba.2015.08.037;http://www.sciencedirect.com/science/a
Zhou, YayunZhou, QiangLiu, YongWang, ZhengliangYang, Huiwang, Qin;0025-5408;http://dx.doi.org/10.1016/j.materresbull.2015.08.022;http://www.sciencedirect
Cao, JianhuaDing, LipingZhang, YuanyuanWang, ShihuaiFang, Yu;1010-6030;http://dx.doi.org/10.1016/j.jphotochem.2015.08.017;http://www.sciencedirect.com/sc
Kneer, JuliaElson, MalteKnapp, Florian;0747-5632;http://dx.doi.org/10.1016/j.chb.2015.07.034;http://www.sciencedirect.com/science/article/pii/S0747563215
Kumari, PujaNanam, J.;1386-1425;http://dx.doi.org/10.1016/j.saa.2015.07.039;http://www.sciencedirect.com/science/article/pii/S1386142515300883;Phosphor;P
Guenin, B.Pivotto, I.Wollan, P.;0195-6698;http://dx.doi.org/10.1016/j.ejc.2015.04.005;http://www.sciencedirect.com/science/article/pii/S0195669815001043;
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Figure 5. Example of data collected from database of publications (http://www.sciencedirect.com/), Source: Own study

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idPatent;Title;Description;PublishedDate
1; LONG-AFTERGLOW LED LUMINOPHORE, OUTDOOR LED DISPLAY SCREEN AND AFTERGLOW PRESENTATION CONTROL METHOD THEREFOR; Provided are a long-afterglow LED luminophore, an out
2; DEVICE FOR MEASURING PRESSURES IN TUBE CUFFS;" The invention relates to a device for measuring pressures in the cuff of endotracheal tubes, said device comprising:
3; SHOOTING SYSTEM, GUN, AND DATA PROCESSING DEVICE; Provided is a shooting system comprising a target, a gun, and a data processing device, wherein the target is equ
4; METHODS AND SYSTEMS TRACKING HEAD MOUNTED DISPLAY (HMD) AND CALIBRATIONS FOR HMD HEADBAND ADJUSTMENTS; Methods and systems are provided for head mounted display (HM
5; APPLIANCE DIAGNOSING DEVICE AND APPLIANCE DIAGNOSING METHOD; Failure diagnosis of an appliance having an LED as the sole output device is performed by a single diag
6; BACKLIGHT SOURCE OF LIQUID CRYSTAL DISPLAY APPARATUS AND DRIVE CIRCUIT THEREOF; A backlight source of a liquid crystal display apparatus comprises an LED lamp bead
7; SEAMLESS TILED DISPLAYS;" A tile and a tiled display system is described comprising at least two adjacent tiles each having a display screen with display pixels wh
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Figure 6 Example of data collected from database of patents (https://patentscope.wipo.int), Source: Own study

Creative agents

The third group in the system proposed consists of creative agents. Their purpose is to generate a collection of creative recommendations relevant to product qualities. Their operations aim at supporting system-users while creating the recommendation. The agents, discovering knowledge by mining data collected in the repository by the capturing agents, create the collection of recommendations. Operating by the way of an association analysis, they

find interrelationships between particular qualities of products and opinions of users on the product ("positive", "negative"), key words within the domains studied (publications, books, and patents). On such the grounds, the collection of recommendations is generated, including specifications of product features on the selected price comparison website that are mentioned and evaluated by their end-users most often as well as the priority of introducing changes (e.g. feature A – very high priority) (Fig. 7).

Yes	Val
fantastic camera	very high
waterproof	very high
battery	high
Nice Feel and Look	high
Performs very well	medium
heart monitor	medium
Fast and Smooth flow	medium
Great all rounder of a phone	low

Figure 7 Example of recommendations, Source: Own study

On the basis of the recommendation collection generated by the agents, the system user obtains the final recommendations, information on, according to system users, what product features are positive and should be developed and/or mastered and what features are negative and should be eliminated. If there is a paper on the subject investigated in the database of academic publications, system users will obtain, additionally, a list of key words and abstracts of suitable academic research papers (with WWW links) as well as a list of patents within this particular domain (if they exist).

Data repository system

Systemic data repository serves storing, analysing, and sharing of the data obtained by the particular creative agents. The data collected in the system are processed and analysed by creative agents. Then, the collections of recommendations are generated and they are saved in a relevant table (recommendation table). Any system user may take into account the recommendations saved and, then, build new ideas on the basis of these recommendations. The new ideas are incorporated in a table with Ideas. Due to such the approach in one information system, the remaining system users and/or stakeholders may view all ideas, comment and evaluate/score

them. The activity of system users (commenting, scoring) are saved in the table.

WWW portal for idea validation and communication

The role of communication, validation, and reviewing new ideas is to ensure any stakeholder of organizational creativity with the space to joint working. The task of WWW portal is providing the intermediation within communication, accompanied by simultaneous and parallel work on creativity throughout the organisation. Therefore, it has to support the operations such as communicating, validating, reviewing, and classifying recommendations and ideas. The project is aimed at stimulating discussion and exchanging information in a group. The key task of communication layer is enhancing the quality of the work of the group by eliminating the problems such as lack of coordination, information lack/overload, and necessity to apply many different non-integrated information systems.

4. Characteristics of selected functions of computer-assisted organizational creativity support system

Under the architecture of computer-assisted organizational support system presented above, it is possible to perform a lot of functions executed in particular modules of the system. The key functions of organizational creativity support system include:

- Integration in one computer system of the idea development at the level of entire organization,
- Identification and acquisition/extraction of data from many different sources with high potential (e.g. library sources, price comparison websites with opinions on products posted by their end-users) - supporting organizational creativity by facilitating data finding, browsing, and visualizing,
- Creativity support, including creative thinking, making correlations/relationships between elements of a problem, intelligent analysis of data directed towards defining the relationship/correlation between information – by applying original projects of data analysis (e.g. QlickView, Tableau, Spotfire or original gravitational graph),
- Creative process support – by loose associations, solution investigation, artefact creation, idea reviews,

- Sharing effects of creative work,
- Providing system users with a virtual environment to teamwork.

Functionality of Multi-Agent System

The multi-agent system proposed consists of three–module groups: (1) agent monitoring data resources/databases (2) agents capturing the data, (3) data repository supplemented by the agents: opinions on products, social media, library databases, and (4) manager agent. The first group of agent is responsible for monitoring the data resources indicated by system user. When any changes/modifications are detected (new opinions, new references in library database), the data capturing agent is activated. The agent, while capturing the data on the basis of regular expressions, collects rough data (without unnecessary html attachments). The group of agents plays also the role of interface connecting Internet resources, namely price comparison websites and/or social media, with information system infrastructure of the organization and data repository system of the organization. Group 3, i.e. data repository, serves storing and processing data captured by the agents. Finally, due to the manager agent, it is possible to configure and monitor/supervise the work of MAC system. A single agent is equipped with functions, rules, and methods to operate in the appropriate domain (WWW monitoring and data capturing). Particular agents are autonomous units, i.e. they can operate alone or cooperate with other agents. The figures below show the effects of operations of multi-agent system proposed.

Functionality of data reconfiguration and analysis

A further function of the system in accordance to requirements of computer-assisted organizational creativity support is to facilitate finding, browsing, and visualizing as well as defining relationships/correlations between information (by loose associations, solution investigation, artefact creation). The function is performed in the system by software that enables the agents a dynamic analysis of data and, on the other hand, limiting, as possible, the necessity to manage the complex structures of data (e.g. data warehouses, OLAP cubes). This tool belongs to, so called, BI in-memory group. One of the examples is QlikView software (Fig. 8).

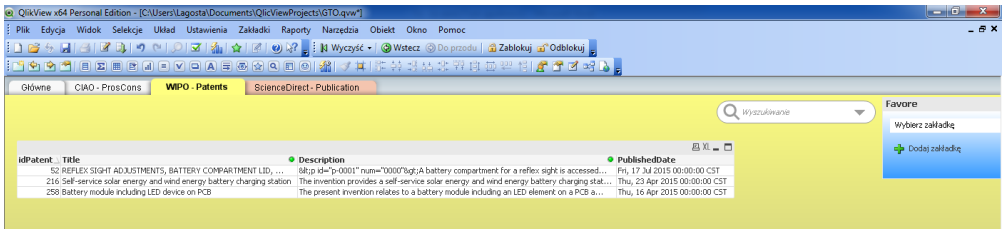

Figure 8 Example of data collected from database of patents (https://patentscope.wipo.int) – only patents with the word battery,Source: Own study

Functionality of graphic analysis and interpretation of data

Due to the graphic analysis, it is possible to download databases acquired from Internet resources. An interesting example of the application of graphic structures in business analytics is knowledge-mining and exploiting the knowledge included in opinions of consumers. The careful analysis of consumer opinions is significant because, firstly, it enables the organization to assess the effectiveness of marketing operations performed so far, and secondly, it may suggest other solutions enhancing the development of organization. One of the crucial issues is the selection of appropriate information range and its visualization.

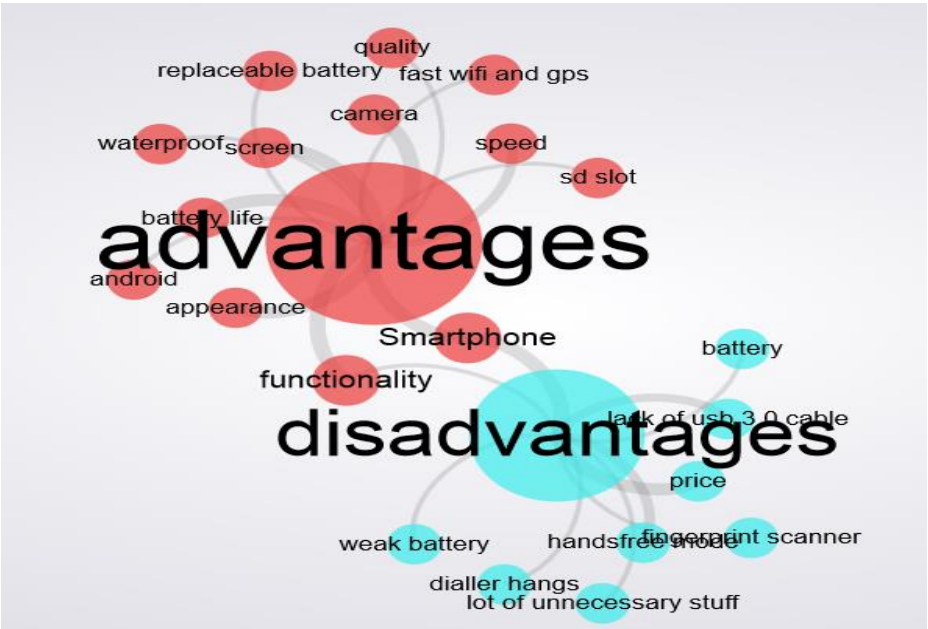

Figure 9 Visualization of relationship between the features of selected product and the users opinions (“positive”,”negative”),
Source: (Olszak, Bartuś, Lorek, 2015).

Lack of the proper selection of information resources, even with the support of data visualization provided, may not bring sufficient knowledge. On the grounds of these assumptions, the software was created involving Gephi libraries (Bastian, Heymann, Jacomy, 2009) and NetworkX (NetworkX, 2015) in order to study and verify experimentally the capabilities of agents to explore the knowledge included in consumer opinions in the form of graphic structures. The example of the non-selected data visualization is presented in the figure below (Olszak, Bartuś, Lorek, 2015).

5. Conclusion

The main conclusion of the project implies that organizational creativity requires the continuous exploration of knowledge, its exploitation, and the creation of new ideas on the grounds of the knowledge possessed. On the other hand, it requires sharing the new ideas developed. From the perspective of organizational creativity, expected is the ability to the fast exploration of interesting information sources, the efficient analysis of information, and, consequently, generating useful recommendations or even new ideas. What is more, organizational creativity support is resulting from the specific properties, such as flexibility, dynamics, process-like nature, lack of structure (un-structured nature) (Mumford, et al., 2011) (Mumford, et al., 2012) and teamwork (Andriopoulos & Dawson, 2014).

A number of studies have demonstrated that suitable IT solutions, selected properly, play a significant role in terms of developing innovations in enterprises (organizations) – comp. e.g. (Kleis, et al., 2012). It is caused by the fact that integrated IT systems improve the business operations of organizations in the domains such as knowledge management, cooperation, research and development, concurrent work (ibidem, also (Pavlou & El Sawy, 2006)). This paper discusses the functionality of computer-assisted system supporting organizational creativity.

Acknowledgements

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Literature

Alvarado, L. D., 2006. The creative organizations as living systems. [In:] *S. Torre i V. Violant,* redaktorzy Understanding and evaluating creativity. Malaga: Editiones Algiba.

Andriopoulos, C. i Dawson, P., 2014. *Managing Change, Creativity and Innovation. Second Edition.* Los Angeles/London/New Delhi/Singapore/Washington DC: SAGE Publications.

Baer, M., 2012. Putting Creativity to Work: The Implementation of Creative Ideas in Organizations. *Academy of Management Journal*, 1 October, 55(1).

Bastian M., Heymann S., Jacomy M. (2009), *Gephi: an open source software for exploring and manipulating networks*. International AAAI Conference on Weblogs and Social Media, gephi.github.io. Access 15.08.2015.

Borghini, S., 2005. Organizational creativity: breaking equilibrium and order to innovate. *Journal of Knowledge Management*, 9(4).

Hirst, G., Knippenberg, D. v. i Zhou, J., 2009. A Cross-Level Perspective on Employee Creativity: Goal Orientation, Team Learning Behavior, and Individual Creativity. *Academy of Management Journal*, 1 April, 52(2).

Huang, M., 2006. *Contextual Factors in Knowledge Networks That Influence Creativity.*

Jay, E. i Perkins, D., 1997. Problem finding: The search for mechanism. W: M. Runco, red. *The creativity research handbook.* Cresskill: Hampton Press.

Kleis, L., Chwelos, P., Ramirez, R. i Cockburn, I., 2012. Information Technology and Intangible Output: The Impact of IT Investment on Innovation Productivity. *Information Systems Research*, 23(1).

Martins, E. C. i Terblanche, F., 2003. Building organisational culture that stimulates creativity and innovation. *European Journal of Innovation Management*, February, 6(1).

Mumford, M.D., Medeiros, K.E., Partlow, P.J. (2012). *Creative thinking: Processes, strategies, and knowledge.* The Journal of Creative Behavior, 46, 30-47.

Olszak C.M. (2015), *Komputerowe wspomaganie twórczości organizacyjnej. Wybrane problemy*. "Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach", 212, pp. 110- 123.

Olszak C., Bartuś T. (2015*), Multi-Agent Approach in Designing of Organizational Creativity Support* [in:] J. Q. Chen, D. Xinghua, W. Hu and R. Zhan (ed.), *IS Management and IS Engineering in the Era of Big Data*, Xi'an University of Technology, Published by Academic Conferences and Publishing International Limited Reading UK, pp. 93-102.

Olszak C., Bartuś T., Lorek P. (2015*), Selected issues in design of it – enabled organizational creativity support* [in:] I Kongres Informatyki Ekonomicznej (in print).

Olszak C.M., Bartuś T. (2013), *Multi-Agent Framework for Social Customer Relationship Management Systems* [in:] E. Cohen (ed.), *Issues in Informing Science and Information Technology*, 10, Informing Science Institute, Santa Rosa, pp. 368-387.

Osborn, A., 1953. *Applied imagination.* Oxford: Scribner'S.

Pavlou, P. i El Sawy, O., 2006. From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development. *Information Systems Research*, 17(3).

Proctor, T., 2002. *Twórcze rozwiązywanie problemów.* Gdańsk: Gdańskie Wydawnictwo Psychologiczne.

Shalley, C.E., Gilson, L.L., & Blum, T.C. (2000). *Matching creativity requirements and the work environment: Effects on satisfaction and intentions to leave*. Academy of Management Journal, 43, 215-223.

Shneiderman B (2007), *Creativity support tools: accelerating discovery and innovation*, Communications of the ACM, Dec., 2007. Vol 50, pp. 20-32.

Woodman, R. W., Sawyer, J. E. i Griffin, R. W., 1993. Toward a Theory of Organizational Creativity. *The Academy of Management Review*, April, Vol. 18

NetworkX – *High productivity software for complex networks*, networkx.github.io (Access: 10.08.2015).

A Typology of Methods for E-learning Assessment

Mariusz Grabowski1

Abstract. E-learning appears to be a pervasive and complex phenomenon. It is also a very difficult object for an effective quality assessment due to its multifaceted nature. The paper presents literature overview of various attempts aimed at quality evaluation and/or improvement of e-learning systems. As a synthesis, the typology of e-learning quality assessment methods is presented. This taxonomy of methods is supplemented with their characteristics that make them suitable for usage in the specific contexts

Keywords: e-learning, assessment methods, evaluation models, typology.

JEL Classification: I23, L86, C52

1 Introduction

Increased use of information and communication technology related to the proliferation of the Internet resulted in the change of life and work in various areas of human activity that does not have an equivalent within the history. The education domain, in general and higher education, in particular are no exceptions, where e-learning tools are a vital innovation. E-learning environment has many references in the literature such as CMS (Course Management System), LMS (Learning Management System), VLE (Virtual Language Environment) or MOOC (Massive Open Online Courses).

E-learning owes its popularity to various factors. The most important evolve around the centric role of the learner who is able to adjust the pace of a learning process and to choose the time and place of training. Other factors include cost effectiveness, potential availability to global audience, unlimited access to knowledge reuse and archiving and sharing functionalities. The other very important benefit of e-learning is the potential for creating equal opportunities in relation to marginalized social groups and third world countries (Murugesan, 2012). It also has some disadvantages, e.g. lack

[1] Cracow University of Economics, Department of Computational Systems, grabowsm@uek.krakow.pl.

of immediate feedback in asynchronous learning process, increased preparation time for the instructor, uncomfortable way of interaction for some people and possibility of creating the frustration, confusion and anxiety in certain situations (Zhang et al., 2004, p. 76).

The main objective of this paper is to present a literature review of various attempts for e-learning quality assurance supplemented with their typology accompanied with comments allowing to decide on appropriate context of their use. The subject is covered in the next three sections of the paper. Firstly, the problems of e-learning quality assurance are briefly described as well as the definition of e-learning quality used in this paper is provided. Then, the literature overview of the main approaches for e-learning assessment is discussed together with their classifications. Finally, the conclusions together with discussion of the obtained results are submitted.

2 Quality assessment of e-learning

E-learning is a widespread and multifaceted concept. Therefore, it constitutes a very difficult object for effective quality assessment. There is no commonly accepted definition of e-learning or a commonly accepted definition of e-learning quality. The limited length of this paper does not allow for a comprehensive discussion of the above issues and only a short description concluded by delivering functional definitions of the above terms will be provided.

In this paper, the term e-learning system is defined as a specialized educational web service, consisting of publically accessible portal-informational part and a restricted area offering access to knowledge resources and communication facilities. E-learning platform includes the following functionalities: providing dedicated content to authorized users, offering the tools to implement the learning process, enabling tracking and evaluating the progress in the learning process, and allowing management of teaching content, users and their groups, access rights as well as generate reports (Dąbrowski, 2013, p. 207). E-learning is however not limited to technological dimension only. As explained in the following section, the quality of e-learning may be assessed only in the relationship to the people who interact with it (learners and instructors) and the organization that creates the surroundings for learning process.

As far as the quality of e-learning is concerned it must be stated that it does not constitute a well-defined measure as it relates to various perspectives (Penna and Stara, n.d.). In this paper the quality of e-learning process is defined in terms of a learner satisfaction. P.-C. Sun at all (2008) identified six quality dimensions (learner, instructor, course, technology, design and environmental) and 13 factors across these dimensions that influence the learner satisfaction. Their study indicated that the most critical factors for the quality of e-learning systems are: learner computer anxiety, instructor attitude toward e-Learning, e-Learning course flexibility, e-Learning course quality, perceived usefulness, perceived ease of use and diversity in assessments.

3 Literature review of e-learning quality assessment

The publications sample for literature study was selected through keyword-based searches conducted on bibliography databases including *ACM Digital Library, EBSCO, Science Direct, JSTOR* supplemented by Internet enquiries. Surprisingly, the number of quality scholarly papers on e-learning quality assessment was rather small. [1] As a result, 18 publications were selected for further analysis. These publications were qualified as related do e-learning (or mixed learning) quality assessment or improvement topics. As a result of the analysis, the selected papers were qualified into three basic categories of e-learning assessment (or improvements) methods: theory-based, institutional and standard-based. The typology of e-learning assessment and/or improvement methods is presented in the Table 1.

The theory-based category consists of two subcategories reflecting the concepts that are the bases of the constructed assessment or quality improvement models: TAM and SCT. The first subcategory relies upon technology accepted model (TAM). It was evidently confirmed within the conducted literature study that TAM (Davis, 1989; Davis, Bagozzi and Warshaw 1989) constitutes the most popular theoretical framework used in order to explain the motives and behaviours of IT users and thus, it may

[1] Within the entire publishing history of *MIS Quarterly*, *Information Systems Research*, *Information Systems Journal*, *European Journal of Information Systems* and *Journal of Information technology* only 6 papers contained „e-learning" keyword on their keyword list and only 3 of them (Cheng, 2011; Gupta and Bostrom, 2012; Santhanam, Sasidharan and Webster, 2008) could be qualified as related do assessing or improving e-learning quality.

be used to improve IT artefact's quality (i.e. effectiveness and efficiency). For this reason, it seemed appropriate to briefly describe this model in the paper.

Table 1 Typology of e-learning quality assessment methods, Source: own.

Category	Concept	Extension	References
Theory-based	TAM		Capece and Campisi (2013), Kim et al (2013), Tselios, Daskalakis, and Papadopoulou (2011),
		Extended by additional construct(s) derived form other theories and concepts including self-efficacy theory, expectation-confirmation theory, SERVQUAL, organizational learning, perceived innovation attributes, usability and media richness theory.	Buche Davis and Vician (2012), Liao and Liu (2012), Cheng (2011), Islam (2011), Martinez-Torrez et al (2008), Read and Leavy (2008), Sun at al (2008), Wong and Huang (2010), Wu and Hwang (2010), Wu, Hiltz and Bieber (2010)
	SCT	Self-efficacy theory	Santhanam, Sasidharan and Webster (2008)
		Adaptive structuration theory	Gupta and Bostrom (2012)
Institutional	Benchmark		Williams, Kear and Rosewell (2012)
	Checklist		NHS (2009)
Standard-based	ISO/IEC 19796-1		Pawlowski (2007)

The theoretical assumptions of TAM are derived from the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) and the theory of planned behaviour (TPB) (Ajzen, 1985). According to these theories the primary predictor of behavioural intention is formed by three mutually conditioning factors: attitude toward the behaviour, subjective norm and perceived behavioural control. If the perceived behavioural control reflects the real impact of a person on a given situation it can be considered as a direct predictor of a behaviour. In TAM (Figure 1) likewise in TPB the actual system use is determined by the behavioural intention. This intention, however, is shaped directly by the attitude toward using and perceived usefulness

and indirectly through perceived ease of use. TAM utilizes structural equation modelling technique (SEM) for a model estimation.

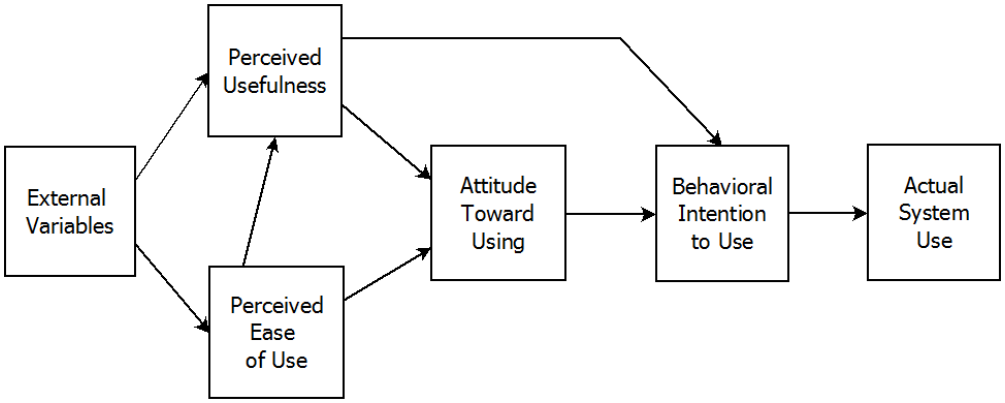

Figure 1 Technology Acceptance Model,
Source: (Davis, Bagozzi and Warshaw 1989, p. 985).

Within this TAM subcategory of the theory-based frameworks, some papers indicate that TAM was used in its original form (Capece and Campisi, 2013; (Kim et al, 2013; Tselios, Daskalakis, and Papadopoulou, 2011) and others show an extended version of TAM by adding some additional constructs from different theories and/or domains. The additional constructs include 'perceived enjoyment' (Cheng, 2011), 'performance' (Buche, Davis and Vician, 2012), 'perceived enjoyment', 'perceived learning' and 'recommendation for use' (Wu, Hiltz and Biber, 2010), and 'communicativeness', 'format', 'user adaptation', 'feedback', 'methodology', 'diffusion', 'user tools', 'enjoyment', 'reliability', 'accessibility', 'interactivity' and 'control' (Martinez-Torrez et al, 2008). Some papers explicitly quote the supplementary theories that were used in order to extend the study. They include self-efficacy theory (Cheng, 2011; Martinez-Torrez et al, 2008; Read and Leavy 2008), expectation-confirmation theory (Islam, 2011), SERVQUAL and organizational learning (Wong and Huang, 2010), perceived innovation attributes (Liao and Liu, 2012) and usability and media richness theory (Wu and Hwang, 2010).

Social cognitive theory (SCT) is a second subcategory for theory-based frameworks. It relies on the assumption that learning process is based on observing others in their social interactions. The papers within the bibliography study sample used two specific theories, i.e. adaptive

structuration theory (Gupta and Bostrom, 2012) and self-efficacy (Santhanam, Sasidharan and Webster (2008). Self-efficacy theory was a source of constructs in the already mentioned TAM category, but in papers belonging to SCT category, do not use SEM technique in the conducted studies.

The publications belonging to the second category of e-learning assessment methods typology originate in the institutions which define them in order to provide the quality of the e-learning courses. They may be benchmark-based or checklist-based. In case of benchmark-based framework (Williams, Kear and Rosewell, 2012) published by The Open University with some partner institutions as a result of various EU-funded projects is to provide a set of 35 benchmarks belonging to various dimensions including strategic management, curriculum design, course design, course delivery, staff support and student support against which e-learning courses may be judged. Checklist-based framework (NHS, 2009) includes a set of quality assurance checklist for evaluating learning objects and online courses. To each item on a given checklist a degree of meeting criteria and/or a comment may be assigned.

The least category of e-learning assessment methods typology contains only one paper (Pawlowski, 2007). This category is similar to the previous one, however in this case the originating institution is a formal commonly recognized standardization organization and thus it gives a higher degree of recognition by the business and educational communities. It also offers general quality reference model that requires adjustment to the given educational needs than predefined benchmarks or checklists.

6 Conclusion

The literature overview comprised in this paper shows that e-learning assessment is still an open question and needs further elaboration. The presented e-learning assessment methods typology qualifies researched papers into three groups which enable to define the appropriate context of their use for the described methods.

The methods qualified to the first category are aimed to assess the quality of existing e-learning systems. This category is based on theoretical concept taken from technology acceptance and use domain, social cognitive theory in general and self-efficacy in particular as well as form expectation-

confirmation theory, usability studies and media richness. It was also indicated that TAM and its derivatives are the most widely used theoretical concept in e-learning assessment scholarly literature. The methods qualified to the second group should be used in the definition phase of e-learning courses. They help to design a course with quality satisfying the educational institutions from which they originate. The standard belonging to the third category is aimed at defining the specific quality e-learning system for any institution.

The proposed typology may be extended by other categories and sub-categories, if needed. It is helpful for structuring the domain of e-learning assessment and thus has relevance for the theory and practice.

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References

Ajzen, I. (1985) 'From intentions to actions: A theory of planned behavior', *Action control: From cognition to behavior*, Berlin: Springer-Verlag, pp. 11-39.

Buche, M.W. Davis L.R. and Vician C. (2012) ,Does Technology Acceptance Affect E-learning in a Non-Technology-Intensive Course?', *Journal of Information Systems Education*, vol. 23, no. 1, pp. 41-50.

Capece G. and Campisi D. (2013) 'User satisfaction affecting the acceptance of an e-learning platform as a mean for the development of the human capital', *Behaviour & Information Technology*, vol. 32, no. 4, pp. 335–343.

Cheng, Y.-M. (2011) 'Antecedents and consequences of e-learning acceptance', *Information Systems Journal*, vol. 21 no. 3, pp. 269-299.

Dąbrowski, M. (2013) 'E-learning w szkolnictwie wyższym', *Studia BAS*, 3(35), pp. 203–212.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, vol. 13, no. 3, pp. 319-340.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989) 'User Acceptance of Computer Technology: A Comparison of Two Theoretical Models', *Management Science*, vol. 35, no. 8, pp. 982- 1003.

Fishbein, M. and Ajzen, I. (1975) *Belief, attitude, intention, and behavior: An introduction to theory and research*, Reading: Addison-Wesley.

Gupta, S. and Bostrom R. (2012) 'Research Note – An Investigation of the Appropriation of Technology-Mediated Training Methods Incorporating Enactive and Collaborative Learning', *Information Systems Research*, vol. 24, no. 2, pp. 454 - 469

Islam, A.K.M.N. (2011) 'The Determinants of the Post-Adoption Satisfaction of Educators with an E-Learning System', *Journal of Information Systems Education*, vol. 22, no. 4, pp. 319-330.

Kim, S.H., Kim, H.C. and Han, S.K. (2013) 'A development of learning widget on m-learning and e-learning environments', *Behaviour & Information Technology*, vol. 32, no. 2, pp. 190–202.

Liao, H.L. and Liu, S.H. (2012) 'A Comparison Analysis on the Intention to Continued Use of a Lifelong Learning Website', *International Journal of Electronic Business Management*, vol. 10, no. 3, pp. 213-223.

Martınez-Torres, M.R., Toral Marın, S.L., Barrero Garcıa, F., Gallardo Vazquez, S., Arias Olivac, M. and Torresc, T. (2008) 'A technological acceptance of e-learning tools used in practical and laboratory teaching, according to the European higher education area', *Behaviour & Information Technology*, vol. 27, no. 6, pp. 495–505.

Murugesen, R. (2012) 'Promising outcomes of an online course in research writing at a Rwandan university', *European Science Editing*, vol. 38, no. 3, pp. 60-64.

NHS 2009 *Quality Assurance Checklists for Evaluating Learning Objects and Online Courses*, [Online], NHS Education for Scotland Available: http://www.knowledge.scot.nhs.uk/media/4088630/quality_assurance_checklists.pdf [15.07.2105]

Pawlowski, J. M. (2007) 'The Quality Adaptation Model: Adaptation and Adoption of the Quality Standard ISO/IEC 19796-1 for Learning, Education, and Training', *Educational Technology & Society*, vol. 10, no 2, pp. 3-16.

Penna, M.P. and Stara, V. (n.d.), 'Approaches to E-Learning Quality Assessment', [Online], Available: http://isdm.univ-tln.fr/PDF/isdm32/isdm_pietronilla.pdf [7 July 2015].

Read M. and Levy Y. (2008) 'Integrating Trust and Computer Self-Efficacy with TAM: An Empirical Assessment of Customers' Acceptance of Banking Information Systems (BIS) in Jamaica', *Journal of Internet Banking and Commerce*, vol. 12, no. 3, pp. 1-18.

Santhanam R., Sasidharan S. and Webster J. (2008) 'Using Self-Regulatory Learning to Enhance E-Learning-Based Information Technology Training', *Information Systems Research*, Vol. 19, No. 1, pp. 26–47

Sun, P.-C., Tsai, R.J., Finger G., Chen, Y.-Y. and Yeh, D. (2008) 'What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction', *Computers & Education*, vol. 50, no. 4, pp. 1183–1202.

Tselios, N., Daskalakis, S., and Papadopoulou, M. (2011) 'Assessing the Acceptance of a Blended Learning University Course'. Educational Technology & Society, vol. 14, no. 2, pp. 224–235.

Williams, K. Kear, K. and Rosewell, J. (2012) *Quality Assessment for E-learning: a Benchmarking Approach (2nd ed.)*. Heerlen: European Association of Distance Teaching Universities.

Wong, W.-T. and Huang, N.-T.N. (2011) ,The Effects of E-Learning System Service Quality and Users' Acceptance on Organizational Learning', *International Journal of Business and Information*, vol. 6, no. 2, pp. 205-225.

Wu, D., Hiltz, S.R. and Bieber, M. (2010) 'Acceptance of Educational Technology: Field Studies of Asynchronous Participatory Examinations', *Communications of the Association for Information Systems*, vol. 26, art. 21, pp. 451-476.

Wu, W. and Hwang L.-Y. (2010) 'The Effectiveness of E-Learning for Blended Courses In Colleges: A Multi-Level Empirical Study', *International Journal of Electronic Business Management*, vol. 8, no. 4, pp. 312-322.

Zhang, D., Zhao, J.L., Zhu, L. and Nunamaker Jr., J.F. (2004) 'Can e-learning replace classroom learning?', *Communication of the ACM*, vol. 47, no. 5, pp. 75-79.

Modern Training Demon of Mobile Applications for the Gene Orchards

Mariana Kaštierová[1], Michal Kováčik, Bruno Jakubec

Abstract. We proposed the development of a mobile application that might be an interactive guide of publicly available virtual guide through an orchard obsolete and regional varieties of fruit plants The State Nature Conservancy of the Slovak Republic under the administration of The Landscape Protected Area of the White Carpathians, localized in the village of Stará Turá. We presented a model locality in teaching of multiple study courses focusing on landscaping and it shows a new innovative approach how to apply knowledge in the practice of the territorial planning. The proposed mobile application we do not understand only as the results of scientific research but also as an educational tool for the public, for various age categories. Public can learn more about the importance of genepool of obsolete and regional species of apple trees (*Malus sp*.) and pear trees (*Pyrus sp*.), that are growing in the genepool orchard. Students can create individual projects of mobile applications in their final theses and by this way they can support the dissemination of scientific information about cultural attractions in Slovakia. The mobile application encourages students to synthesize actively their findings from the study courses and it promotes the attractiveness and the efficiency of the learning process.

Keywords: mobile application, interactive learning, new technology, websites, public.

JEL Classification: I21, L86

1 Introduction and purpose

Since November 2013, Slovakia launched a national project Digitalization of the educational system of regional education project was completed in September 2015, its mission is to create an electronic education system and the introduction of electronic services in operation (Ministry of Education, Science, Research and Sport SR, 2015). This program is aimed at nursery, primary and secondary schools, and should be linked to university education system so that students' progress with the application. But not as users but as plaintiffs and designers. One of the challenges to higher education should be to build on the knowledge acquired during their studies at the

[1] Technical University in Zvolen/ Faculty of Ecology and Environmental sciences, Department of Landscape Planning and Creation, T.G. Masaryka 24, 960 53, mlynarcikova@tuzvo.sk

university for designing mobile application from the Department of studying by the student. In our contribution we present a concrete example of the mobile application for the study program protection and land use, the Faculty of Ecology and Environmental Sciences, Technical University in Zvolen. We offer students a new perspective on the possibility of using their knowledge in a practical manner through cooperation with the government, with the State nature Protection of the Slovak Republic, and the NGOs that the purchasers are potential mobile applications.

Our aim was to create a mobile application design, which presents to visitors the gene orchard of obsolete and regional varieties of fruit plants. It is located in the territorial scope of the Protected Landscape Area White Carpathians. The application aims to explain the occurrence of natural conditions, history and importance of fruit plants for the region White Carpathians. Therefore forms the basis for the work map (offline map) and database and fruit plants varieties application presents the natural and cultural-historical context investigated territory to visitors of different ages.

2 Materials and methods

Model locality represented the gene orchard with extensive care of the obsolete and regional varieties of fruit trees that occur within the territory of the White Carpathians governance, State Nature Conservancy of the Slovak Republic. It located in the district of the Nove Mesto nad Vahom, in the cadastral area of the village of the Stara Tura in parts Súš and Lazy. The orchard has an area of 1.9 hectares and it is strongly sloping plot with an altitude of 480-500 m n. m. The aspect is mainly south and south-west. The site is located on a flysch zone and the main soil unit is cambisol. Here is accessible collection of genetic resources who representing an important role in further dissemination, research, cultivation of fruit plants the gene orchard offers a suitable space for the realization of educational events. Part of orchard also includes a new economic building built in the style of traditional White Carpatian architecture. In the future, will be added other elements enhancing biodiversity of the agricultural ecosystem (Jakubec et al., 2015).

The information about orchard and varieties of fruit trees have been acquired gradually from November 2013 until the end of 2014 of the available

maps: Atlas landscape of Slovakia (Miklos, Hrnciarova, eds., 2002) and the National Geoportal that the web site: http:// www.geoportal.sk/sk/geoportal.html provides mapping services to the public. Important data for varieties of fruit trees we obtained mainly from field mapping obsolete and regional varieties in the region of the White Carpathians, in the Protected Landscape Aarea White Carpathians. Map data have been processed in ArcGIS 10.2

From all the information gathered from maps and terrain had created group, selected only off relevant information, with attributes appeal to people to using applications, and forcing him more to deal with the issue.

Visualization is an integral part of dealing with this sort of project. Important, but challenging is the view individual ideas of the sponsor to applications. This step, required many sketches and working drawings for design and regular consultations with the programmer. This phase is complicated, it may happen that the proposal will have to be recast several times. The proposal itself will be implemented in meta-graphic programs (GNU GIMP 2.8, Adobe Photoshop CS6TM, CorelDRAW X4TM). This will create a series of images with the appropriate use of colors, textures, layout images, tables, buttons, so that the application was the most natural and intuitive, and at the same time enthrall a distinctive design. Once the proposal is finished followed programmatic step in which had been processed selected information and visualization "come alive".

Programming step doing commissioned by a specialist, an expert in the development of mobile applications. For the presented mobile application we chose Android operating system, as the most widely used operating system for smartphone in Slovakia. Furthermore, because exist in the market Bundle Android (Android Studio), since is free available development environment for creating applications for Android operating systems. Furthermore, the use of the programming language Java (Java 6 EDK) and XML. In an open programming window will gradually encode different parts of applications as text boxes, maps, paragraphs, images, timers, etc. that will be inputted from the .xml files. After the programming all the application components, run the emulator, which serves as a simulator for system Android in the desktop computer, and is part of the Android package Studio (Chovaňák, 2013).

The testing phase is time-consuming. The process of programming and testing, provides accuracy and reliability of the application, can be repeated several times until exclude any estimated and actual program error.

Sharing the application is a step in the distribution of electronic educational materials to the public, students or professionals. The new application will be published on GooglePlay or another server, from where you can download it.

The result of work will be freely available mobile application, will be used by general as well as professional public, and all who are interested to learn more about the obsolete and regional varieties of apple and pear in a playful, innovative and easy way.

Figure 1 Examples of visualization windows mobile application, Source: own.

In the orchard is concentrated 69 genetic resources, namely 48 varieties of apple (Malus domestica Borkh.) and 21 varieties of pears (Pyrus communis L. emend. Burgsd.). The varieties are planted in the clasp 10 x 10 m, in two individuals, ie the total number of individuals in the set is 138. They are arranged by the oldest varieties to the youngest, landraces form a special group, and the positioning of trees in the gene set is shown in Fig. 2.

List of varieties of apple (Malus domestica Borkh.) and pear (Pyrus communis L. emend. Burgsd) which will be planted in the orchard:

Apple tree: Ananásová reneta, Antonovka, Astrachán biely, Banánové zimné, Blenheimská reneta, Boikovo, Boskoopské, Bročák (MO), Cár Alexander, Citrónové zimné, 'Croncelské', Červené tvrdé, Gascoyneho

šarlátové, Gdanský hranáč, Holubička MO, Homolka zelená MO, Hontianska končiarka, Hviezdnatá reneta, Jadernička moravská, Jeptiška, Kalvil červený jesenný, Kanadská reneta, Kardinál pásikavý, Kasselská reneta, Kniežacie zelené, Kožená reneta zimná, Kráľovnino, Krivostopka rýnska, Lebelovo, Londýnske, Malinové hornokrajské, Matkino, Parména zlatá zimná, Priesvitné letné, Ribstonské, Signe Tillish, Smiřické vzácne, Solivarské ušľachtilé, Stark Earliest, Strýmka, Ušľachtilé žlté, Vilémovo, Vlčí Vrch č.193 MO, Watervlietské mramorované, Zárostopka (MO), Zelenče rhodeislandské, Zuccalmagliova reneta.

Pear trees: Amanliská, Dekanka Robertova, Drouardova, Dvorná maslovka, Eliška, Esperanova Bergamotka, Hardyho, Charneuská, Konferencia, Kongresovka, Krivica, Krvavka (MO), Lucasova, Madam Verté, Marillatova, Mechelenská, Nagevicova, Pastornica, Ružová (MO), Smolienka (MO), Thiriotova.

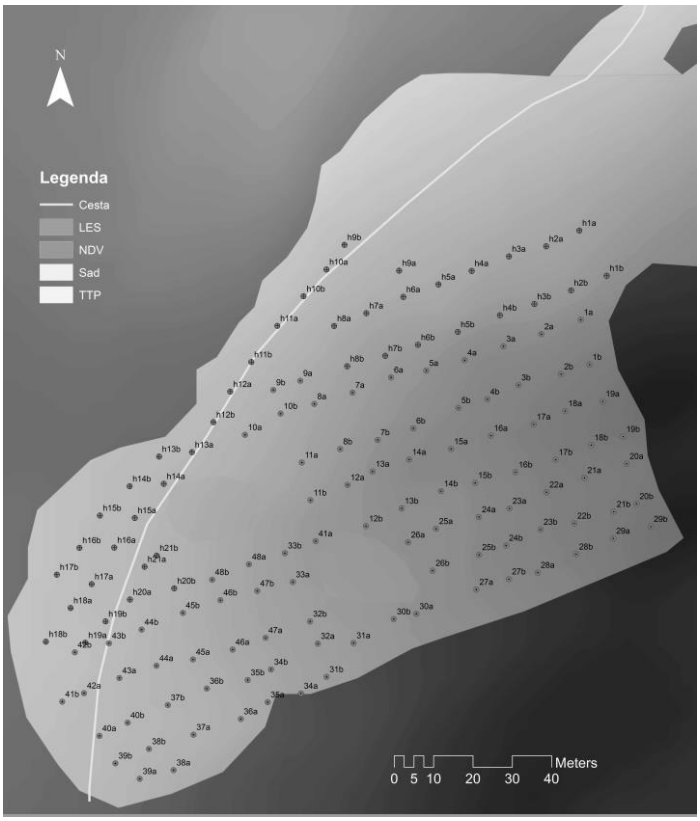

Figure 2 Location planted varieties of apple (Malus domestica Borkh.) And pear (Pyrus communis L. emend. Burgsd.) Of the synthetic gene pool orchard, Source: own

3 Discussion and conclusion

Mobile applications are suitable means as interesting and promptly to provide information to the target group of people and popularize the lesser known attractions of the region to tourists. Mobile application "Interactive walk through the orchard obsolete and regional varieties of fruit plants the State Nature Conservancy of the Slovak Republic, under the administration the Landscape Protected Area White Carpathians, we want to popularize the theme of traditional fruit growing and the issue of obsolete and regional varieties of fruit plants and bring a new perspective to orchards as part of our cultural, historical and natural heritage. Similar activities we did in the past, when we published for example, memory game, shown in Fig. 3, under the project "White Carpatian fruit treasure", which was supported by the Block Grant for NGOs and Partnership Support of the Swiss-Slovak cooperation, which was successfully completed in 2014.The application could be designed for several target groups:

Figure 3 Memory game, Source: own

1. Children - version of the application would be accessible in mobile games, such as a memory game, snake, and children can learn basic distinguishing marks to fruits obsolete and regional varieties of apples and pears.
2. The lay public - Simple intuitive version of the application, a few clicks giveaway about the varieties, the situate conditions, the characteristics of fruits and most appropriate utilization, of the cultural and historical

context of enlargement varieties in the region and their distribution in the Slovakia. Acquired knowledge, can also be used to custom designs and plans for planting fruit trees in the garden.

3. The professional public is the extended version of the application for lay public where you learn the latest information on grafting, cultivation, breeding varieties and of the pest. This will include a hyperlink to the professional and scientific projects available on the Internet related to a topic.

The trend of mobile applications is growing. Available is a multitude of applications, whether it is the application to facilitate online sales (banking application), learning (tests, presentations and whiteboards), moving in the country (GPS Navigation, the closest shops, etc.) and games. Of this amount can choose the most interesting and practically useful. The use of mobile applications in teaching is a perfect example to the popularization of science and technology not only among students but also among the general public. During the design the application, students can test their knowledge as well as skills they have acquired during their studies, and can transform the skills into beneficial service to public. Manage such a demanding project is currently beyond the study, but if it students successfully completed, it could have added value in their education system and a great experience to future employment.

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References

CHOVAŇÁK, M. 2013. Programovanie Android aplikácií pre začiatočníkov (1. Časť). Online: https://www.mojandroid.sk/programovanie-android-aplikacii-pre-zaciatocnikov-1-cast/

JAKUBEC, B., UHERKOVÁ, A., RAJCOVÁ, K., IŠTVÁNOVÁ, Z., MERTAN, V., DOVALA, O., BENEDIKOVÁ, D., STANO, D. 2015. Bielokarpatský ovocný poklad -

záchrana starých a krajových odrôd ovocných drevín v regióne Bielych Karpát. Banská Bystrica: Štátna ochrana prírody Slovenskej republiky, 2015, 67 s.

KELLY, T. M., VICE, J. 2015. Resources on the GO: Providing Support for Student Writters in a Mobile World. In: Student Succes in Writting Conference. Online: http://digitalcomons.georgiasouthern.edu/sswc/2015/2015/33

MIKLÓS, L., HRNČIAROVÁ, T., eds. 2002. Atlas krajiny Slovenskej republiky. Bratislava: MŽP SR, Banská Štiavnica: Esprit, 2002, 342 s.

MINISTERSTVO ŠKOLSTVA, VEDY, VÝSKUMU A ŠPORTU SLOVENSKEJ REPUBLIKY, 2015. Digiškola. O projekte. Národný projekt Elektronizácia vzdelávacieho systému regionálneho školstva. Operačný program informatizácia spoločnosti. Online: http://www.digiskola.sk/o-projekte/

Rich-media Innovative Technologies at Czech Secondary Schools

Ivo Martiník[1]

Abstract. The term rich-media describes a broad range of digital interactive media being increasingly used for the support of synchronous and asynchronous communication. Although the information technologies penetration reaches the world standard within the population of the Czech Republic, the exploitation of the new technologies including the rich-media technologies in everyday teaching and learning is far behind expectations. This is rapidly changing in a group of six Czech secondary schools. Based on the earlier pilot project at one of them, the Slavonic Grammar School in Olomouc, and under the technical guidance by the VŠB-Technical University of Ostrava, new approach to rich-media based interactive materials has been introduced, including completely symmetric asynchronous communication channels between teachers, students and their parents.

Keywords: Rich-media, EduArt, asynchronous communication, secondary schools.

JEL Classification: C63, C88.

1 Introduction

The term *rich-media* describes a broad range of digital interactive media being increasingly used for the support of synchronous and asynchronous communication, through which it is possible to share and transfer information and communicate in various ways. Moreover, rich-media enable interactivity, i.e., bidirectional communication. The characteristic feature of the rich-media technologies is their accessibility on-line or on-demand, followed by the support of the dynamics of changes. An example can be online streaming video reporting, which is updated during broadcast, or a record of presentation placed on a web site jointly with the synchronized slide show, which the user can interactively work with.

Rich-media technologies can be found in many areas of economy, but mainly at schools (e.g., record of presentations of lectures available in real time or upon request in all the forms of study, social communication among

[1] VŠB-Technical University of Ostrava, Faculty of Economics, Department of Applied Informatics, Sokolská třída 33, Ostrava, Czech Republic, ivo.martinik@vsb.cz.

the teachers and students, in the support of the educational process of students with special needs, mainly those with locomotive, aural and visual disability), in medical facilities (e.g., records of unique medical interventions and their distribution in real time), in the commercial sphere (e.g., mass interactive enterprise staff training, interactive communication in geographically distant locations), in public sector, in press and mass media, in culture, etc.

Currently, it is possible to detect interdisciplinary design in the area of rich-media technologies development and implementation. The results of the research in the following disciplines are mainly applied in:

- theory dealing with the issue of rich-media implementation in the extraordinary active part of research of Human-Computer Interaction. This is an adjoining discipline of informatics, psychology and sociology and in the context with rich-media the concepts are being studied from the areas of Asynchronous Videoconferencing (Tang et al, 2012), Media Richness Theory (Daft, 1986), Media Naturalness Theory (Kock et al, 2008) and Social Presence Theory (Short et al, 1976);
- selected areas of pedagogy (including special pedagogy), followed by the sociology and social psychology;
- the area of the support of users with special needs at the implementation of rich-media in assistance, interpreting, record-keeping and other services provided mainly for those with visual, aural or locomotive disability, or for socially-disadvantaged users;
- the selected areas of artificial intelligence, mainly in the theories of neural networks, genetic programming, etc. These are applied in the areas of recognizing spoken word and text, in adaptation of recordings (e.g., in Braille format) and in others;
- the selected areas of the theory of distributed systems and supercomputing applied at the accessibility of extensive databases of multimedia educational objects on the basis of rich-media, indexing of audio and video recordings in real time and in other demanding tasks of computing.

The issue of key aspects of implementing rich-media technologies at selected universities in the Czech Republic is dealt with in the MERLINGO Project (*MEdia-rich Repository of LearnING Objects*) (MERLINGO, 2015). By using rich-media technologies currently available at many educational

institutions, it is possible to carry out automated complete records of the educational process with minimum demands on financial, time, personnel and technological costs and to achieve their immediate access in the environment of the central database of learning objects. Those technologies can be thus crucially beneficial at the establishment of "barrier-free" information access to records of presentations.

At the same time it is obvious, that avalanche-like spreading popularity of mobile multi-media devices and ongoing availability of networking services requires the natural demands on records and transfer of general communication between "those providing" and "those receiving" not in direct, but in asynchronous communication. However, user demands are developing faster than the development of tools for production of rich-media recordings, because the communication mediated by asynchronous way via computer networks is more and more perceived as a full-value substitution of the direct communication. So this is a very current field of research (Borup et al, 2013) in the area of Human-Computer Interaction, massively invested by forefront companies such as Phillips, Microsoft, Polycom, etc.

Although the information technologies penetration reaches the world standard within the Czech population, and the Czech Republic belongs to the main hot spots of computer industry internationally, the exploitation of the new technologies including the rich-media technologies in everyday teaching and learning is far behind expectations. This is rapidly changing in a group of six secondary schools involved in the current project "Clever helpers for teaching - using ICT in a simple and creative way" run jointly by the University of Ostrava and the VŠB-Technical University of Ostrava. Based on the earlier pilot project at one of them, the Slavonic Grammar School in Olomouc, and under the technical guidance by the VŠB-Technical University of Ostrava, new approach to rich-media based interactive materials has been introduced, including completely symmetric asynchronous communication channels between teachers, students and their parents.

The article presents the findings from the project. In particular the experience with the new revolutionary programming system *EduArt* (EduArt, 2015) featuring unique characteristics in this area of rich-media recordings complying with demanding requirements of teachers in the availability and quality of presentation recordings, that is being used also

for the asynchronous communication purposes, concrete results in the area of mobile devices deployment in the educational process of selected secondary schools, and other results of the above project. Further developments in this fascinating area of future education are also shortly described.

2 EduArt Programming System and Its Main Properties

EduArt (*Education Art*) is a new revolutionary programming system determined for the realization of asynchronous communication and recordings on the basis of rich-media technologies and their publishing on-line or on-demand. As opposed to similar commercially available products, this software can be used on any workstation, notebook, netbook, mobile device, etc. with installed operating system *Microsoft Windows*. Its basic functionality is a possibility of recording and synchronization of image and sound with the presentation on a display of particular computer. It also allows using of any programming system (e.g., *MS PowerPoint, Adobe Acrobat*, etc.) for the presentation purposes, followed by visualizer, electronic table, tablet and other devices connected to the computer with installed *EduArt* system via standard input interface.

Resulting presentation (see Fig. 1) can be passed to the end user on-line or on-demand and the user can playback it anytime and anywhere required. The record of the presentation can be exported to a web server or stored on various memory media (CD/DVD/BD, USB keys, external discs, etc.). In the output presentation are synchronously recorded all individual channels in the original distinction (i.e., audio, video, images and metadata). End user can playback the presentation as it originally was, or via controller of the video-record or views of recorded slides to move forward or rewind it thus repeating certain sections, or to look at only those sections of his interest. All channels (video, slides and sound) remain continuously synchronous. In the presentation can be stored even other metadata, such as URL images which will lead the viewer to next connected resources within the Internet (scripts, CVs, manuals, etc.). In the case of access to the presentation record on-line the *EduArt* system will ensure continuous data transfer during presentation, i.e., of its audio and video content and pages of presentation.

The key characteristics which differentiate the programming system *EduArt* from other commercially available solutions enabling recording and publishing of presentations with rich-media technologies are mainly the following:

- existing solutions were designed primarily as dedicated systems while EduArt system primarily as user software;
- existing solutions require specialized and costly hardware while EduArt system hardware requirements are flexible and the system can be operated even on common personal notebooks of teaching staff;
- contemporary solutions were designed for IT professionals and are relatively complicated operation-wise, while EduArt system has been designed with respect to the fact that it will not be used by IT specialists and thus its control is user-friendly and simple.

A basic ambition of the implementation team of the *EduArt* system is also the development of the own server side of this new product solution called *EduArt Server*, which will dispose of the full localization in the Czech language and the full compatibility with programming system *EduArt* (automatic recognition of the type of content and allocation to particular groups for publishing and cataloguing).

EduArt programming system is also extensively applied at the practical application of the methodology of adaptation of existing and newly created learning objects which are adapted for students with special needs. In past years, the support for students with special needs at their enrolment and study at university became a part of standard services provided by majority of universities in the Czech Republic, where specialized centres and clinics established for that purpose have been intensely dealing with that. Moreover, an integral part of their work is the development of technical infrastructure supporting students with special needs at the learning process within their studies, as well as the preparation and increase of competencies of pedagogical and technical staff regarding the issue of education of students with special needs, followed by the establishment of inclusive environment at individual workplaces. By using rich-media technologies currently available at many educational institutions, it is possible to carry out automated complete records of the educational process with minimum demands on financial, time, personnel and technological aspects and to achieve their immediate access

in the environment of the central database of learning objects. Those technologies can be thus crucially beneficial during qualitative extension of provided services by specialized support centres for students with special needs, mainly at the establishment of "barrier-free" information access to records of presentations and practicing in real time or upon request, adapted to needs mainly for students with locomotive, visual aural disability while using internationally valid standards (WCAG, 2008).

Figure 2 MERLINGO rich-media resources with translation into the sign language

3 Pilot implementation of the rich-media technologies at secondary school in the Czech Republic

Currently, one of the key tasks for the MERLINGO project investigators is a pilot implementation of rich-media technologies in the educational process at six selected secondary schools which has been running already for several months within the project of "Clever helpers for teaching - using ICT in a simple and creative way".

For many years already, basic and secondary schools in the Czech Republic are relatively well equipped by information and communication technologies (ICT). However, it has not been reflected yet in their effective use and a sufficient integration in the teaching process by teachers. Therefore, the above stated project objectives mainly involve realization of educational

courses for teaching, managing and ICT staff of partner basic and secondary schools, followed by providing an intense presence and on-line methodology and technical support in order to reach increased competencies of the stated staff at ICT integration in teaching. In-depth evaluation is also paid attention which will enable to map needs of teachers. A significant element will be as well the active involvement of mentors in working with a target group of teachers. All project activities have been realized via unique collaboration of the Pedagogical Faculty and the Faculty of Science at the University of Ostrava providing mainly professional guarantee and educational courses for teachers, and VŠB–Technical University of Ostrava offering mainly methodology and technical support in ICT.

If competencies of basic and secondary school teaching staff are to be increased at ICT integration in teaching as a part of the project solving, it is necessary to meet several preconditions. Apart from pupils and students for whom the teaching is determined including eager teachers equipped and mastering adequate technology, it is necessary that the trend of ICT integration to teaching was fully supported by the particular school. Therefore, the management of each participating school in the project must be equipped by such knowledge and experience in the area of ICT, that their members should understand teaching trends, needs of pupils, students and teachers in such an extent that they could sufficiently motivate them in the area of ICT. Moreover, ICT represent an important managerial tool for school management and monitoring status and development of individual school activities, e.g. management of human resources, finances, ICT management, evaluation of teaching, administration of school operative and system documents, etc.

In that sense, rich media technology implementation can have an irreplaceable task mainly at increasing the teaching process level, support of asynchronous communication realization between teachers and students, mobilization of students in the teaching process and last, but not least, support of students with special needs. At present, the programming system *EduArt* has been already implemented within the project at six secondary schools: Slavonic Grammar School in Olomouc, Grammar School Hello in Ostrava-Poruba, Olga Havlová Grammar School in Ostrava-Poruba, Information Technology High School in Frýdek-Místek, Secondary Vocational School of Třinec Steelworks and Secondary Technical School in Šumperk. All listed

secondary schools are using for storage rich media recordings made by them at the central repository MERLINGO.

The most significant results in this area were achieved at Slavonic Grammar School in Olomouc where a group of 10 teachers are dealing with the *EduArt* programming system implementation in the teaching process. They are actively making recordings of their teaching lessons. Then, they are available in the on-request mode by all students of relevant subjects who can go over the topic they did not fully comprehend again, or they can play back the recording from the time when they were absent, for example when they were ill. It total 10 mobile cameras are available for teachers that can be used by them in different lecture rooms at the Grammar School. In a specialized lecture room of physics an independent camera system has been installed including next infrastructure elements needed for making recording of presentations and their publicising in the environment of web browsers.

Rich-media technologies at this Grammar School are not implemented only at the recording of the teaching process alone, but recently more and more at various forms of asynchronous communication of teachers with students. In fact, certain teachers started pilot recordings of their procedure when correcting written exams via the programming system *EduArt* (see Fig. 2) (SGO, 2015). Then, those are available for particular students and they can immediately check the teacher´s objectivity at their assessment.

Figure 3 Correcting written exams via the programming system *EduArt*

Generally it can be stated that implementation of those technologies at secondary schools significantly contribute to mobilizing students at the learning process. Through realized recordings of teaching lessons the students can both repeat the theme, and understand it better, which has obviously a positive impact on the overall level of their knowledge and improvement of their study results. Moreover, due to realization of recordings and their asynchronous availability, the mutual communication between students and teachers is significantly enriched. Hence, asynchronous communication becomes an excellent tool for the support of inclusive education as it enables access to the educational process from multiple points, various time and any number of repetition. Bearing in mind the level of school and student outfit with multimedia tools (tablets, notebooks), nothing stops it from its immediate frontal implementation. Finally it can be stated that rich media technology implementation at secondary school environment is a pilot activity not only at the level of secondary schools in the Czech Republic, but also within the EU.

4 Conclusion

The central repository of multimedia learning objects based on rich-media technologies MERLINGO, using organically the properties and services of a selected document management system, is an important step in the introduction of eLearning technologies in the Czech universities and the selected secondary schools. The support of integration of students with specials needs in the learning process while using possibilities of rich-media technologies is a very advanced direction among MERLINGO project activities.

Next pilot activities realized or prepared as a part of the MERLINGO project supporting the students with special needs at their studies mainly involve:

- pilot performance of indexation of audio recordings made by the rich-media based technologies and the possibility of browsing in them according to entered key words which is technically realized by using Automatic Speech Recognition technology with language and acoustic models adjusted to a specific nature, subject and proficiency in the specific environment. It was implemented in NovaVoice programming system by Consulting Company Novasoft firm (NovaVoice, 2015);

- the transcription of standard eLearning text study supports in the audio form and their availability obtained via podcasting as a part of the MERLINGO portal services;
- automated transcription of spoken text of the lecture recorded by the recording and assistance service into the written text and their availability upon request as a part of services of MERLINGO portal. Those services are determined mainly for hearing disability students.

References

Borup, J., West, R. E., & Graham, C. R. (2013). 'The influence of asynchronous video communication on the social presence: a narrative analysis of four classes'. *Distance Education*, 34 (1), pp. 48-63.

Daft, R. L., & Lengel, R. H. (1986). 'Organizational information requirements, media richness and structural design'. *Management Science*, 32 (5), pp. 554-571.

EduArt (2015) '*Education Art*' [Online], Available: http://www.polymedia.cz/eduart.php [10 May 2015].

Kock, N., Hantula, D.A., Hayne, S., Saad, G., Todd, P.M., & Watson, R.T. (2008). 'Introduction to Darwinian perspectives on electronic communication'. *IEEE Transactions on Professional Communication*, 51 (2), pp. 133-146.

MERLINGO (2015) '*Media-rich Repository of Learning Objects*'. [Online]. Available: http://www.merlingo.cz [10 September 2015].

NovaVoice (2015) 'NovaVoice - řešení pro převod mluvené řeči na text'. [Online]. Available: http://www.ccnovasoft.cz/cz/novavoice/co-je-novavoice-/ [10 September 2015].

SGO (2015) 'Díky moderní výuce s webkamerou už žáci nezameškají'. [Online]. Available: http://www.ceskatelevize.cz/ct24/regiony/304111-diky-moderni-vyuce-s-webkamerou-uz-zaci-nezameskaji/ [10 September 2015].

Short, J., Williams, E., & Christie, B. (1976). '*The social psychology of telecommunications*'. London: John Wiley.

Tang, J. C., Marlow, J., Hoff, A., Roseway, A., Inkpen, K., Zhao, Ch., & X Cao, X. (2012). 'Time Travel Proxy: Using Lightweight Video Recordings to Create Asynchronous, Interactive Meetings'. In *CHI 2012, ACM Conference on Computer-Human Interaction*, pp. 3111-3120.

WCAG (2008) 'W3C Web Content Accesibility Guidelines 2.0'. [Online]. Available: http://www.w3.org/TR/WCAG [10 September 2015].

Teaching of Dimensional Modeling in Microsoft Excel 2013 from ERD to reports

Vítězslav Novák[1]

Abstract. Microsoft Excel is the fundamental software tool of every economist and very often the only tool which the economist is capable to use. Although there are better business intelligence software tools for dimensional modeling for solving of business intelligence problems and Excel should be used maximally for creation of analyzes and reports, it can be used also in the other phases at least for teaching. This paper should demonstrate the use of Excel 2013 version for teaching of dimensional modeling from design dimension tables and facts by entity-relationships diagrams to creating reports.

Keywords: teaching, business intelligence, dimensional modeling, Microsoft Excel.

JEL Classification: A25

1 Introduction

Microsoft Excel is the fundamental software tool of every economist and very often the only tool which economist is able to use. This regards not only students of economics but, as experience often shows, also some members of companies' managements. Other software tools are often available to them, nevertheless, using them often ends with exporting data to Excel, where the manager can handle processing the data.

Practicing of dimensional modelling to solve business intelligence applications is most often performed on the selected relational DBMS, which can be a problem for students of economics. This article should demonstrate that also Microsoft Excel can be meaningfully used for dimensional modelling to solve business intelligence applications.

Excel 2013 version took another step to increase its usefulness as a tool for business intelligence. Previous versions of Excel already increased the number of rows of sheets from the original 65,536 rows to 1,048,576 rows, so Excel became more meaningful as a data source. Such Excel tools as import or export, filtering, removing duplicates etc. can be used as an ETL tool

[1] VŠB-TU Ostrava, Department of Applied Informatics, Sokolská třída 33, 701 21 Ostrava 1, vitezslav.novak@vsb.cz.

(Extract, Transform, Load). Likewise, Excel has successfully been used for many years as a tool for data analysis or creation of output reports with using of pivot tables or charts.

Moreover, Excel 2013 version adds other important functions for business intelligence needs. It is particularly the possibility to understand tables as relational tables for defining relationships between such tables. Another important function could also be PowerPivot, which has become a direct part of Excel in the Professional edition. According to Laurenčík (2014), PowerPivot allows to create more types of pivot tables and particularly pivot charts than with common work with them.

But concerning the design of dimension tables and fact tables itself, it is unfortunately not very comfortable and clear directly in Excel. For this purpose, it would certainly be more preferable to use one of CASE tools designed for it with the possibility of generating Excel tables directly with export of created diagram of entities and relationships. Most of CASE tools can of course create designed tables in the chosen database management system, or at least create a script consisting of the CREATE TABLE SQL statement that will create designed database. However, no CASE tool can create directly Excel tables in the required structure. In spite of that, it is possible to use CASE tools for creating excel tables. The aim of this article is to demonstrate this possibility and to include this phase in the overall concept of using of Excel as a tool for dimensional modeling to solve business intelligence applications.

This article relates to a similar article by Novák and Rozehnal (2014), and it expands further the design dimension and fact tables by CASE tools and using of a new functionality available in Microsoft Excel version 2013. This includes mainly the ability to create relations between tables and PowerPivot application, which has become an integral part of Excel.

2 Excel in teaching of dimensional modelling

How Novák and Rozehnal (2014) write, the dimensional modeling in solving BI applications typically consists of the following steps:

- design of dimension tables and fact tables,
- filling dimension tables and fact tables with data,
- creating views over dimension tables and fact tables,

- performing of analyses and reports over the created views.

The following chapters focus particularly on those steps, where a new version of Excel allows you to use a different and more effective approach than that referred to in Rozehnal and Novák (2014).

1.1 Design of dimension tables and fact tables by ERD

To be able to understand and use an Excel table as a relational table, it must fulfill certain requirements. Each "relational table" should be composed of one table in the form of a list. According to Dodge and Douglas (2011) a table in the form of a list must have the following properties:

- the names of the fields (columns) must be in the first row of the list, the field name must be in one cell, for a more detailed description of the fields a comment is more suitable,
- in other rows are individual records (items of a list),
- only one list should be on one sheet, the list can start in any cell,
- in the list there must not be any empty rows,
- in one field there must be the data of one data type (to ensure this condition it is possible to use data validation).

To be able to join such lists of Excel they must be also formatted "as a table" (*Format as table gallery* menu on the *Home* tab). Only then Excel understands these tables as relational tables which it is possible to join with relationships (*Relationships* menu on the *Data* tab) (Laurenčík, 2014).

How Novák (2015) writes, to define each table with its header on each sheet individually is very uncomfortable and unclear, because you cannot see the definitions of other tables on the overlapping sheets. Here it would certainly be more suitable to use an appropriate CASE tool to design the tables, use it to create an entity-relationship diagram and then subsequently export it to Excel. The idea of the export of a designed ERD diagram of a fictional simple star database schema to Excel is schematically shown in the following figure 1.

It is evident from figure 1 that for the export of the designed ERD diagram to Excel two conditions must be fulfilled:

- each entity of ERD diagram should be exported to a special table on a separate sheet of Excel workbook,

- each relationship of ERD diagram should be exported to a relationship of Excel data model.

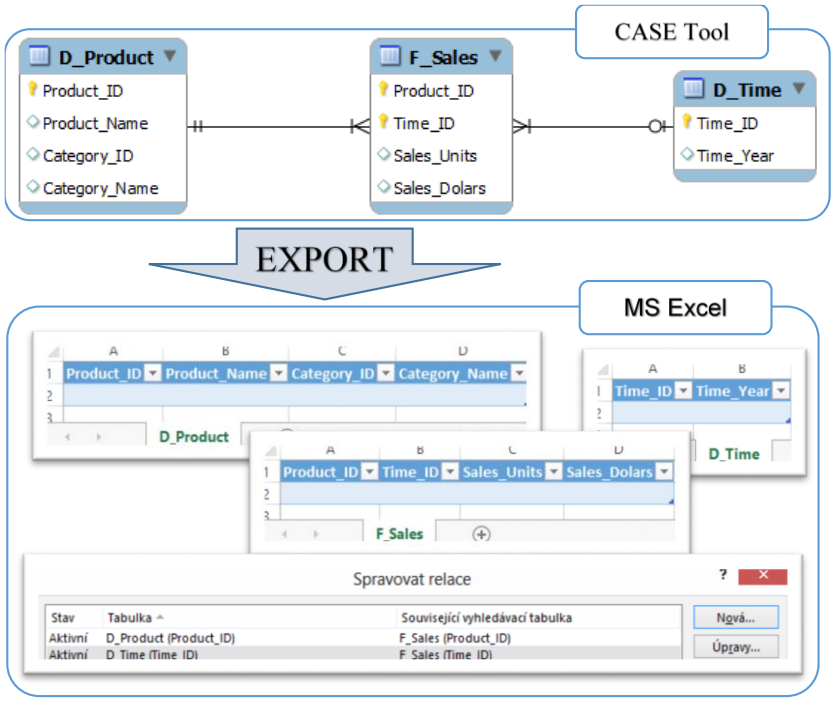

Figure 4 Export of an ERD diagram to Excel, Source: own.

Unfortunately it is necessary to say that with a probability close to certainty no CASE tool is able to export the defined structure of a database in the form of ERD diagrams directly to Excel in the structure mentioned above. Therefore we must ask the question if there is a way usable generally across many CASE tools which would enable to export the created ERD diagrams to Excel at least indirectly via a transport format.

A natural mediator for export ERD diagrams from selected CASE tool into Microsoft Excel seems to be Microsoft Access. Microsoft Access is according to Microsoft (2015) a desktop relational database management system usable to create simple database applications running either on one computer or in a local network. It is thereby possible to use some CASE tools to export created ERD diagrams also to Microsoft Access. Such a Microsoft Access database can easily be imported into Excel (Get External Data from Access menu on the Data tab). The database .MDB or .ACCEDB file format would just form a kind of transport format between CASE tool and Microsoft Excel. An enormous advantage of this process is that the tables are exported

to Excel including the necessary formatting of tables and as well as including relationships, so the Excel data model no longer needs to make any adjustments.

On the other hand the main disadvantage of this process might be the inability of the selected CASE tool to export the designed ERD to Access, because the support of the export in Access is not great across the available CASE tools. According to the list of available CASE tools published e.g. at Database Answers (2015) or Wikipedia (2015a), only about one-third of CASE tools allows you to export a database design to Microsoft Access.

Microsoft Access database format is certainly not considered as a common format for data transferring between different platforms. For these purposes XML format is generally thought the most suitable one. According to the W3C (2015) XML is a simple, very flexible text format derived from SGML which is playing an increasingly important role in the exchange of a wide variety of data.

It is true that many CASE tools including the ones of the open source type enable to export the created diagrams to the XML language. Using the general XML language as a mediator between the CASE tools and Excel has nevertheless one basic disadvantage. The resulting XML code differs completely throughout the CASE tools enabling the export of ERD diagrams to XML language in elements used as well as attributes, so it is not possible to create a general tool which would be able to process output XML database design from any usable CASE tool.

Nevertheless, there is also positive development in the field of portability of created diagrams between different CASE tools. The result of this development is the standard XML Metadata Interchange (XMI). Object Management Group (OMG) consortium is responsible for XMI standard. They develop standards for development of applications using the object-oriented programming techniques. According to OMG (2015) the XMI is a standard for exchanging metadata using XML language. Programmers who use UML modelling language with help of various CASE tools can exchange data models with help of XMI. The following figure shows an example of the part of XMI output which is truncated to the definition of a single column of the table because of its too large range of XMI output:

```
<ownedMember name="Product_ID" xmi:id="CmTifVKE8xFghgOf" xmi:type="dbColumn" type="9" syncType="1"
unique="false" scale="0" primaryKey="true" nullable="false" length="10" idGenerator="native">
    <foreignKeyConstraints/>
    <columnUserTypes/>
  - <xmi:Extension extender="Visual Paradigm">
        <qualityScore value="-1"/>
    </xmi:Extension>
</ownedMember>
```

Figure 5 XMI output from Visual Paradigm for UML, Source: own.

As you can see in figure 2, XMI output is simply an XML document with exactly given elements and attributes, so it should not be a problem to create a parser of such XMI outputs which would subsequently create the required Excel tables. It is possible to develop the required parser in Visual Basic for Application language with using the Microsoft XML library in Excel. According to Microsoft Developer Network (2015) Microsoft XML library provides a comprehensive W3C compliant XML API set for building high-performance XML-consuming/producing applications. The created parser of XMI output could then be distributed in the form of an Excel add-in.

The advantage of the XMI parser output against an XML output is that it should be universally applicable to any CASE tool allowing export ERD diagrams in XMI output. Regarding the support of exporting to XMI format at particular CASE tools, it is higher than the support of exporting to Microsoft Access format. According to the list of available functionality of the particular CASE tools published at Wikipedia (2015b), approximately half of the CASE tools support export to XMI format.

1.2 Using created Excel tables for the needs of dimensional modeling

After dimensional tables have been created it is possible to work just with Excel tools in the following phases of dimensional modeling. To fill tables with data it is possible to use some menus from *Read external data* options group on the *Data* tab. It is possible to transform data further with other functions of the same tab like *Sort*, *Filter* or *Remove* duplicates.

If there are no real data, it is possible to generate them. To do this, you can either use standard functions of Excel such as RAND or RANDBETWEEN or create custom functions for generating data, as described by Novák and Rozehnal (2014). The generated values can then be very effectively copied or filled into even a large number of rows.

Afterwards it is possible to start analyzing the filled dimensional tables. For this purpose pivot tables or charts are most often used (*Pivot Table* or *Pivot Chart* menu on the *Insert* tab). It is also possible to use other menus such as totals (*Total* menu on the *Data* tab) or PowerPivot available only in the Professional Edition, 2013 version (*PowerPivot* tab, it is necessary to activate).

3 Conclusion

In the previous chapters the possibilities of using Microsoft Excel in dimensional modeling in solutions of BI applications have been described. However, Excel is not a very suitable tool for designing of dimensional and fact tables. Using CASE tool with export of ER diagrams to Access format or to XMI output seems to be a preferable option for designing dimensional and fact tables. It is then relatively easy to import your real data from almost any external sources into created skeletons of dimension and fact tables and if there is no real data, it is relatively simple to generate such data. In this way it is possible to use Excel for dimensional modeling to solve business intelligence applications.

References

Database Answers (2015). Data Modelling Tools, [Online]. Available at: http://www.databaseanswers.org/modelling_tools.htm [cited 2015-03-09].

Dodge, M. and Douglas, C.S. (2011) *Mistrovství v Microsoft Excel 2010. Kompletní průvodce do posledního detailu*, 1st edition, Brno: Computer Press.

Laurenčík, M. (2011) *Excel 2010. Práce s databázemi a kontingenčními tabulkami,* 1st edition, Praha: Grada Publishing.

Microsoft (2015). Microsoft Access, [Online]. Available at: http://products.office.com/en/access [cited 2015-02-22].

Novák, V. and Rozehnal, P. (2014) Teaching possibilities of Dimensional Modeling in Microsoft Excel, *Proceedings of the 17th International Conference on Information Technology for Practice 2014*, Ostrava, pp. 237-244.

Novák, V. (2015) Possibilities of using CASE tools for designing Microsoft Excel tables. In: *Proceedings of the 11th international conference on Strategic Management and its Support by Information Systems 2015*. Ostrava: pp. 447-453.

OMG (2015). XML Metadata Interchange (XMI), [Online]. Available at: http://www.omg.org/spec/XMI/ [cited 2015-01-09].

W3C (2015). Extensible Markup Language (XML), [Online]. Available at: http://www.w3.org/XML/ [cited 2015-03-12].

Wikipedia (2015a). Comparison of data modeling tools, [Online]. Available at: http://en.wikipedia.org/wiki/Comparison_of_data_modeling_tools [cited 2015-03-09].

Wikipedia (2015b). List of Unified Modeling Language tools, [Online]. Available at: http://en.wikipedia.org/wiki/List_of_Unified_Modeling_Language_tools [cited 2015-03-12].

New Trends in Educating IS Experts for Practice

Tomáš Pitner[1], Jan Ministr[2]

Abstract. The demand for IT experts capable to master new technology, development methods, user orientation, security and other aspects of current information system analysis, design, implementation and deployment requires a wise combination of hard- and soft-skills. The paper presents the highlights of an upgrade of a traditional Master study programme on Information Systems at Masaryk University. It can serve as an example of such changes and hopefully inspiration for others.

Keywords: Information system development, University Master study programme.

JEL Classification: C61

1 Introduction

In the last decade, we face a quick evolution of IT develop profession corresponding to the changing structure of the IT development industry towards acceleration, industrial-production style, outsourcing, agility, and different modes of IS deployment and operation.

Therefore, also the requirements on future information system (IS) developers change during the time. The requirements also depend on local (region) structure of IT industry and is affected by the whole regional economy profile. Universities playing major role as suppliers of future IT expert in regions must therefore reflect such needs without sacrificing general principles.

The goal of this paper is to give insight into changing requirement namely on IS developers and propose fundaments of changes in the overall composition of study programmes. This process will be shown on the case of the Master study programme on Information Systems at Faculty

1 Masaryk University, Faculty of Informatics, Department of Computer Systems and Communications, Botanická 68a 602 00 Brno, tomp@fi.muni.cz.
2 VŠB-Technical University of Ostrava, Faculty of Economics, Department of Applied Informatics, Sokolská 33, 702 00 Ostrava, jan.ministr@vsb.cz

of Informatics, Masaryk University in Brno, where we also will highlight the most significant courses that would be newly included in the programme.

Major factors influencing the IS development and its education include:

- changing *roles of IS developers* – from selling boxes to provision of services;
- changing *working environment of developers* being now more integrated with other professions, such as business analytics, (UI) designers – and also directly customers;
- changing *software development methods* towards more agile approaches;
- changing *software lifecycle* – from rather slow and stable to dynamic: frequent or even continuous releases, particularly if software is delivered as a service;
- changing *development and deployment technology* which is gradually more completely online which means easier sharing and faster development;

The above factors show the need of pro-active approach for the study programme construction since they are not fully reflected in the study field yet.

Close relation between education and practice

Students of computer science are earlier than ever confronted with the need to participate in professional activities, such as projects, open source communities, or part time jobs during their studies. Therefore, going to *practice* their competencies in reality is not a subsequent step after studies but an *integral part* of them. This trend represents a challenge but also an opportunity to bring a new quality into the study process.

Secondly, mainly due to increasing demand for future IT professionals from large enterprises, the number of students wanting to run their own businesses after graduation does not grow and remains very low, not higher than 1-2 % and is in sharp contrast to top schools in the Western world, namely the USA. Thus, we claim that fostering entrepreneurship among students is important.

Requirements from practice

The IT/IS developer profession encompasses nowadays new areas that used to be traditionally out of focus or underestimated. It namely includes:

- *Constructive communication* and *teamwork*, see (iCom Team, 2014);
- Stronger focus at *quality* of work and its *sharing* (Steidl, 2014);
- Importance of *security* aspects;
- User-centeredness, orientation to *user experience* (UX) namely with the advent of *mobile technology*;
- Reflection of dynamically *changing requirements* leading to more *agile* approach;

New approach to development

The education of future development professionals must encompass new trends in IS development, particularly:

- *Agile* development using XP or SCRUM, *Lean* development using Kanban;
- Relaxed- and *heterogeneous* teams, deeper integration of other *creative professions* such as UI designers (Law & Lárusdóttir, 2015);
- Software frequently emerges from *community development* as *open-source* (Rossi, Russo & Succi, 2007);
- New technology for development, namely *online (cloud) development platforms* facilitating smooth code sharing, easy integration, and fast deployment of the created code (Cloud9, 2015);

Software lifecycle

Software lifecycle is nowadays more dynamic (frequent or continuous releases), flexible, and reacts of changing demands, such as *functionality* or *scaling* if the user community grows. It focuses at providing *services* rather than selling boxes and therefore it has more demanding *lifecycle*- and *change* management.

New technology

Popularity of new deployment and operation environments for information systems based on clouds or containers such as *Docker* grows. To build an information system, a mobile front-end is a standard requirement even for enterprise systems (El Kadiri, 2015). Once a system is deployed, services like monitoring and auditing of infrastructures and applications is expected. The same applies for security, reliability, and robustness, preferably ensured *by design* (Hsiao et al, 2014).

2 Education of IS experts at Masaryk University

The abovementioned trends should be reflected in the profile, structure and content of the future information system experts at the university level. Apart of the evolution in requirements, each education institution represents a specific environment, context, and it has its own specific goals. It case of Masaryk University, the specific goals for an upgrade of the programme include:

- *Specialization*, i.e. fine-grained profiling of the study reflecting new requirements and priorities we mentioned above;
- New priority areas such as *security-assured* information systems, *critical infrastructures*, *software architectures*, and *software quality*.
- *CERIT Science Park* located at Masaryk University creates a new context for industrial cooperation.
- New infrastructure provided by *CERIT Scientific Cloud* represents a platform for scientific computing, big data processing, and simulations, but also environment for student interims and training in research labs.

Newly, we propose three specialisation fields within the studies for information systems specialists:

- *Secure and reliable* information systems with a concept similar to "Security-assured IS" provided by LERSAIS Lab at the University of Pittsburgh, http://www.sis.pitt.edu/lersais, critical infrastructure systems, monitoring and surveillance systems;
- *Software architecture and technology* focusing at architectures and technology used to build and operate enterprise and web-based systems, mobile development etc.;
- *Software engineering* with the emphasis on software quality and agile approaches;

Students can either choose one of the options, or none, or even more of them together. To fulfil the requirements, the study programme will be enhanced with new forms of teaching:

- *Short-term internships* in real operation environments;
- Courses encouraging *entrepreneurship*;
- Courses targeted at growing *soft-skills*;
- Structures fostering *personal growth*.

Implementation issues

There are several implementation issues that must have been resolved. Primarily, there are new requirements for mandatory and optional courses which could lead to lack of human resources. Fortunately, most of the courses newly prescribed as mandatory or optional already exist, at least in a pilot phase, so there is maximum reuse of existing courses and their extension, in particular:

- explicit addition of existing courses for specialization profiles mainly from existing study fields of *computer security* and *service science* without mutual cannibalization;
- full use of courses already introduced and currently under pilot testing (*Software Quality*, *Agile Requirements Engineering*, *Innovation and Entrepreneurship*, *Internships*);
- Adding *seminars of relevant laboratories* at particular faculty departments.

Internships

We will look at potentially demanding newly required courses, namely Internships which need selection of industrial or research partners, coordination of internship topics, and supervising protocols written during the internships. Internships (formally the *Interim Project* courses) have been part of the *Service Science* study programme (http://ssme.fi.muni.cz) for years in two forms – longer, two-days per week at research labs and four-days per week in companies. In the *Information Systems* study plan, the internships would be shorter, usually 12 weeks part-time stays in companies, labs, or operation units at the university or collaborating organizations.

The internships can typically take place at *companies located in CERIT Science Park* and/or with members of the *Association of Industrial Partners* of the Faculty of Informatics. Internships *abroad at research institutes* and *companies* are foreseen, too.

Creative work and entrepreneurship

More focus at creative work is a result of current situation where IT companies solely oriented at reproduction of existing design patterns cannot keep enough added value for a longer period. Creative business is also

frequently the domain of start-ups. Therefore, in the renewed study programme, the following activities are planned:

- *pre-incubation of* promising *business ideas* in laboratories, for example at Lab of Software Architectures and Information Systems;
- *startup hosting* or *co-working* in CERIT Science Park;
- extended course on *Enterprise and Innovation in IT*.

Student personal growth

Finally, we show another new aspect of the Information Systems studies – orientation towards individual personal growth of the students. Master studies are just one part of each individual's career path. However, at the beginning of Master studies, the students have already enough experience to actively plan their career. So, we propose for the future setup of the study programme the following:

- The *University Career Centre* will be more involved in this process.
- Newly, an existing introductory course on Communication and Soft-skills will be a mandatory part of the programme.

The ecosystems around *CERIT Science Park, Technology Transfer Office* at the university together with *South Moravian Innovation Centre* provide experienced consultants to *help startup projects* at *pre-incubation* and later phases. There is also a concentrated expertise in *legal* and *business* aspects which can help future entrepreneurs.

Finally, during the last years, a short *mentoring programme* has been tested. It trained the first group of mentors to help expert in companies collaborating in IT with Masaryk University. If feasible, it will be prolonged also to the Information System study programme students.

Conclusion

The paper described requirements on future IS developer experts. These requirements project to reasons for a thorough upgrade of an existing study programme at Masaryk University. We showed main characteristics of changes in the programme.

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References

Bazsova, B. (2014). 'Analysis and evaluation of quality in university education'. In *Proceedings of the 24th International Business Information Management Association Conference - Crafting Global Competitive Economies: 2020 Vision Strategic Planning and Smart Implementation*. Milan, Italy, pp. 738-745.

Cloud9 (2015). '*About Cloud9 Development Platform'*. [Online], Available: [https://c9.io/site/about].

Danel, M, Řepka, M. (2015). 'Analysis of Weak Point of Collaboration of VSB – Technical University of Ostrava with Industry in the Fields of Automatization and Information Science', In *IDIMT-2015: Information Technology and Society Interaction and Independece: 23nd Interdisciplinary Information Management Talks*. Podebrady, Czech Republic, pp. 147-154, ISBN 978-3-99033-395-2.

El Kadiri, S., Grabot, B., Thoben, K. D., Hribernik, K., Emmanouilidis, C., von Cieminski, G., & Kiritsis, D. (2015*). Current trends on ICT technologies for enterprise information systems. Computers in Industry*.

Hsiao, D. K., Kerr, D. S., & Madnick, S. E. (2014). '*Computer security'*. Academic Press.

Law, E. L. C., & Lárusdóttir, M. K. (2015). 'Whose Experience Do We Care About? Analysis of the Fitness of Scrum and Kanban to User Experience (UX)'. *International Journal of Human-Computer Interaction*, (just-accepted).

Masaryk University, Faculty of Informatics (2015). *Service Science, Management and Engineering*, Master study programme.

Ministr, J., Pitner, T. (2014). 'Towards an ecosystem for academic-industrial cooperation' In *IDIMT-2014: Networking Societies – Cooperation and Conflict: 22nd Interdisciplinary Information Management Talks*. Linz : Trauner, 2014. pp. 71-78, ISBN 978-3-99033-340-2.

Ministr, J. Pitner, T. (2015). 'Academic-Industrial Cooperation in ICT in a Transition Economy – Two Cases from the Czech Republic'. *Information Technology for Development*, Vol. 20, No. 3, pp. 480-491. ISSN 0268-1102. doi: 10.1080/02681102.2014.903887.

Motschnig, R., Pitner, T., Kozlíková, B., Škrabálek, J., Pekárková, L., Kolář, J., Novák, M., Tomaschek, N., Hammer, E., Haselberger, D., Böhm, Ch., & Standl, B. (2014). *Constructive Communication in International Teams: An Experience-Based Guide*. 1. Edition. Münster: WAXMANN Verlag GmbH, 2014. 248 pp. ISBN 978-3-8309-3025-9.

Rossi, B., Russo, B., & Succi, G. (2007). Evaluation of a migration to Open Source Software. *Handbook of Research on Open Source Software*: Technological, Economic, and, 309.

Steidl, D., Deissenboeck, F., Poehlmann, M., Heinke, R., & Uhink-Mergenthaler, B. (2014, September). Continuous software quality control in practice. In *Software Maintenance and Evolution* (ICSME), 2014 IEEE International Conference on (pp. 561-564). IEEE.

TAM Model as an Assessment Method for Moodle E-Learning Platform

Adam Sagan[1], Mariusz Grabowski[2]

Abstract. The paper is devoted to identifying the structure of attitudes towards e-learning platform Moodle and their determinants, which are the indications of potential improvements of this type of educational assistance. The theoretical basis is the theory of reasoned action (TRA) and the theory of planned behavior (TPB). Based on theoretical assumptions, attitudes toward the behavior are derived from the technology acceptance model (TAM) used in the studies on the IT/IS acceptance and use. The study was carried out on the basis of quota sample of 150 students of the Cracow University of Economics. Estimation of the TAM model was made by partial least squares (PLS) and maximum likelihood estimators using the statistical packages SmartPLS, Mplus, library plspm of R package and Stata.

Keywords: e-learning, Moodle, TAM, PLS.

JEL Classification: L86, I23, C51, C69

1 Introduction

The dynamic development of information and communication technologies (ICT) related to the expansion of the Internet, browsers and mobile solutions, caused the spread of electronic systems for e-learning. E-learning is implemented through many forms and/or extended functionalities e.g., CMS (Course Management System), LMS (Learning Management System), VLE (Virtual Language Environment) and MOOC (Massive Open Online Courses). While CMS, LMS and VLE complement the educational process conducted in a traditional manner, MOOC constitute a challenge for the existing educational pattern as it is conforming to the model described in the theory of disruptive innovation (Christensen, Johnson and Horn, 2008; Hyman, 2012; Martin, 2012).

The aim of the paper is to present the results of research concerning the attitudes toward the Moodle platform, representing a pilot study on a further

[1] Cracow University of Economics, Department of Market Analysis and Marketing Research, sagana@uek.krakow.pl.
[2] Cracow University of Economics, Department of Computational systems, grabowsm@uek.krakow.pl.

comprehensive evaluation of the use Moodle e-learning system at Cracow University of Economics (CUE). In the study TAM model was utilized to measure the structure of attitudes and intentions of use of the Moodle platform by the CUE students. Studies are pioneering in the CUE and are among the few studies using TAM models in assessing attitudes towards Moodle.

2 Technology Acceptance Model

Technology acceptance model (Davis, 1989; Davis, Bagozzi and Warshaw 1989) is one of the most widely used theoretical frameworks to explain the behavior of ICT users and is often used to assess the effectiveness of e-learning (Cheng, 2011; Liao and Liu 2012; Wu, Hiltz and Bieber 2010). Theoretical basis for this model is the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975; Ajzen and Fishbein 1980) and the theory of planned behavior (TPB) (Ajzen, 1985, 1991).

In the light of this theory, the behavioural intention is shaped by three mutually conditioning factors: an attitude toward the behaviour, a subjective norm, and a perceived behavioural control. In TAM-based research model used in the study (Figure 1), the actual use of the system is determined by usage intention that serves as a mediator with relation to attitude toward the behaviour, perceived usefulness and perceived ease of use[1].

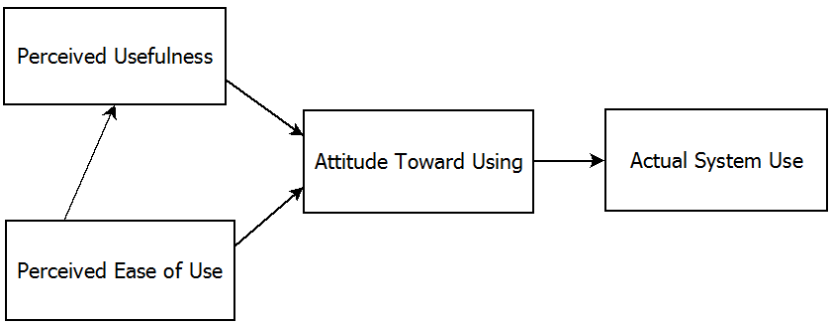

Figure 1 TAM-based research model used in the study, Source: Adopted and adapted from: (Davis, Bagozzi and Warshaw 1989, p. 985).

The constructs and indicators used in the survey of 150 selected respondents (users of e-platforms Moodle at CUE) are presented in Table 1.

[1] There are many modifications of the basic TAM model. The most recognized include TAM2, TAM3 and UTAUT versions (Venkatesh, 2003).

Table 1 Constructs and indicators used in the study, Source: own.

Indicator	Constructs and items
PEOU	**Perceived ease of use**
PEOU1	E- platform CUE is easy to use
PEOU2	E-platform CUE is convenient
PEOU3	E-CUE platform is easy to mastering the material
PEOU4	E-CUE platform is easy to understand
PEOU5	E-platform CUE is readily available
PU	**Perceived utility**
PU1	E-Platform CUE allows to learn more effectively
PU2	E-Platform CUE allows to learn in a faster way
PU3	E-CUE platform allows greater control of the learning process
PU4	E-CUE platform saves time
PU5	E-CUE platform allows for significant advancement of knowledge
A	**Attitude towards the platform**
A1	E-Platform CUE is an attractive method of teaching
A2	E-Platform CUE is an improvement of the educational process
A3	E-CUE platform satisfies my need for e-learning
A4	I like to use e-Platform CUE
B	**Behavior and use of system**
B1	I use the CUE-platform to prepare for the exam session
B2	I am using e-Platform CUE on daily basis
B3	I am using e-Platform CUE whenever I have a problem to solve
B4	I am using e-Platform CUE because I can do it at any time
B5	I am using e-Platform CUE regularly
NPS	**Net Promoter Score**
PNPS	Please specify the extent to which you will recommend the use of e-Platform CUE to other students

***** Variables PEOU1-5, PU1-5, A1-4 and B1-5 are measured on a 5-point Likert scale. PNPS variable is measured on a 1-10 scale.

3 Estimation of the model - a comparative approach SEM vs. PLS-PM

In the evaluation TAM-based model of e-learning platform, two analytical approaches were used: 1/ explanatory SEM model (LISREL-type) associated with the analysis of covariance structures and parameters estimation using the maximum likelihood method, and 2/ predictive PLS-PM model based

on two-step regression OLS model, estimated with partial least squares (PLS) method.

In the first approach, the covariance structures are estimated simultaneously in the measurement and structural part of the whole model using the reflective indicators only[1]. In the second approach (PLS-PM) estimation are based on the raw data (not a covariance matrix), and has two steps (first, latent variables are estimated and then, the structural relations between them). The indicators may be both reflective and formative, and evaluation of model fit is performed separately for measurement and structural part of the model2 . TAM covariance structure model is shown in Figure 2. In this model, all indicators are reflective and in addition there is an observable outcome variable (recommendation of e-learning platform).

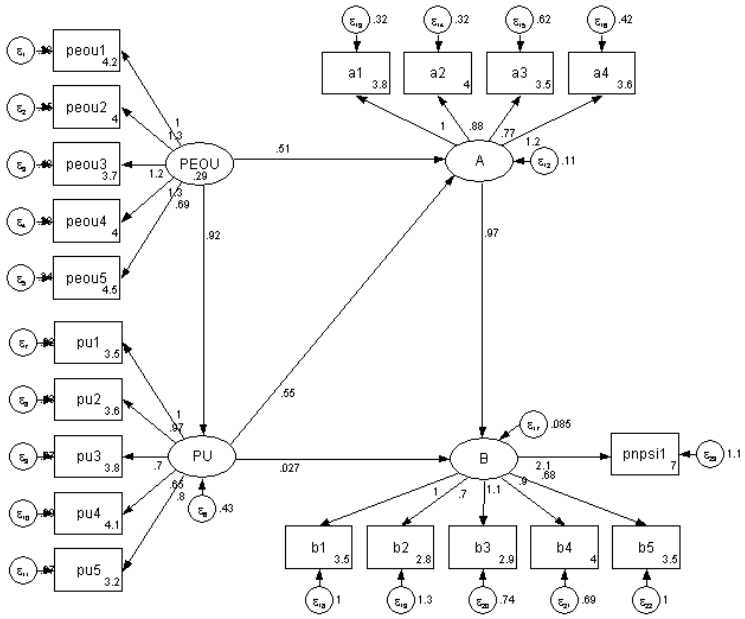

Figure 2 TAM model based on SEM approach, Source: own

The model shown in Figure 2 does not have a very good fit. The value of $\chi 2$ statistic is 419.78 (165, p-level = 0.00). Root mean square error of approximation (RMSEA) is 0.10 and comparative indices of Tucker-Lewis

[1] There is a wide literature on structural models with latent variables. These include the developments of K. Bollen (1989), F. Hoyle (1995) T. Raykov and G. A. Marcoulides (2000).

[2] The basic books on PLS-PM models are (Vinzi et al, 2010), (Lohmoller, 1989), (Hwang and Takane, 2015).

(TLI) and comparative fit (CFI) are respectively 0.82 and 0.84. This demonstrates the low power of TAM explanatory model. Analysis of structural relations indicates the positive relationship between all the constructs that were measured. The perceived ease of use (PEOU) significantly affect the perceived usefulness of the platform (PU). Both of these factors also affect significantly the attitude of the user toward the system (A). Attitude toward the system also is strongly associated with the actual use of the system (B). The actual use also has a positive and significant relation with recommendations to other users (PNPS). Analysis of Net Promoter Score Item (PNPS) indicates that the users of the platform consist of approximately 28% of the detractive users (percentage ratings of less than 7), 50% passive users (percentage ratings 7-8) and 22% of promoters of the platform (percentage of assessments 9-10). The net effect (Net Promoter Score) is the difference between fractions of promoters and critics (22% - 28%) and equals -6%, which indicates a low level of satisfaction with the Moodle.

The PLS-PM model has a similar structure but consists of the blocks of formative (variable PEOU & PU) and reflective (A and B) indicators. In the case of formative indicators, the relationship between constructs and items are determined by the multiple regression coefficients and for reflective indicators a series of simple regressions between the component and each of the indicators are used. The model PLS-PM is depicted on Figure 3.

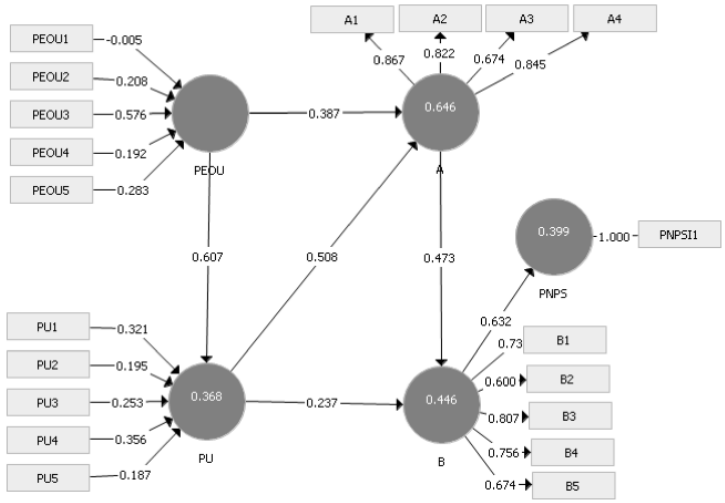

Figure 3 TAM model based on PLS-PM approach, Source: own.

The structure of the path coefficients is quite similar to the model that is shown on Figure 2. The only exception is an important parameter that specifies the direct impact of perceived usefulness (PU) to use the platform (B).

Table 2 presents the comparison of both models. It shows the standardized parameters and model fit in these two approaches. In order to estimate TAM-SEM model parameters Mplus and STATA programs were used. PLS-PM model was estimated with the help of plspm library of R package.

Table 2 Mediation effects of the TAM-PLS model, Source: own.

		SEM			**PLS-PM**		
		Estimates	C.I	R^2	Estimates	C.I.	R^2
PEOU	**PEOU1**	0.76	0,67-0,84	0,57	0,61	0,44-0,76	0,36
	PEOU2	0,77	0,68-0,85	0,59	0,75	0,61-0,84	0,56
	PEOU3	0,66	0,55-0,77	0,43	0,89	0,78-0,95	0,79
	PEOU4	0,81	0,73-0,88	0,64	0,73	0,56-0,84	0,53
	PEOU5	0,61	0,49-0,72	0,37	0,69	0,47-0,83	0,47
PU	**PU1**	0,82	0,75-0,89	0,68	0,83	0,71-0,91	0,70
	PU2	0,78	0,70-0,85	0,60	0,78	0,62-0,89	0,60
	PU3	0,52	0,40-0,65	0,27	0,64	0,46-0,77	0,41
	PU4	0,65	0,54-0,75	0,42	0,77	0,66-0,80	0,60
	PU5	0,74	0,65-0,82	0,54	0,76	0,64-0,82	0,57
A	**A1**	0,79	0,72-0,86	0,63	0,87	0,82-0,90	0,75
	A2	0,75	0,67-0,83	0,56	0,82	0,75-0,88	0,67
	A3	0,60	0,49-0,71	0,36	0,67	0,55-0,76	0,45
	A4	0,81	0,75-0,88	0,66	0,84	0,80-0,89	0,71
B	**B1**	0,62	0,51-0,73	0,38	0,74	0,66-0,81	0,55
	B2	0,45	0,32-0,59	0,21	0,61	0,47-0,71	0,37
	B3	0,71	0,59-0,80	0,51	0,83	0,73-0,85	0,64
	B4	0,65	0,55-0,76	0,43	0,75	0,66-0,81	0,56
	B5	0,49	0,36-0,62	0,24	0,67	0,52-0,78	0,46
Model fit	χ^2	419,78 (165), P=0,00			**GoF**	0.53	
	RMSEA	0,10, (0,09 – 0,11)					
	CFI	0,84					

The reliability coefficients for the reflective indicators are acceptable. For attitude factor (A) Cronbach's alpha coefficient is 0.82 and Dillon-Goldstein's rho = 0.88. Behavioural intention (B) reliability is respectively 0.77 and 0.84. Estimates of factor loadings in measurement models in both approaches are comparable. Generally narrower confidence intervals for estimates of PLS-PM vs. SEM should be noted. This means more accurate estimates of parameters and thus less type II error probability. Path coefficients in structural part of the model are also generally consistent in both approaches, and are also characterized by a similar property associated with the width

of the confidence intervals (in this model path between the perceived utility of the use of the system is statistically significant). A characteristic feature of the model SEM as compared to the PLS-PM is, its weaker explanatory power measured by determination coefficient R2. These coefficients are usually higher for endogenous latent variables in the SEM model, which shows superiority of explanatory SEM models in comparison to predictive PLS-PM.

4 Conclusion

The use of path models in the study of attitudes towards the E-platform at CUE provides some interesting conclusions. Firstly, it outlines the factors that most strongly explain the use and recommendation of the platform (the important role attitudes toward the platform). Secondly, it allows for the identification of mediational effects (mediation function of the attitude toward the system) and the measurement errors for the blocks of reflective indicators. The comparative analysis confirms the predictive character of PLS-PM-TAM model and explanatory aspect of TAM-SEM model that is characterized by poor fit and relatively wider confidence intervals as compared to the PLS-PM.

Analysis of the relationship between the indicators and the constructs shows the importance of such attributes as the system availability, ease of use and time saving capability that the users find important. At the same time one can point to key areas of functionality improvement. These include first and foremost shaping the attitudes of users associated with the knowledge acquisition, activity in solving problems and systematic and regular use. It should also draw attention to the improvement of the design of course content to better suit the educational needs of users and increase the efficiency and speed of learning process.

The presented results are a pilot and preliminary in their nature. They are performed on a non-random sample from one university only. Nevertheless, they indicate the usefulness of application of this type models and may form the basis for actions related to improving the quality and functionality of educational platforms.

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References

Ajzen, I. (1985) 'From intentions to actions: A theory of planned behavior', *Action control: From cognition to behavior*, Berlin: Springer-Verlag, pp. 11-39.

Ajzen, I., (1991) 'The theory of planned behavior', *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179-211.

Ajzen, I. and Fishbein, M. (1980) *Understanding attitudes and predicting social behavior*, Englewood Cliffs: Prentice-Hall.

Bollen, K.A. (1989) *Structural Equations with Latent Variables*, New York: Willey and Sons.

Cheng, Y.-M. (2011) 'Antecedents and consequences of e-learning acceptance', Information Systems Journal, vol. 21 no. 3, pp. 269-299.

Christensen, C., Johnson, C.W. and Horn, M.B. (2008) *Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns*, New York: McGraw-Hill.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, vol. 13, no. 3, pp. 319-340.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989) 'User Acceptance of Computer Technology: A Comparison of Two Theoretical Models', *Management Science*, vol. 35, no. 8, pp. 982- 1003.

Fishbein, M. and Ajzen, I. (1975) *Belief, attitude, intention, and behavior: An introduction to theory and research*, Reading: Addison-Wesley.

Hoyle, R. (1995) *Structural Equation Modeling: Concepts, Issues and Applications*, London: Sage Publications.

Hwang H. and Takane, Y. (2015) *Generalized Structured Component Analysis. A Component-Based Approach to Structural Equation Modeling*, Boca Raton: CRC Press Taylor & Francis Group.

Hyman, P. (2012) 'In the year of disruptive education', *Communication of the ACM*, Vol. 55, No. 8, pp. 26-28.

Liao, H.L. and Liu, S.H. (2012) 'A Comparison Analysis on the Intention to Continued Use of a Lifelong Learning Website', *International Journal of Electronic Business Management*, vol. 10, no. 3, pp. 213-223.

Lohmoller, J-B. (1989) *Latent Variable Path Modeling with Partial Least Squares*, Berlin: Springer-Verlag.

Martin, F.G., (2012) 'Will massive open online courses change how we teach?', *Communication of the ACM*, vol. 55, no. 12, pp. 20-22.

Raykov, T. and Marcoulides, G.A., (2000) *A First Course in Structural Equation Modeling*, Mahwah: Lawrence Erlbaum Associates Publishers.

Venkatesh, V. (2003) *Unified Theory of Acceptance and Use of Technology (UTAUT)* [online], http://www.vvenkatesh.com/organizations/Theoretical_Models.asp [5 June 2015].

Vinzi, V., E., Chin, W., Henseler, J. and Wang, H. (2010) *Handbook of Partial Least Squares. Concepts, Methods and Applications*, Berlin: Springer-Verlag.

Wu, D., Hiltz, S.R. and Bieber, M. (2010) 'Acceptance of Educational Technology: Field Studies of Asynchronous Participatory Examinations', *Communications of the Association for Information Systems*, vol. 26, art. 21, pp. 451-476.

INFORMATION SECURITY

Security of Information Systems for Production Control

Roman Danel[1], Marcin Reklin[2], Michal Řepka[3], David Johanides[4], Lukáš Otte[5]

Abstract. This paper focuses on the security of information systems for control of continual technological processes in the raw materials industry. The first part of the paper describes our experience with the use of database mirroring technology to provide for continuity of sampled data in a fault-tolerant solution of the information system. The subsequent part describes penetration tests of information systems and principles of security policy for personnel

Keywords: Information Security, Fault-tolerant System, Database Mirroring, Penetration Tests

JEL Classification: D8

1 Introduction

At the Institute of Economics and Control Systems we are involved long-term in information and control systems in the raw materials industry. Knowledge of the controlled technological processes, as well as awareness of the goal of control, is key for the design of an information system in the raw materials industry. However, determining the reliability and security of the system is an integral part of the design too.

2 Technical security and reliability

Systems for controlling continual technological processes in 7x24 mode require a high level of reliability and availability. Today´s technical equipment enables achievement of high availability at an acceptable cost. In the case

[1] VŠB-Technical University of Ostrava, Institute of Economics and Control Systems, 17. listopadu 15, 708 33 Ostrava – Poruba, Czech Republic, roman.danel@vsb.cz.
[2] WSG-University of Economy, Institute of Informatics and Mechatronics, Garbary 2, 85-229 Bydgoszcz, Poland, marcin.reklin@byd.pl.
[3] VŠB-Technical University of Ostrava, Institute of Economics and Control Systems, 17. listopadu 15, 708 33 Ostrava – Poruba, Czech Republic, michal.repka@vsb.cz.
[4] VŠB-Technical University of Ostrava, Institute of Economics and Control Systems, 17. listopadu 15, 708 33 Ostrava – Poruba, Czech Republic, david.johanides@vsb.cz.
[5] VŠB-Technical University of Ostrava, Institute of Economics and Control Systems, 17. listopadu 15, 708 33 Ostrava – Poruba, Czech Republic, lukas.otte@vsb.cz.

of availability of critical system in the order of 99.9999 % (this value means a maximum system downtime of 5 minutes per year) all critical systems (servers, network components, databases…) must be duplicated. We are speaking about the fault-tolerant category of systems (an even higher level of security is provided by disaster-tolerant systems – resistant to catastrophes, in which case the backup systems are geographically separated). The securing of continuity of data in databases is an integral part of a fault-tolerant solution – replication or mirroring database technologies are used for this purpose. The use of mirroring is essential especially for technological data creating timelines (sampling of data from sensors) which are used to calculated trends or predictions of technological quantities.

During 2006 and 2007 we participated in the design and implementation of an information system at the Darkov Mine Coal Cleaning Plant, where a Microsoft SQL Server 2005 database mirror was successfully implemented to provide a fault-tolerant solution of technological data storage (Danel and Neustupa, 2011).

Based on this experience, in 2014 at the Institute we solved a research project with the aim of analyzing and testing technologies for fault-tolerant solutions of databases from prime database producers. For these purposes the replication or mirroring technologies can be used in the standard versions of database systems. For testing we used Dell servers with a Windows Server 2012 operating system. The testing servers were used to perform tests of measurement of the duration of sampling data loss during inaccessibility of the production system (i.e. how big is the delay before the information system is recovered from the backup system) and crash tests (forceful shutdown of server during operation). Testing was done with the current versions of systems Microsoft SQL Server, MySQL (replication, the MySQL database does not have mirroring technology) and InterSystems Caché. All systems showed a very good resistance and reliability. During simulation of outages when using the standard database versions and producer predefined configurations, the maximum storage outage is 20 seconds. Crash tests showed very high resistance of all systems – not ever in one case data files or database servers get damaged (Danel et al, 2015).

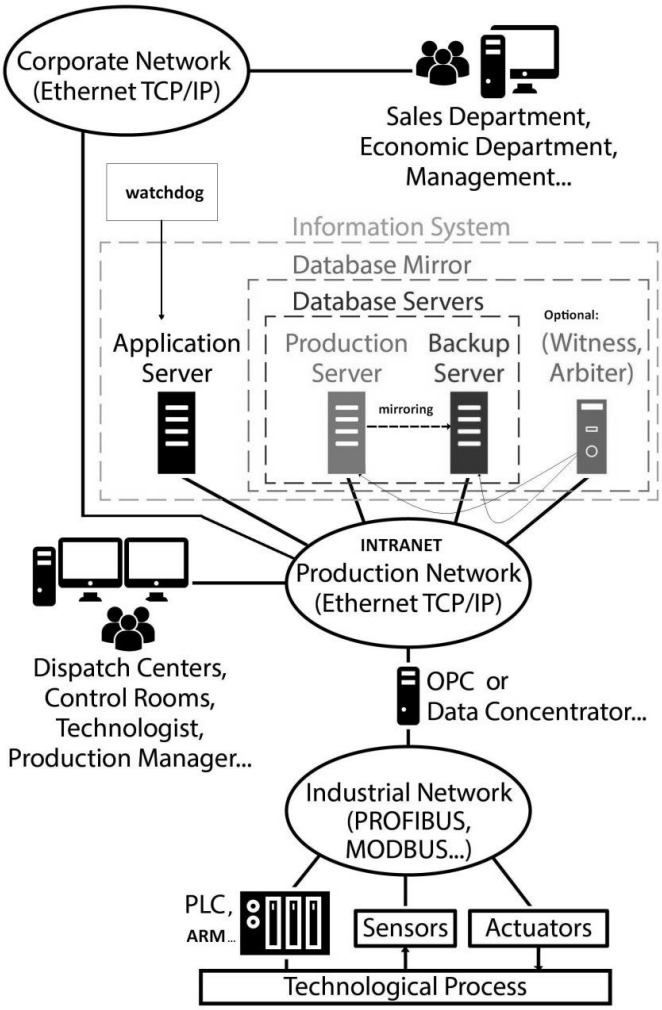

Figure 1 Scheme of fault-tolerant information system for production control, Source: own

The reliability increases substantially when the enterprise versions of databases are used, which enable backup of database instances by clustering (Ministr and Pitner, 2014). However, the enterprise solutions raise the prices of systems by one order. There is a whole host of solutions in this category, led by Oracle. Oracle offers numerous technologies – Real Application Cluster (technology based on a cluster, focused at high availability and the recommended solution by Oracle for failure recovery during computer or database instance failure - the database is divided into several active cluster nodes, Data Guard (recommended solution for recovery during failure of storage or data damage; provides for high availability, high output and

automated accessibility of backup database) or Oracle GoldenGate – solution based on replication recommended for heterogeneous server platforms and database implementations. Also Microsoft SQL Server 2012 Enterprise provides the clustering technology. However, in the case of using clusters all operating systems and database servers must be licensed in Enterprise editions.

The results of the research project can be utilized to create a more reliable, robust and well-priced fault-tolerant information system, applicable for controlling and monitoring continual technological processes (Figure 1). As a possible further development in this area we are contemplating performing similar tests for systems based on Linux operating systems, as well as implementing watchdog components (Danel, Neustupa and Neustupa, 2013) to automate mirror operation and its automatic switching in case of a fault. Another possibility is using NoSQL (Not Only SQL) databases, which enables data management of the distributed data store (Pitner and Ministr, 2015).

3 Security of systems and penetration tests

Besides technical reliability and availability it is also necessary to focus on security when designing systems. In the case of information systems for controlling productions two areas of risk are vital in terms of security – securing technological and production data against unauthorized access and attacks aimed at damaging or malfunctioning systems.

One of the procedures of unveiling the security weaknesses of a system is to perform penetration tests. Penetration tests can be done using commercial or open-source tools. If such tools find security insufficiencies during the penetration testing, it can be fairly assumed that the same tools are available to a potential attacker and can therefore damage the examined system.

At WSG in Bydgoszcz penetration tests were performed in the laboratory with the aim of creating a procedure (methodology) for quick testing of the information system in terms of security loopholes. The penetration tests were performed to the OWASP (Open Web Application Security Project) standard, which defines the most common attacks recorded in 2014 (OWASP – Top 10 Attacks, 2015).

The testing configuration was a system comprising a HP Proliant (G4p a G5) server with a Windows Server 2008 R2 operating system

and CISCO network components. The operating system and operating systems of network components (Nas4Free) were commissioned in standard configuration with installed updates.

Commercial tools GFI LanGuard and Nessus and open-source tool Linux Kali were used for testing.

Nessus software (Nessus Vulnerability Scanner, 2015) performs scanning of the network using the ICMP ping, ARP ping, TCP and UDP ping protocols. Further, it is possible to scan open ports, which partially enables determining which services are active in the tested system. Also, it is possible to detect which web services are running on the system and to what extent they are available. The GFI LanGuard tool checks the operating system and application equipment using the ICMP (Internet Control Message Protocol) protocol and by checking network communication.

Linux Kali (Kali Linux, 2015), after detecting data about the system and operated applications, enables performance of testing of certain threats and attacks, for example:

- Injection of unauthorized code into the operating system or LDAP protocol;
- Incorrect configuration and security of network components;
- XSS – cross-site scripting (insufficient security at web browser level);
- Unauthorized access to applications (back doors);
- Absence of updates of known security errors;
- Rerouting of DNS, phishing, etc.;

In the case of critical systems the latest technologies for securing network communication can be used, which enable creation of separated logical network wholes. Modern protocols, such as MPLS TE (Multiprotocol Label Switching Traffic Engineering), enable full control of the movement of packets in TCP and UDP networks.

In the tested laboratory system at the Nessus scanner found one critical error which led to the unveiling of the username and password of a network router (the device still had the default password of the administrator account).

A certain weakness of many systems is the insufficient security of wireless networks, security of industrial networks (Franeková et al, 2007)

or underestimation of security in case of identification of products by RFID technology.

Another area which must be given attention is the change and release management, where insufficiently managed processes of change implementation in the system can lead to its unavailability.

4 Principles of security for personnel

An integral part of system security solutions is a corresponding human resources policy and the related security measures. This includes, for example, updating access rights to the system according to changes in engagement of working positions. In the past we have seen a situation in production companies, where access rights were not recovered from employees with changed position or employees with terminated contracts (or not updated). Another security fault that you can encounter is control of access for external workers or workers of subcontractors. A serious risk can be posed by the still active authentication of a subcontractor´s worker after a project has ended.

In technological procedure plants we have found success during implementation of systems (e.g. information systems of the OKD coal cleaning plant) in minimizing the access of control room operators to the operating system. Computers for visualization of technological processes are used as single-purpose equipment without access of dispatchers to the operating system (only an administrator has access). This solution does lead to a situation where each set of tasks requires another computer with monitor, but the number of service interventions is substantially reduced.

A certain weakness can be the system administrator and access rights to data backup. Numerous companies also don't have a controlled process concerning duration of data archiving, where data are archived and who can decide about their deletion. To provide for system security up-to-date operating documentation is also very important. Particularly in the case of control system out-of-date documentation can cause problems during solving of non-standard or crisis situations. Documentation should be controlled, updated regularly and all key control and inspection processes should be documented.

5 Conclusion

This paper focused on information systems for controlling continual technological processes with respect to security. The design of systems for controlling production sometimes underestimates this area, which can potentially lead to substantial damages. A good IS design includes solutions for system reliability, high availability and security. Today´s technical equipment enable solving of high security levels at acceptable costs.

References

Danel, R. and Neustupa, Z. (2011) 'Data Continuity Solution in Fault-tolerant Information Systems'. *Proceedings of 12th International Carpathian Control Conference - ICCC 2011*, Velké Karlovice, Czech Republic, pp. 70-73.

Danel, R., Neustupa, Z. and Neustupa, Z. Jr. (2013) 'Design of Watchdog Component for Fault-tolerant Information System Solution'. *Proceedings of International Symposium on Earth Science and Technology CINEST 2013,* Fukuoka, Japan, pp. 292-295.

Danel, R., Otte, L., Kozel, R., Johanides, D., Vilamová, Š., Janovská, K. and Řepka, M. (2015) 'Database Mirroring in Fault-tolerant Continuous Technological Process Control'. *Metalurgija*, vol. 55, no. 1, pp 83-86.

Franeková, M., Kállay, F., Peniak, P. and Vestenický, P. (2007) *Komunikačná bezpečnosť priemyselných sietí*, Žilina: EDIS – Vydavateľstvo Žilinskej university.

GFI LanGuard (2015), [Online], Available: http://languard.gfi.com/ [1 Sep 2015].

Kali Linux – Penetration Testing Platform (2015), [Online], Available: http://www.kali.org [5 Sep 2015].

Ministr, J and Pitner, T. (2014) 'Towards an ecosystem for academics-industrial cooperation'. *Proceedings of the 22nd Interdisciplinary Information Management Talks: Network Societies – Cooperation and Conflict, IDIMT 2014*, Podebrady, Czech Republic. pp. 71-78.

Nessus Vulnerability Scanner. Tenable Network Security (2015), [Online], Available: https://www.tenable.com/products/nessus-vulnerability-scanner [1 Sep 2015].

OWASP - Top 10 attacks in 2014 (2015), [Online], Available: https://www.owasp.org/index.php/Top_10_2014-Top_10 [16 Jun 2015].

Pitner, T. and Ministr, J. (2015) 'Security Aspects of PaaS Cloud Model'. *Proceedings of the 11th International Conference on Strategic Management and Its Support by Information Systems SMSIS 2015*, Uherske Hradiste, Czech Republic. pp. 463-469.

Operational Risk Management System for Bank

Volodymyr Chaplyha [1]

Abstract. Necessity introduction standards by Basel III until 2019 is required complex researches of peculiarities integrated systems of performance management and risk in banks in conditions of the global financial instability. This article is devoted to the principles and practical recommendations for well-construction of operational risk management system as part of an integrated system of risk-based performance management of bank.

Keywords: Operational risk management system, integrated risk-based performance management system, bank.

JEL Classification: G21, G32.

1 The concept and modern features of the operational risk of bank

Operational risk associated with all directions of banking and is particularly important for functioning of the bank. The Basel Committee on Bank Supervision (BCBS, June 2004) puts importance on operational risk in second place among the other risks and defines it as "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk". Within the framework, of the so-called "Basel III", the most important aspects improving of BCBS approaches to Operational Risk Management have become: revised principles on risk management in corporate governance for banks (July 2015); formulation and practical aspects of bank of the principles (June 2011) and recommendations to optimize the basic elements of operational risk management (October 2014); recommendations on use of the Advanced Measurement Approaches for operational risk (June 2011) and proposals to correct deficiencies of the Simpler Approaches for operational risk measurement (October 2014); principles of effective aggregation and reporting of operational risk events (January 2013) and analysis of progress in their application in order to improve operational risk management (December 2013).

[1] Lviv Institute of Banking the University of Banking of the NBU, Department of Accounting and Audit, Lviv, 9 Shevchenko Avenue, 79005, Ukraine, 4vovik@gmail.com.

About a large scale of losses in 60 banks around the world and frequency distribution events of standard categories of operational risk aside typical business lines by 2008 - 2013 years shows information of The Operational Risk data eXchange Association ORX (2014). The total amount of losses from operational risk by 2013 was 11,399 MEUR.

Recent events in the banking system of Ukraine also related with material and financial losses of banks. It led to liquidation of 50 banks and a range of banks in stage of liquidation (the list is constantly growing). The reasons analysis allows to conclude about modern features of operational risks of Ukrainian banks. They are associated with such categories of the operational risk as: the risk of damage to material values, including the risk of business interruption; risks of changes in laws and regulatory requirements; risks of internal and external fraud; risks of relationships of the stakeholder bank.

Problem of identification, quantitative assessment, monitoring, control and prediction of essential operational risks due to their features which, in our opinion, are as follows:

- typical is slight probability of events and their rarefaction in time in conjunction with devastating character of financial and other effects of events;
- typical is not repetition of events and the emergence and creation of new risky situations and risk factors;
- often operational risks arising in conjunction with other risks or its groups;
- part of operational risks has latent nature, that is, implementation of risks is manifested not immediately after the event, subsequently (or never) and amount of the losses from not detection of several such events can reach the critical values for business;
- catastrophic events are mainly the result of the coincidence (concentration) in space and time several risk factors which may located within the permissible deviations of operation and therefore guilty in the event may not be;
- the risk is specific for a particular bank and depends on its organizational structure, system of information flows, quality and management practices, products and business processes;

- the difficulties of determining factors and the impossibility of complete removal of risk sources.

This problem in Ukraine also deepens due to the absence of temporal rows of historical data that there is enough for reliable appraisal of operational risk; different character of distribution losses from operational risk for different directions of bank; insufficiency of knowledge concerning mutual integration and correlation of different kinds of risks between themselves and others. It sets in front of bank management the task based on analysis and modelling of developing effective mechanisms of operational risk management.

2 Operational risk management in the risk-based performance management system of bank functioning

The recommendations of Basel III in front of modern system the operational risk management set difficult tasks:

a) harmonization of the operational risk management with new business models and strategic risks of bank development, often with limited capital;

b) ensuring continuity of activity and positive impact on business results and effective functioning of bank.

With it, the operational risk management are integrating into the general system of performance management of the bank and aggregative (basic and other risks of the bank), while effectiveness is increasing by improving the decision making process from effective use of limited resources based on forecasting and eliminating the causes and consequences of adverse events.

General system of efficiency management of the bank presented in the form of hierarchy system. Fig. 1 shows the structure of integrated system of risk oriented efficiency management of bank functioning; an integrated system of continuous aggregate risk management of the bank; systems of operational managing and other risks of the bank; system of chances management.

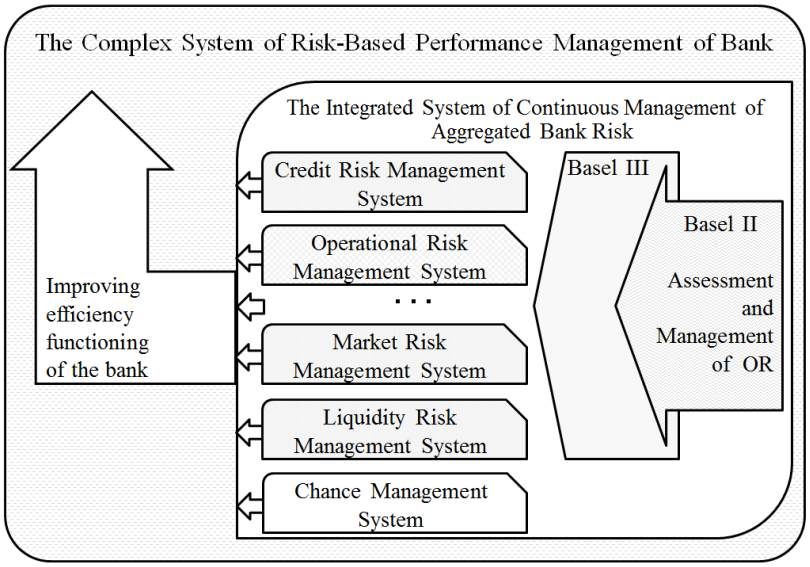

Figure 1 System approach to risk-based performance management functioning bank. Source: own.

The main goal for risk management (of chances and losses) in the bank is a positive impact on achievement of target value of its objective function *FG*. In scientific literature authors, in particular, Topolya (2004) consider different models Main objective functions. Analysis of specific in point of view consideration of interests bank stakeholders allows us to conclude that most appropriate is a model of maximizing the value of bank *V*:

$$FG = V \rightarrow max. \tag{2}$$

Because growth of market value of the bank can be achieved both on the basis of revenue growth, reduce transaction costs, increase sales of banking products, and through by increasing competitive advantage, maximize value added.

Accepted above definition of operational risk and formed the complex its parameters and also concepts and criteria of the efficiency of functioning of the bank allow to establish the factors of influence operational risk at improving the efficiency of the bank for the time T. Such factors can be considered reduction of:

- aggregated costs *VP (T)* at preventive operational risk management during time *T*;

- total losses *VZ (T)* as a result of operational risk events during *T* (excluding of amounts reimbursed damages and insurance cover);
- the value of reserve capital *OR (T)* under operational risk on the basis of sound use of appropriate methods of assessment for the time *T*;
- the total cost *VN (T)* at investigation and neutralize the effects of operational risk, at ensuring the business continuity, at restoring the activities, at introducing and improving the operational risk management system;
- lost revenue *VLR (T)* as a result interruption of operations, business processes, activities and also damage to the reputation of the bank and other reasons caused by the realization of operational risks.In this case total bank losses from the realization of operational risk events take into account both direct and indirect loss.

The positive impact of reduced operational risk on efficiency of functioning bank is to increase its sustainability, stability of activity and competitiveness.

Having determined the objectives function of effective functioning of the bank *FG(T)* in the interval *T* and structure of each of the factors of impacts by operational risk on it *VP(T), VZ(T), OR(T), VN(T), VLR(T)* is possible, using the tools of correlation and regression analysis, and taking into account nonlinear dependence of variables of influence and stationarity of processes in time, to build the multifactor model of efficiency $FG(T)$:

$$FG(T) = = \gamma_0 [VP(\mathrm{T})]^{\gamma_{VP}} * VZ(\mathrm{T})]^{\gamma_{VZ}} * [OR(\mathrm{T})]^{\gamma_{OR}} * [VN(\mathrm{T})]^{\gamma_{VN}} * [VLR(\mathrm{T})]^{\gamma_{VLR}} * \varepsilon, \quad (2)$$

where γ_0 = *const* - free term of model; γ – elasticities with variable factor, ε – error of model.

The proposed approach allows to determine most effective ways to optimize operational risk management from the standpoint of the efficiency of the bank.

Operational Risk Management in maintenance of effective functioning of the bank envisages selection of approaches to building systems and methods for performing process of the ORM, using international standards. Model integrated operational risk management process based on ISO 31000 (2009) is shown in Fig. 2.

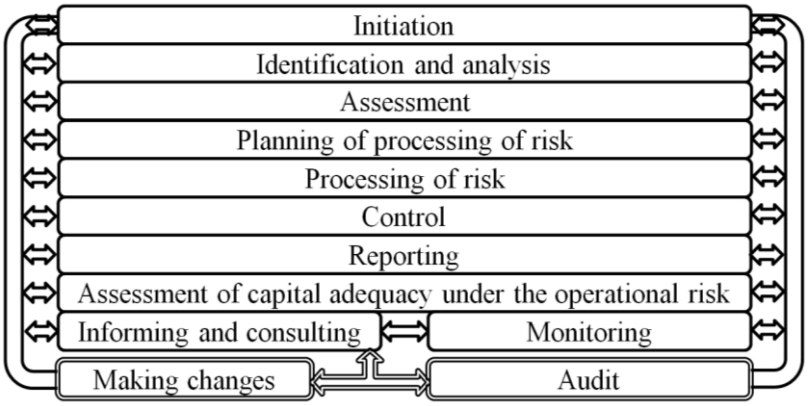

Figure 2 Model integrated operational risk management process in bank. Source: ISO 31000, 2009; own.

The model contains the following procedures:

Initiation - defining of the objectives, objects, tasks, methods, models, tools and criteria for risk management by analyzing the environment;

Identification and analysis - identifying operational risk, spatial-temporal analysis of risk factors;

Assessment - the choice of adequate methods and assessment models; assessment taking into account the relationships between the different categories of risk; Rankings, separation (for further processing) significant operational risks and areas of concentration in space and time; Update registers;

Planning of processing of risk - the choice of optimal methods and instruments of processing operational risk by the criterion of maximum economic effect, defining the action plan and necessary resources;

Processing of risk - implementation of the approved action plan with dedicated resources;

Control of implementation the action plan, analysis of their effectiveness and actual efficiency;

Reporting - documenting information and formation of a database of risks, preparation of reports on results of processing risk;

Assessment of capital adequacy for operational risk;

Monitoring of risks and control of the established indicators; of capital adequacy under the operational risk; of effectiveness of the procedures;

Informing and consulting of subjects operational risk management;

Audit of the reports and the effectiveness of managerial procedures, consulting.

One of the key in the integrated process of operational risk management is the assessment process of operational risk. Risk assessment gives for the Decision Makers and Stakeholders a clear understanding of how operational risk can affect the achievement of the objectives of the bank as well as information on the adequacy and effectiveness of controls. It is proposed to consider the purpose of measuring risk from the standpoint of the "Three Lines of Defense" Models (Базель II, 2004). For each of these "Lines" need to choose the appropriate type and the time horizon of assessment and required parameters of operational risk. Also proposed to classify evaluation methods in relation to the time (before or after) the realization of operational risk events.

Conscious choice of the method of measurement of operational risk and evaluation of the reserve capital is based on the appropriate classification. Figure 4 is presented the classification of methods for assessing operational risk by parameters: {Sign of Class of methods; Type of Class of methods; Task which is solved this Class of methods}.

Note, that the choice of specific methods for each "Line of Defense" imposed certain limitations. These limitations are caused by the quality and quantity of available resources (human, financial, information, IT systems and time) in bank for operational risk assessment and by the level of maturity of the processes.

3 Structure and efficiency of the Operational Risk Management System for Bank

The structure of operational risk management in accordance with the "Three Lines of Defense" Models depend on a number of factors, in particular, on the characteristics of a portfolio of products, structure, size, complexity, activities, processes and systems, as well as from the bank's governance structure and risk profile of the bank.

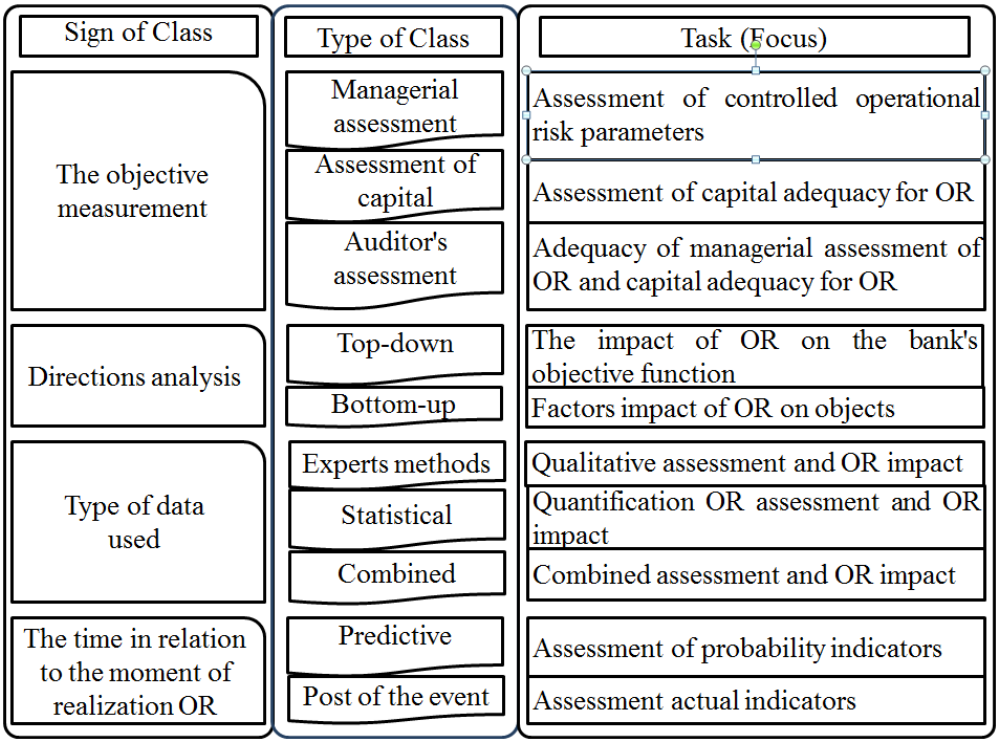

Figure 3 Classification of methods for assessing operational risk. Source: Stupakov V. S. and Tokarenko G. S., 2005; own.

The contribution of the first "Line of Defense" in the efficiency of bank is: to prevent events of operational risk (on the objects of areas her responsibility), minimize losses of their realization, also minimizing the time and costs of eliminating the consequences of events while ensuring that stability and not exceed the permissible limits the operating parameters specific objects.

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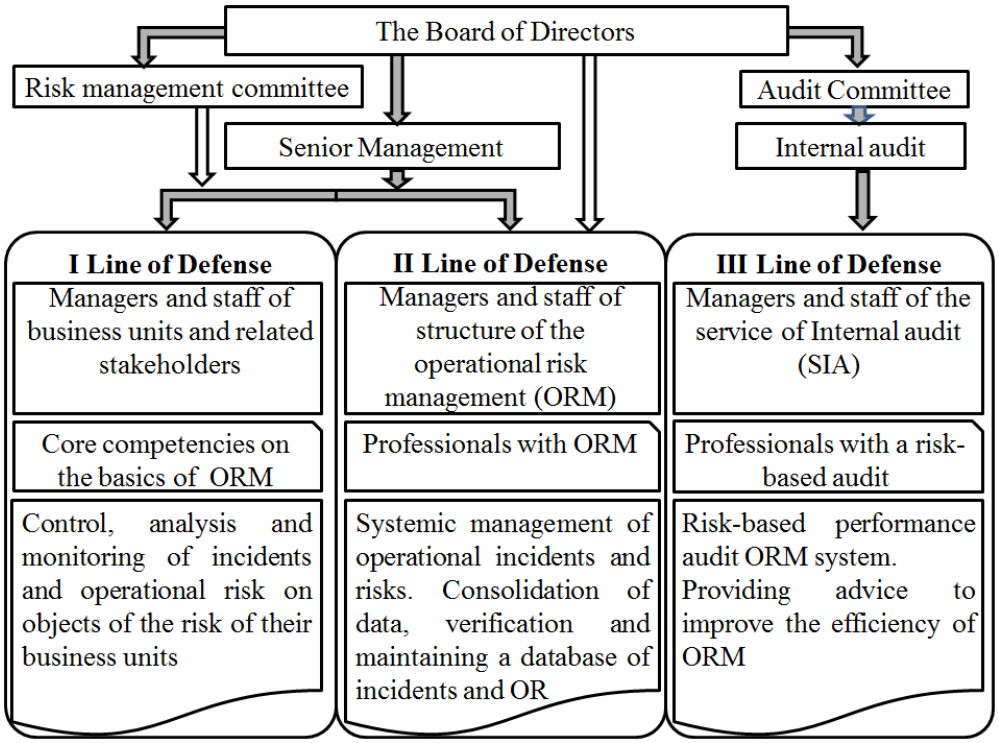


Figure 4 Subjects of the "Three "Lines of Defense", their necessary key competencies and functions in the operational risk management. Source: BCBS, 2011; own.

The contribution of the first "Line of Defense" in the efficiency of bank is: to prevent events of operational risk (on the objects of areas her responsibility), minimize losses of their realization, also minimizing the time and costs of eliminating the consequences of events while ensuring that stability and not exceed the permissible limits the operating parameters specific objects.

Contribution of the second "Line of Defense" to the effective functioning of the bank according to the ratio of (2) are: proactive operational risk management; optimal allocation of the necessary costs VP on objects and in time by the criterion of their overall minimizing; adequate assessment of the required reserve capital for operational risk OR(T); optimal management of the necessary changes (the implementation of operational risk events) by criteria for minimizing total losses V_{Σ}:

$$V_{\Sigma}(\mathrm{T}) = \{VZ(\mathrm{T}) + VN(\mathrm{T}) + VLR(T)\} \rightarrow \min = V_{\Sigma min}; \qquad (3)$$

ensuring sufficiency of the reserved capital:

$$V_{\Sigma}(\mathrm{T}) \leq OR(T); \quad (4)$$

ensuring continuity and stability functioning of the bank in the current environment and its survivability in an emergency.

The economic effect of the third "Line of Defense" can estimate of the size of cost savings and reduce losses from identified violations in the management of operational risk of the first and second "Lines of Defense", of reducing the cost of internal audit operational risk management system relatively costs of other types of audits, as well as the relatively costs in business processes.

Note, that factors such as high corporate culture of operational risk management, good interaction "Lines of Defense" between themselves and their integration into the Comprehensive System of Risk Management ensure the success of all three "Lines of Defense" of the bank.

4 Conclusion

The systems approach involves the integration of operational risk management to the hierarchical structure of the integrated system of risk-based performance management and aggregate risk of the bank. Methodological basis for developing and improving the management of the bank is in the BCBS guidelines and international standards. The "Three Lines of Defense" Models and proposed the Integrated ORM Process Model, as well as approaches to classification and selection of methods for assessing risk, the structure and performance criteria for each of the "Lines of Defense" can determine the most effective ways to optimize operational risk management system in the bank.

References

BCBS, (2004) The Basel Committee on Bank Supervision. *Basel II: International Convergence of Capital Measurement and Capital Standards: a Revised Framework*, [Online], Available: http://www.bis.org/publ/bcbs107.pdf [23 Sep 2006].

BCBS, (2015) *Corporate governance principles for banks* [Online], Available: http://www.bis.org/bcbs/publ/d328.pdf [10 Aug 2015].

BCBS, (2011) *Principles for the Sound Management of Operational Risk* [Online], Available: http://www.bis.org/publ/bcbs195.pdf [15 Sep 2012].

BCBS, (2014) *Review of the Principles for the Sound Management of Operational Risk* [Online], Available: http://www.bis.org/publ/bcbs292.pdf [10 Aug 2015].

BCBS, (2014) *Review of the Principles for the Sound Management of Operational Risk* [Online], Available: http://www.bis.org/publ/bcbs292.pdf [10 Aug 2015].

BCBS, (2013) *Principles for effective risk data aggregation and risk reporting* [Online], Available: http://www.bis.org/publ/bcbs268.pdf [15 Sep 2012].

BCBS, (2013) *Progress in adopting the principles for effective risk data aggregation and risk reporting* [Online], Available: http://www.bis.org/publ/bcbs268.pdf [21 Feb 2014].

Topolya, I. V. (2004) 'Economic theory and corporate objective function models'. *Control Sciences.* no. 1, pp. 54-59.

ISO, (2009) International Organization for Standardization. *Risk management -- Principles and guidelines* [Online], Available: https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-1:v1:en [15 Mar 2010].

Stupakov V. S. and Tokarenko G. S. (2005) *Risk management*, Moscow: Finance and Statistics.

Software Tools in System of Operational Risk Management in Bank

Vyacheslav Chaplyha[1], Volodymyr Chaplyha [2]

Abstract. Introduction of Information system for operational risks management can significantly increase the effectiveness of the Bank by streamlining and reducing the cost of implementation of the requirements of the Basel Committee. This article is devoted to reviews and recommendations for banks on selection the software tools for system of operational risk management.

Keywords: System of Operational Risk Management, enterprise GRC solution, software tools, bank.

JEL Classification: M15, G21, G32

1 Introduction

Introduction of automated control system of operational risks significantly improves the effectiveness of the Bank by optimizing and reducing expenses on realization of key objectives of operational risk management in accordance with the requirements of The Basel Committee on Bank Supervision (BCBS, 2011).

The current operational risk management system must be based on a powerful information system. This is due to the following: complex and distributed nature of information flow in the bank; the necessity of rapid processing, storage and subsequent use vast amounts of information (the problem of Big Date); the complexity of the models used; BCBS requirement to integrate risk management into all core business processes of the bank. For example, without specialized information systems is impossible to perform dynamic simulations using Monte Carlo method of potential losses from the realization of operational risk event, that it is necessary for the correct calculation of economic capital for operational risks.

[1] Lviv Institute of Banking the University of Banking of the NBU, Department of Economic Cybernetics, Lviv, 9 Shevchenko Avenue, 79005, Ukraine, 4vyach@gmail.com.
[2] Lviv Institute of Banking the University of Banking of the NBU, Department of Accounting and Audit, Lviv, 9 Shevchenko Avenue, 79005, Ukraine, 4vovik@gmail.com.

Please be aware that full automation of operational risk management of the bank is impossible. Such a system should include not only technological tools to prevent incidents. For system of operational risk management (ORM) in bank an important part are policy, risk management culture and organizational measures: multilevel control of business processes and each operation, reserve data centers and offices, security, interoperability staff, etc. This means that can only automate warning system, registration of incidents and develop measures to minimize operational risk and ensure continuity of operation of the bank.

2 IT solutions for System of Operational Risk Management in Bank

Typically, automated operational risk management is a “billet”, which then adapted to the actual conditions and business processes of a particular bank. Specificity of operational risk management cannot establish such production systems "turnkey"

From the perspective of practitioner Petrov (2014) automation allows to solve the following tasks on operational risk management:

- collecting, processing and storing information about the risks and risk factors necessary for risk management;
- automation of algorithms of risk analysis and risk portfolios, the calculations and mathematical modeling;
- provision to participants of risk management processes of the necessary information,
- the creation of conditions for effective information exchange;
- formation of regular reporting of risk management.

System IT solutions are helping take into account all the events of operational nature that led to the loss. The bank, on the basis of space-time analysis of retrospective data, may change internal processes and techniques to the future similar situations do not recur. Such systems can also assist in improving the information security of the bank. These systems help to identify weaknesses in security, and management of the bank offers solutions to problems.

The most mature functional of the risk management provide class of solutions GRC (governance, risk management, and compliance), which refers to a system integrated to an organization's processes that offers a holistic view of the organization's core and support functions.

Among the main processes of bank which automated are: corporate governance in accordance with the standards BCBS (2015), management of the overall risk and allocation of reserve capital to business units, compliance and social responsibility. Such systems are divided into two types: enterprise GRC (eGRC) and IT-GRC. The first of them is the only platform for managing different types of operational risk and compliance the entire organization. The second - more "sharpened" to problem solving Risk Management Information Security, for instance, class SIEM (Security information and event management solutions). The current generation of SIEM solutions gravitates to ensuring that combines traditional SIEM, and also functions network traffic analysis and risk management.

The essence of class IT solutions GRC concerning risks is to automate labor-intensive processes that form the basis of risk management:

- data collection for risk assessment where as sources act as staff, and various automated systems (mostly business applications, and various systems monitoring and event correlation);
- risk assessment, which is held on the stage after data collection according to the procedure laid down in the decision;
- presenting the results of the risk assessment as reports in various formats and with varying degrees of detail;
- control of implementation the risk treatment plans.

Already now instead of purchase separate solutions for finance, risk management, audit, IT and for other functional business units, many banks choose the single integrated platform eGRC with the basic modules. These modules are automate the processes of corporate governance and risk management, audit and regulatory and legal regulation of changes. In development of banks may pass through the gradual introduction of compatible modules and function-specific applications. Examples of such applications are data privacy compliance standards against bribery, business

continuity management (BCM), compliance with PCI, Basel II, Solvency II, management of external risks and many others.

eGRC Platforms can also be integrated with business applications such as business intelligence (BI), corporate culture management, control of automation, monitoring solutions (e.g., separation of duties), management of IT hardware (for example, audit of configuration server), continuous control monitoring (CCM) for transactions. EGRC platform also integrates with specialized solutions GRCM, such as compliance with EH & S standards, IT-GRC management, quality management, financial GRCM applications.

Note that these solutions themselves do not minimize the risks, but only help to reduce the risk. They make internal processes of the organization more transparent for the leadership; minimize the costs of activities of operational risk management; facilitate the timely detection of risk associated with these processes; allow more quickly respond to identified risks and control the activities of processing risks.

3 ORM Software Tools for Banks

Currently the market offers software solutions from international and Ukrainian companies. The research results who regularly carry known companies, for example, Gartner Inc. and Chartis Research Ltd., help to choose choose the best solution on the market to improve corporate governance, risk management, business continuity and the bank's ability to achieve defined business goals.

Research Gartner Inc. take into account the opinion of more than 13,000 companies worldwide. For Market Operational risk & GRC - decisions in 2014 and 2015 Gartner (2015) presented complex of the results their research: Hype Cycle for GRC Technologies and Market Guide for GRC Platforms (see Fig. 1).

Gartner Hype Cycle (2015) highlights GRC vendor solutions “that provide a “forward-looking” approach to risk management that goes beyond simply complying with the latest regulation or industry standard. Areas such as IT risk management (ITRM), vendor risk management (VRM) and digital GRC are critical components of the evolving digital business landscape”.

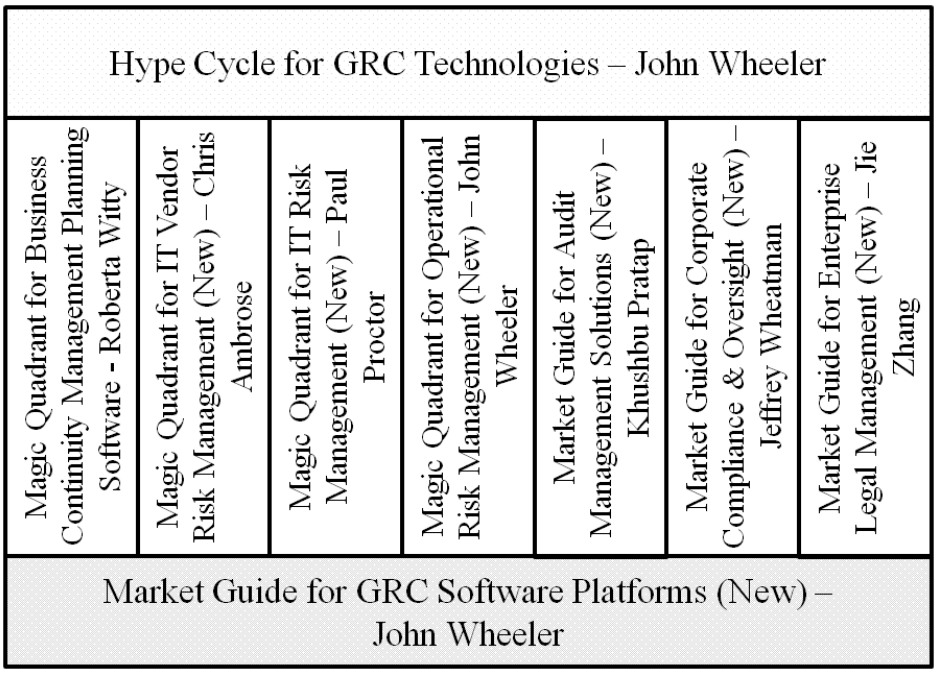


Figure 1 Complex Gartner research results of the market GRC solutions, Source: Wheeler, 2015.

Graphical representation of the results of market research GRC software platforms Gartner by Wheeler and Paul (2014) have submitted in the form of "Magic Quadrant". Axis X - "Completeness of vision" takes into account 8 evaluation criteria: Market Understanding, Marketing Strategy, Sales Strategy, Offering (Product) Strategy, Business Model, Vertical / Industry Strategy, Innovation, Geographic Strategy. Axis Y - "Ability to Execute" takes into account 7 evaluation criteria: Product / Service, Overall Viability, Sales Execution / Pricing, Market Responsiveness / Record, Marketing Execution, Customer Experience, Operations. Scale of measurement criteria includes 3 values (High, Medium, Low).

As shown in Fig. 2, on "Magic Quadrant" IT companies are divided into four category to the integrated characteristics: Leaders (with high evaluations of both criteria - completeness of vision and their ability to execute), Challengers (with high evaluations only by the ability to execute), Visionaries (with high evaluations only on completeness of vision) and Niche Players (with low evaluations of both criteria).

Figure 2 Magic Quadrant for Operational Risk Management, Source: Wheeler and Paul, 2014.

As a result of this market analysis Operational Risk Management solutions in 2014 (see Figure 2) many companies are offering the GRC solutions, which can be deployed within a cloud-based or on-premises environment. However, none of the vendors did not have a complete or ideal solution to manage operational risk, which would be fitted to all financial institutions. For example, The Security Division of EMC (RSA) demonstrated Archer GRC Platform v.5.5 SP1 to a wide variety of end users, and supports a spectrum of use cases related to ORM. This Platform is scalable but well-suited for large, dynamic and complex organizations.

The GRC solutions from MetricStream also focused on large-scale implementations (with unique requirements) that demand a highly tailored solution. For this purpose a base platform integrated with purpose-built

modules, such as Risk Management, Compliance Management, Loss Management, Scenario Analysis Management and Issue Management.

Increasingly in demand are solutions for sophisticated analytics and modeling capabilities offered by vendors like IBM, SAP and SAS. IBM's core platform, OpenPages GRC Platform v.7.0 is offered as an on-premises or SaaS-based solution для larger, more complex environments and with limited functionality for small and midsize businesses. SAP Risk Management is oriented by companies that utilize SAP ERP modules or other SAP software products that will use the required infrastructure / support and allow for easier integration. SAS Enterprise GRC v.5.1 includes operational risk module SAS, and SAS OpRisk VaR modeling and statistical tools and well suited to the financial services industry.

The company Chartis Research Ltd. especially for market analysis Operational risk & GRC - solutions developed its own methodology RiskTech100®, taking into account production, technological and organizational capabilities vendors. A description of the study and comparison of results for 2014 - 2015 years presented by SAS (2015). The methodology contains six areas of research (Functionality, Core technology, Organizational strength, Customer satisfaction, Market presence, Innovation) and Total score for the top 100 risk technology providers in the world. According to the research results in 2015 once again IBM ranked number one. Also took first place SAS, while SunGard retained third place. The following took 7 seats of Wolters Kluwer FS, MSCI, Oracle, Moody's Analytics, Thomson Reuters, Misys, OpenLink, respectively.

The RiskTech Quadrant® is a proprietary methodology of Chartis Research Ltd. for describes view of the vendor landscape for operational risk technology solutions. It takes into account product and technology capabilities of vendors as well as their organizational capabilities. The sophisticated methodology of ranking allows to explain which solutions would be best for specific buyers. On Figure 3 presented by SAS (2014) Chartis RiskTech Quadrant® for operational risk management systems for financial services. Completeness of offering analyzed by of 15 parameters, Market Potential takes into account 10 parameters.

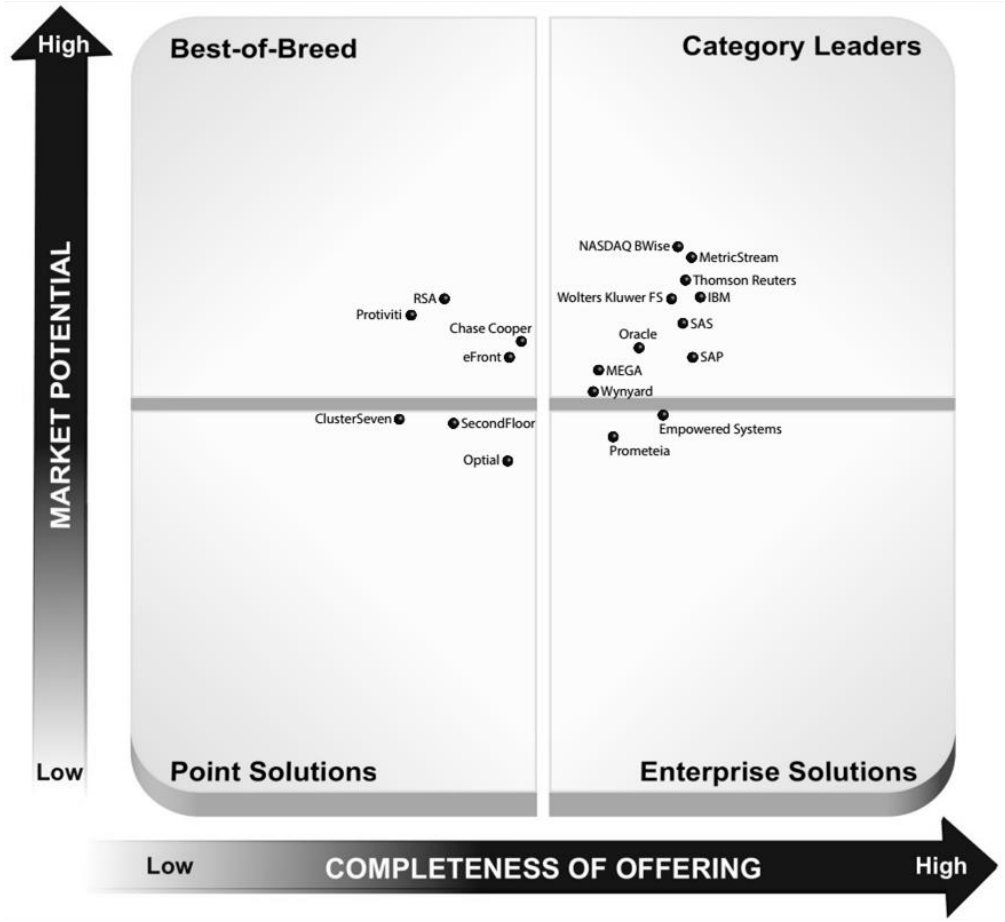


Figure 3 Chartis RiskTech Quadrant® for operational risk management systems, Source: SAS, 2014.

Mismatch of the groups of leaders in Magic Quadrant and RiskTech Quadrant points out that vendors are viewed from different positions. This allows the bank to more accurately select the appropriate product to him.

It should be noted that implementation of GRC solutions - it is always a long and time-consuming project that requires interaction between business and IT departments of the bank, company consultant and vendor. Typical solutions here does not and can be, every project is unique. But not always objective is modification of software solution by the vendor, more often it is works works to implementation, that is performed by consulting company. First of all, this adaptation of decision under the specific business processes of a particular bank and under risk assessment methodology, which accepted by it. Labor input of implementation usually depends on the maturity of risk

management processes, risk assessment techniques used in the company and the specific technical solutions.

Banks can use the synergies arising from the integration of standard business models vendors solutions and personal experience, specific of the business, as reflected in their own or in customized solutions.

4 Conclusion

The current stage of development GRC solutions market includes integrated product for performance management and risk management, and also function-specific applications and applications that support the mobility of users.

Using the results of the analysis Market Operational risk & GRC by different consulting companies allows banks to comprehensively evaluate proposed IT solutions and choose the most suitable product.

Large integrated operational risk management systems demand only the largest banks. For these banks, it is important to improve their efficiency and reduce the likelihood of risk due to a high volume and velocity of information, complexity of algorithms processing. Also, the big banks have the necessary resources for implementing best-in-class products for high reliability and security requirements imposed for risk-management systems.

Small banks are trying to make their own analysis and forecasting of operational risks. But the modern tendency to increase competition, the persistence of instability and amplification regulation in the banking sector the demand for operational risk management system will only grow.

References

BCBS, (2011) *Principles for the Sound Management of Operational Risk* [Online], Available: http://www.bis.org/publ/bcbs195.pdf [15 Sep 2012].

Petrov, P. P. (2014) *The relevance of automation of operational risk management*, [Online], Available: https://sites.google.com/site/operrisks/ [19 Mar 2015]

BCBS, (2015) *Corporate governance principles for banks* [Online], Available: http://www.bis.org/bcbs/publ/d328.pdf [10 Aug 2015].

Gartner, Inc. (2015) *Hype Cycle for Governance, Risk and Compliance Technologies, 2015* [Online], Available: https://www.gartner.com/doc/3091517/hype-cycle-governance-risk-compliance [10 Aug 2015].

Wheeler J. A. (2015) *Gartner Expands Coverage of GRC Technologies* [Online], Available: http://blogs.gartner.com/john-wheeler/gartner-expands-coverage-of-grc-technologies/ [10 Mar 2015].

Wheeler J. A. and Paul E. P. (2014) *Magic Quadrant for Operational Risk Management* [Online], Available: http://www.gartner.com/technology/reprints.do?id=1-26BF755&ct=141219&st=sb [10 Mar 2015].

SAS (2015) *RiskTech100®2015* [Online], Available: http://www.sas.com/content/dam/SAS/en_us/doc/analystreport/chartis-risktech100-2015.pdf [18 May 2015].

SAS (2014) *Chartis RiskTech Quadrant® for Operational Risk Management Systems for Financial Services 2014* [Online], Available: http://www.sas.com/content/dam/SAS/en_us/doc/analystreport/chartis-risktech-quadrant-for-operational-risk-management-systems.pdf [10 Aug 2014]

Technique of Measuring of Identification Parameters of Audio Recording Device

Volodymyr Chaplyha [1], Elena Nyemkova [2],
Zenoviy Shandra[3]

Abstract. This article is devoted to research of dynamic noise spectra of audio recording device. It is proposed identification technique of audio device. The technique is based on comparing Hurst exponent for parameters of spectral densities of non-stationary noise. The results allow identifying specific audio device. There are made the conclusion about the general nature of this technique for the analysis of any nature noise and identification of their sources

Keywords: Identification, audio recording devices, dynamic spectrum of noise, measuring parameters, Hurst exponent.

JEL Classification: C61

1 Introduction

Devices identification is attracting the interest of researchers for many reasons: during the forensic examination audio files, Rybalskiy (2010); due to the requirements of The European Central Bank recommendations on the use of mobile devices for banking transactions; for solving problems of security in cyberspace, and more.

The task consists in development of audio recognition methods that would provide unambiguous information on the type of device and its components based, etc. Obviously, the most appropriate would be to identify the device signals some characteristics that are unique to this particular device. Many researchers have come to the conclusion that such information may be inherent in noise signals.

Any audio device consists of a set of elements that are different in the parameters within the variation of parameters. You cannot make exactly the same elements at the micro level so at the macro level these differences

[1] Lviv Institute of Banking the University of Banking of the NBU, Department of Accounting and Audit, Lviv, 9 Shevchenko Avenue, 79005, Ukraine, 4vovik@gmail.com.
[2] Lviv Institute of Banking the University of Banking of the NBU, Department of Economic Cybernetics, Lviv, 9 Shevchenko Avenue, 79005, Ukraine, cyberlbi12@gmail.com
[3] National University Lvov Polytechnic, Department of Informatoin Protection, Lviv, 3 Prince Roman, 79008, Ukraine, zshandra@gmail.com

are manifested in deviations of parameters of devices: linear gain tract characteristics, resonant frequencies, noise ratio and others.

The nature of modern audio noise is caused by uneven processes of generation and recombination of charge carriers in semiconductor devices, thermal motion of current carriers in conductors and external interferences. Tract audio device acts on noise on two ways: on the one hand noise as the signal to be amplified, and on the other side system of noise canceling will not amplified significantly the noise. As a result, noise spectrum is complex no stationary nature, the specificity of noise behavior depends on the deviations audio device parameters.

We know that noise is characterized by wide spectrum capacity and spectral density. Currently, attempts have been made to identify noise depending on these characteristics, such as noise spectrogram analysis, Chumachenko (2007). It has been wavelet analysis of signal to determine whether compilation record. In principle, the aforementioned noise characteristics can replicate, thereby leveling the difference between the devices. Therefore, a more delicate method of identification is needed, which would exclude manipulations with noise characteristics.

The proposal is provided in order to distinguish between cellular phones of one model series on the characteristics of noise, Hasse (2013). Note that for many problems it needs to have a method of identifying audio device online, which imposes requirements on time and hardware capabilities procedure.

In this paper we used the method RS-analysis for solving the problem of identification of audio devices. Methods used for processing experimental data with random time series behavior and allows you to find the nature of random: persistence or anti-persistence time series data, Kalush (2002). Note that this technique most commonly is used in economic sciences for problems forecasting.

2 Methods of RS analysis and noises classification

Method of RS analysis deals with equidistantly time series, which accumulated swing deviations from the moving average value, normalized to the sliding standard deviation depends on the length of sampling accumulation as exponential function, Kirillov (2013). The indicator function is called

the Hurst exponent *H*. Hurst exponent can be calculated as the regression coefficient logarithm normalized accumulated magnitude to the logarithm of the length of the sample for each time series

In most applications fractal analysis of time series is used as forecasting tools, Shiryaev (1998). Resistance of trend is assessed how changes over time of normalized magnitude R/S (the ratio magnitude *R* to standard deviation *S*) of time series or as Hurst exponent *H* exceeds the value of 0,5.

If the time series reflects a purely random process, the values of Hurst exponent *H≈0,5*. If the Hurst exponent *H>0,6(6)*, the time series has a long memory. In our case fractal characteristics of noise series make it possible to estimate the identification parameters of studied devices.

In this paper we use the following algorithm RS-analysis. We consider the one-dimensional time series x_n, where n is number of elementary events for the random timing *t(n)*, which determines parametrically the function variable *x(t)* on the set of discrete points.

1. For the original time series $X=\{x_1, x_2, \ldots, x_n\}$ moving average value of increments *x(n)* is calculated in step *n* on sampling of length *k*:
$$\overline{x}(n,k) = \frac{1}{k}\sum_{i=n-k+1}^{n} x(i). \tag{3}$$
2. The moving dispersion is calculated:
$$\sigma_x^2(n,k) = \frac{1}{k}\sum_{i=n-k+1}^{n} (x(i) - \overline{x}(n,k))^2. \tag{2}$$
3. Accumulated deviation from the average for sampling of length *k* (magnitude) is calculated:
$$R(n,k) = \max_{j\le n}\left(\sum_{i=n-k+1}^{j} (x(i) - \overline{x}(n,k)\right) - \min_{j\le n}\left(\sum_{i=n-k+1}^{j} (x(i) - \overline{x}(n,k)\right). \tag{3}$$
4. The scale is normalized to the standard deviation:
$$RS(n,k) = {R(n,k)}\Big/{\sigma_x(n,k)}. \tag{4}$$

5. Then logarithm of $RS(n, k)$ is calculated. *RS*-path is represented on the chart as point's sequence. By the method of least squares based trend line (direct). The Hurst exponent H is the regression coefficient.

The Hurst exponent is often used to predict of financial processes in time, such as forecasting stock market prices. Also common is the practice of forecasting the weather and other natural phenomena, Loginov (2009). In such cases is talk about persistence (time series continuing trend) and anti-persistence (time series not continuing trend) time series.

Methodology of RS-analysis is also used to describe the nature of the noise, which makes it possible to characterize the process that generates noise, and compare it to the same process. Scope can be medicine, technical sciences.

Traditionally find that white noise is characterized by intervals $H \in [0,4;0,6)$, brown noise is characterized by intervals $H \in (0;0,2)$, that is expected to complete uncertainty with regard to forecasting time series. For pink noise $H \in [0,2;0,4)$ time series is anti-persistent. Grey noise is characterized by intervals $H \in [0,6;0,6(6))$ - fuzzy transition area between black and white noise. For black noise $H \in [0,6(6);1)$ and time series characterized by sufficient stability trend.

3 Hypothesis of conduct of spectral components of non-stationary noise

The idea of the proposed approach is based on the conception of noise as non-stationary system of uncorrelated harmonic oscillations. Each spectral component of the noise varies over time in amplitude and phase, taking in some times the maximum value or disappearing completely.

Time of occurrence of each spectral component, its duration increase or decrease, time intervals between the maximum values are determined by internal processes occurring in the recording device and depend on its concrete physical implementation.

Since there are no identical devices, the intervals between the maximum spectral amplitude values for different devices will vary slightly, besides increasing or damping of spectral components does not occur uniformly. The magnitude of the deviation from uniformity is also due to from the disparity devices.

Thus, the noise is the vibrations ensemble in which each spectral component appears, reaches a maximum and damped independently of the other component (in the linear approximation), and this process is uneven in time. We can assume that the process of Hurst for each spectral component is individual.

So set of Hurst exponent for all spectral components should better characterize differences in nuances of different devices. This set of index is prompted to call the Hurst portrait. The following is the method of measurements and calculations of characteristics of the device proposed.

4 Methods of measurements and calculations

The main idea of identification off noise signal, which is proposed in this paper, is the difference in time dependences scatter of spectral noise components for different objects. Hurst portrait is considered the dependence of Hurst exponent from spectral components of the Fourier transform of the signal.

It was used the method according to Figure 1 for a Hurst portrait of receiving for chosen audio device. Noise signals measurements, which were taken from the output audio board of computer, were conducted using a computer program Oscillometer. It was tested 4 different boards.

The signals were characteristic of noise signals with frequency range from 10 Hz to 20 kHz, the amplitude of signals was about 10 mV and frequency of digitization was 44.1 kHz. Then the audio file was recorded in stereo with the extension *wav*.

Expansion *wav* not compress data and allows you to explore the amplitude of voltage for each timing. The record lasted for about 2 seconds, thus, recording each track containing up to 88,000 readings. For data processing program MathCAD was used. The file imported into the program, for further calculations data from one track were used.

The window was chosen at a rate of 128 readings, corresponding to 2.9 msec. Application of Fast Fourier Transform 128 readings allowed to obtain reference values of 65 of spectral components, each of which is complex amplitude. Thus was obtained dynamic range noise.

Note, that an additional indicator of the accuracy of calculations is serving size standard deviation, which for random bit sequence equals to 0,5 and for the rational random numbers in the interval [0,1] equals to 0,297.

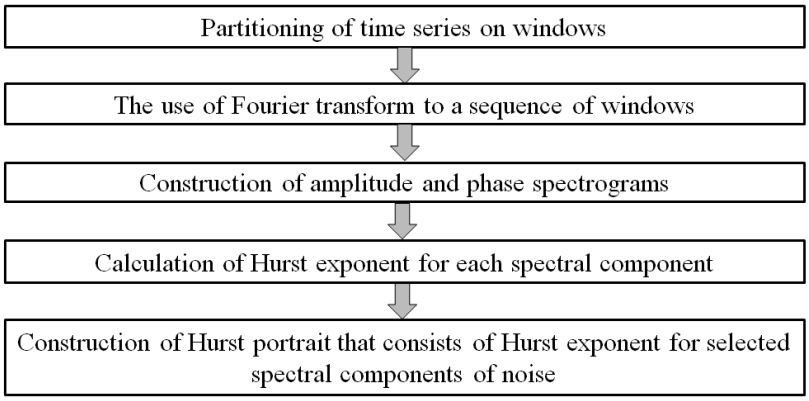


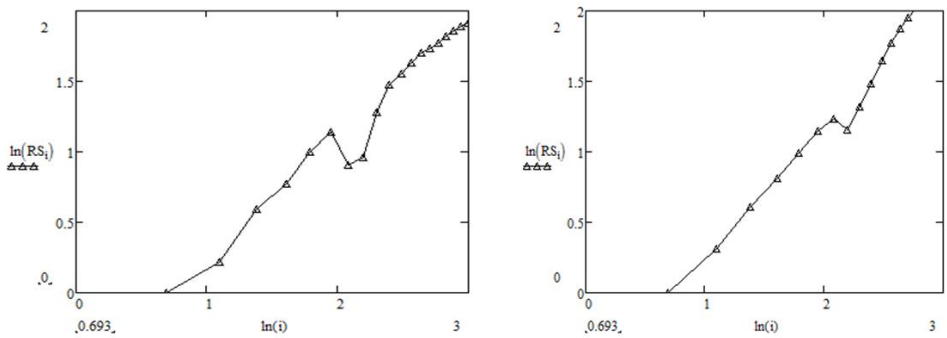
Figure 1 The method of constructing Hurst portrait of audio device, Source: own.

The same number of readings *n* must to be in the calculation of Hurst exponent for comparable sequences.

5 Experimental results

Test of methods and accuracy of calculations was performed using the testing noise - white noise that was generated by a software generator. Results for the noise test are presented in Figure 2.

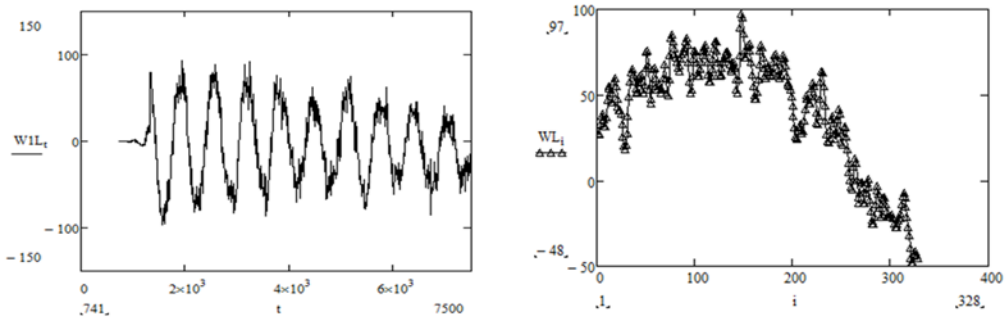
It was found that Hurst process is the same for different spectral components. An indicator of this is the angles of inclination of trends that ware almost the same for different spectral components.



a) b)

Figure 2 Plot RS statistics for spectral component of the noise generator software: a) for the 64th component b) for the 10th component, Source: own.

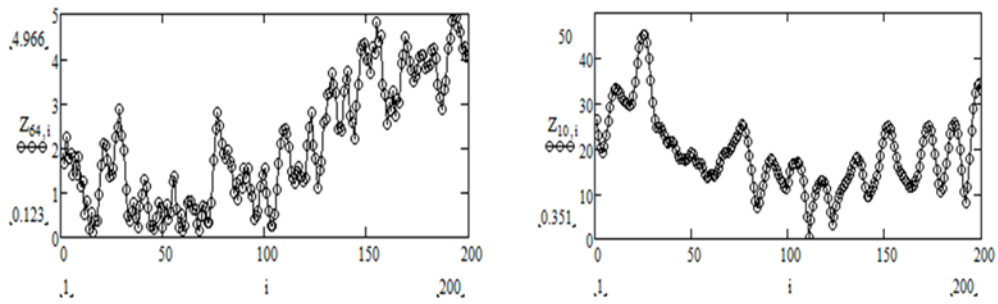
Calculation results of RS statistics for microphone are presented on the Fig.3-5. There is represented the amplitude of intrinsic noise of microphone in Figure 3. There is showed the dynamics of spectral components of noise depending on the time in Figure 4. The Hurst processes for high and low frequency components are different. Changes of amplitude of spectral component for low frequencies were smoother.



a) b)

Figure 3 Own microphone noises: a) microphone noise amplitude versus time. b) area of the plot (a) readings in the vicinity of t = 2440, Source: own.

You can observe a substantial difference between the Hurst processes for high and low spectral components. For low spectral components there can expect larger Hurst exponent compared to high-frequency components, as evidenced by Figure 5.



a) b)

Figure 4 Evolution of spectral components of noise: a) for the 64th component b) for the 10th components, Source: own.

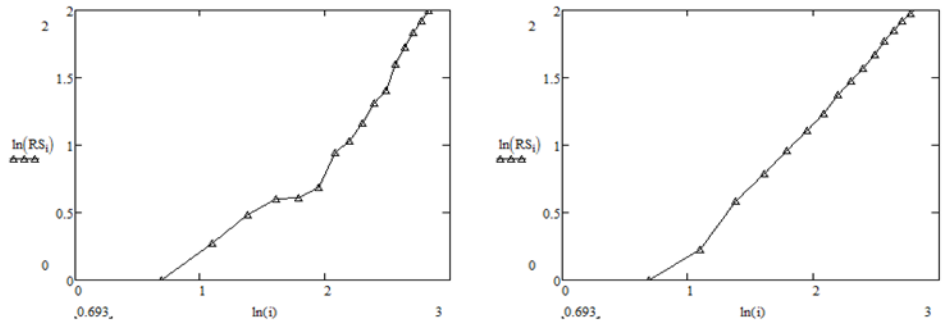


Figure 5 Graph of RS statistics of noise spectral components: a) for the 64th component b) for the 10th components, Source: own.

In Figure 6 there are presented the results of the experiment for audio plats of different computers. On the vertical axis there are showed values of Hurst exponent, which calculated by the described above method. On the horizontal axis there are showed numbers of harmonic of noise signal: point *k* = 1 corresponds to the eighth harmonic decomposition in Fourier series, each successive values of k is a multiple of 8 (16, 24, 32, 40, 48, 56, 64 harmonics respectively).

As shown in Figure 6, the Hurst exponent for audio board of stationary computer are quite close to all frequency range, while for audio board of netbook starting from 24 to 56 harmonics, its value are significantly different.

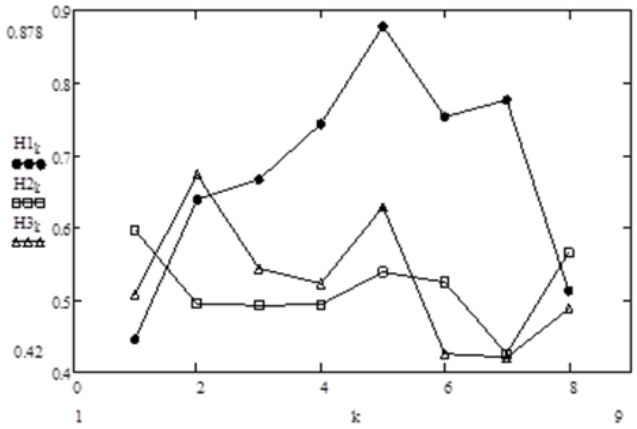


Figure 6 Hurst portrait for three files with the recorded noise. Charts with white squares and triangles were obtained for a desktop computer sound card, graphic with black dots obtained audio board netbook, Source: own.

Consequently, there are possible the identification of audio board of computer and microphone through the Hurst portrait.

6 Conclusion

There are presented a conceptual basis of method of identification parameters measurement of audio recording devices. Method is based on the hypothesis that the Hurst process of time series, which is formed from readings of noise amplitudes in sound range, depends on specific features of individual devices - the natural scatter of their parameters.

Characteristics of the device, consisting of a set of Hurst exponent (Hurst portrait) for the time sequence of amplitudes of spectral components will be more details. It was proved experimentally, that the Hurst portrait for audio recording device uniquely identifies the device and is independent of specific implementation of noise process. Also experimentally was shown that Hurst portrait does not depend on the starting point sampling process of Hurst.

This allows us to offer this feature, and the method of measurement and calculation as a reliable identifier for a specific device. Methods are tested on the test sequences of white noise and harmonic signal that were generated by software generator. Thus, the results show that it is necessary to calculate the Hurst portrait, to identify an audio device for its characteristics of noise. Along with spectrogram Hurst portrait enhances audio device identification. Looking more broadly proposed methodology for using Hurst exponent at the problem of determining the specific parameters of the dynamic range of noise, we can conclude that it is applicable not only to audio signals, and signals of a different nature, for example, for identification of the characteristics in the spatial region.

References

Rybalskiy, O. V. and Solovyov, V.I. (2010) 'Identification system equipment audio recording based on multifractal approach'. *The Bulletin of Eastern European Dal National University.* no. 9 (151), pp.58-63.

Chumachenko, A. B. (2007) 'Identification of digital microphones for recording nonideal tract', *News SFU. Technical science, Special Issue "Information Security", Taganrog,* no 8, pp.84-92.

Hasse, J., Gloe, Th. and Beck, M. (2013) *Forensic Identification of GSM Mobile Phones* [Online], Available: http://www.dence.de /publications/Hasse13_GSM MobilePhoneIdentification.pdf [10 Oct 2013].

Kalush, Yu. A. and Loginov, V.M. (2002) 'Hurst coefficient and its hidden properties', *Sib.zhurn. industry. Mat*, no. 4, vol. 5, pp.29-37.

Kirillov, D.S. (2013) *Distribution of the Hurst exponent of non-stationary time series market* [Online], Available: http://library.keldysh.ru/preprint.asp?id=2013-11 [5 Sep 2015].

Shiryaev, A.N. (1998) *Essentials of Stochastic Financial Mathematics*, Moscow: Fazis.

Loginov, O.A. and Sarycheva, L.V. (2009) 'Prediction of groundwater level by using cellular automata', *Control systems and machines*, no. 1, pp. 86-92.

The Methods of Reorganization of Information Security Corporate Network Bank

Sergiy Ivanyshyn[1]

Abstract. In the article general approach for information security of corporate network of bank is applied. Methods of reorganization of the information security system are offered. These methods are based on implementation of international standards requirements in the field of information security, and instructions of the National bank of Ukraine. Much attention is paid to planning of the system of information security guaranteeing in bank. The model of building of the information security system is examined from the point of view of managing and natural influences on the information resources of bank.

Keywords: information security system, security profile, risk evaluation algorithm.

JEL Classification: M15, D82, G21

1 Introduction

The primary objective of the information security system of bank is providing its permanent functioning, security threats prevention, legal interest's protection from unlawful encroachments, exclusion of financial means plundering, disclosure, loss, leakage, misrepresentation and erasing of proprietary information, as well as providing of normal functioning of all bank divisions. Also one of the main objectives of the information security system of bank is upgrading of services quality and guaranteeing safety of property rights and clients' interests.

The main objectives of any information security system of bank are:

- referring information as limited access (official or commercial secret);
- prediction and timely detection of information resources security threats, causes and circumstances, which contribute to financial, material and moral losses, interruption of normal functioning and development of bank divisions;

[1] University of Banking of the NBU, Department of Economic Cybernetics, 1 Andriyivska str., Kyiv, 04070, Ukraine, sergiy.ivanyshyn@gmail.com.

- providing conditions for normal functioning of information resources with decreasing probability of their security threats realization and suffering different types of losses;
- creating of mechanism and conditions for quick reacting on information security threats and negative tendencies in information systems' functioning, effective stopping of information resources encroachments on the basis of legal, organizational and technical measures and security instruments;
- creating of conditions for maximally possible compensation and localization of losses, which are inflicted by illegal actions of physical and legal persons, weakening of negative influence of information security breaches consequences on achievement of strategic aims.

2 Model of creation information security system

In the process of reorganization, we can accept the following model of creation of the information security system, which is based on operational control adaptation and risk analysis (see figure 1).

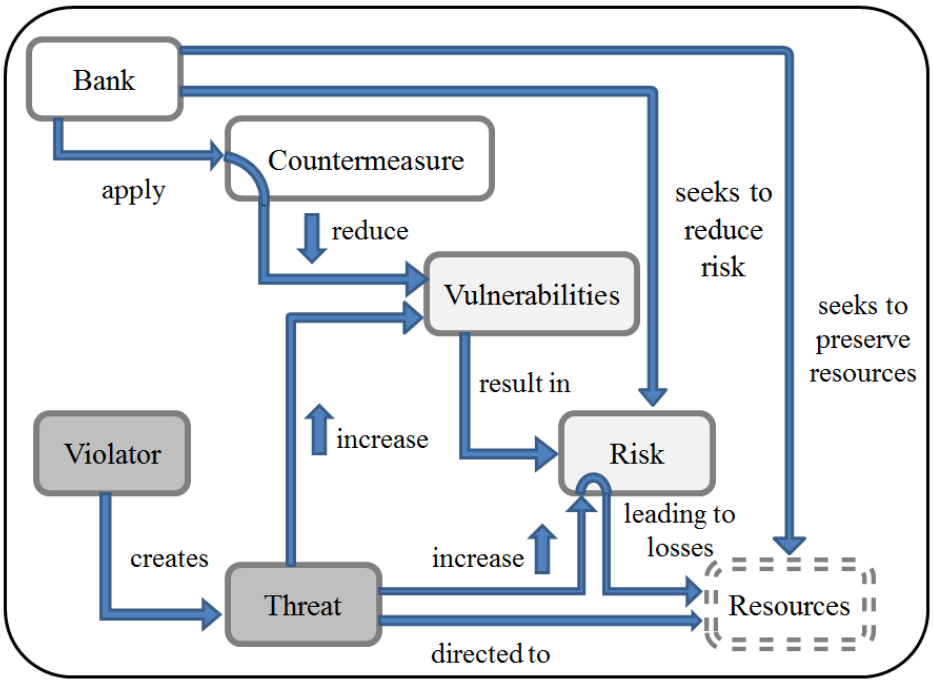


Figure 1 The model of creation of the information security system, Source: own.

This model meets the requirements of special Ukrainian regulatory information security documents, Resolution of NBU (2010) and Letter of NBU (2011);international standard ISO/IEC 15408 "Information technology - Security techniques - Evaluation criteria for IT security", ISO/IEC 15408-1:2009 (2009) and ISO/IEC 27002:2013 (2013); standard ISO/IEC 17799 "Information security management", ISO/IEC 17799:2005 (2005); and takes into account tendencies of domestic regulatory base development (in particular, Directive of the National bank of Ukraine) in the field of information security, SU guidelines NBU (2010).

The presented model of the information security system is a collection of external and internal objective factors and their influences on the state of bank information security and on preserving of material or information resources.

In the model objective factors are examined:

- information security threats, which are characterized by probability of appearing and probability of realization, as the Petrenko wrote (2005);
- information system or counter-measures system (information security system) vulnerabilities, which have impact on probability of threat realization;
- risk-factor, which reflects the possible losses of organization as a result of information security threats realization: leakage of information and its illegal use (finally, risk represents probable financial losses - direct or indirect), as the Petrenko wrote (2006).

3 Methods of analytics

The offered methods must allow:

- to fully analyses and document requirements, related to information security guaranteeing;
- to avoid charges on excessive security measures, which are possible as a result of subjective evaluation of risks;
- to give help in planning and realization of deference at all stages of bank information systems lifecycle;
- to provide realization of works in short terms;
- to imagine a ground for counteraction measures choice;

- to estimate efficiency of counter-measures, compare different variants of counter-measures.

During realization of works, research scope must be set. For this purpose, it is necessary to distinguish information system resources, for which in future risks evaluations will be received. Upon this, it is required to divide bank own resources and external elements for cooperation. Among resources, there are money, computer engineering, software and data. The examples of external elements are communication networks, external services, etc.

In the process of building of the disclosed model all functional interconnections between resources must be taken into account. For example, any equipment failure can result in data loss or failure of other critical element of the system. Such interconnections determine the basis of organization model building from the information security point of view.

This model, according to the methods offered, can be built as following: value of dedicated resources is estimated, both from the point of view of associated with them possible financial losses and from the point of view of bank reputation risks, bank operations disorganization, non-material losses from the confidential information disclosure, etc. Then resources interconnections are described, security threats are determined and probabilities of their realization are estimated.

On the basis of the model built, it is possible to reasonably choose the counter-measures system, which will reduce risks to acceptable levels and has the best price efficiency. Recommendations for carrying out regular inspections of security system efficiency will be a part of the counter-measures system.

Providing of the increased requirements for bank information security foresees corresponding measures on all stages of information technologies life cycle. Planning of these measures is conducted on completion of the stage of risks analysis and counter-measures choice. The mandatory component of these plans is periodic checking of accordance of the existing security policy, certification of information system (technology) for conformity to the requirements of certain security standard.

Upon completion of works it is possible to define the measure of security guaranteeing of bank information environment. This approach foresees that

bigger efforts during safety assessment result in better security guaranteeing. In addition to that, adequacy of such assessment is based on:

- bringing of bigger number of bank information environment elements in the process of assessment;
- intensity, which is provided by usage of bigger number of projects and implementation details description during the process of system planning;
- application of bigger number of search instruments and methods, aimed at detection of less obvious vulnerabilities or at diminution of their presence probability.

4 Methods of information risks analysis

The purpose of risks evaluation process is to define risks characteristics in information system and its resources. On the basis of such data necessary information security management tools are chosen.

The process of risks evaluation can contain the following stages:

- description of object and protection measures;
- resource identification and evaluation of its quantitative indexes (estimation of potential negative influence on business);
- analysis of information security threats;
- analysis of vulnerabilities;
- evaluation of existing and predictable information security tools;
- risk evaluation.

A risk characterizes a danger, which the system can undergo and which its organization uses and depends on:

- resources value indexes;
- probabilities of resources losses (expressed through probabilities of resources threats realization);
- degree of vulnerabilities usage easiness (vulnerability of defense system);
- existing or planned information security tools.

The calculation of these indexes is executed on the basis of mathematical methods, which have such characteristics, as grounds and exactness parameters of method.

5 Planning of enterprise information security system

Planning of bank information security system can be developed through following scenario.

1.3 Creating protection profile

On this stage the projecting plan of bank information security system is developed. The estimation of accessible tools is conducted, an analysis and planning of development and security tools integration are carried out. The necessary element of work is possible risk statement of defense object. Providing of increased requirements to information security foresees corresponding measures on all stages of information technologies life cycle. Planning of these measures is conducted on completion of the stage of risks analysis and counter-measures choice. The mandatory component of these plans is periodic checking of accordance of the existing security policy, certification of information system (technology) for conformity to the requirements of certain security standard.

Creating bank defense plan begins with creating defense profile of this object. Part of this work was already done while making of risk analysis.

1.4 Forming of organizational security policy

Before offering any technical solutions on the bank information security system, it is required to work out its security policy. The security policy describes the order of granting and using of access rights, and also requirements of users reporting for their actions from the security point of view.

The bank information security system will appear effective, if it will reliably support implementation of security policy rules, and vice versa.

The steps of creating organizational security policy are:

- bringing value structure in description of automation object and making of risk analysis;
- determination of rules for any process of using this kind of access to the resources of automation object, which have this degree of value.

The organizational security policy is designed as separate document, which is conformed and adopted in a bank.

1.5 Terms for IT safe use

It is foreseen that the system of providing of bank security, which corresponds the selected defense profile, must provide necessary level of security only in case if it is applied, managed and used in accordance with the accepted rules. An operating environment must be managed in accordance with accepted for this type of defense profile normative documentation, and also with instructions of administrators and users.

The following types of terms for IT safe use are distinguished:

- physical conditions;
- conditions for personnel;
- connections conditions.

Physical conditions have to do with object resources placing, and also security of hardware and software, which are vulnerable to security policies violations.

Conditions for personnel contain organizational questions of security management and supervising users' access rights.

Connections conditions do not contain obvious requirements for networks and distributed systems, but, for example, the condition of position equality means the presence of the only area of management of all object networks.

The terms for safe use of automation object are designed as separate document, which is conformed and adopted in a bank.

1.6 Phrasing of bank security aims

Detailed description of general purpose of bank security system construction is given in this part of defense profile, which is expressed through the totality of factors or criteria, specifying the purpose. The totality of factors serves as a basis for determination of system requirements (alternatives choice). Security factors, in their turn, can be divided into technological, technical and organizational.

1.7 Security functional requirements definition

Defense profile functional requirements are determined on the basis of well-known, worked out and conformed security functional requirements. All requirements for security functions can be divided into two types: information access control and management of information flows.

On this stage correct definition of bank security functions components is required. The component of security function describes the certain set of security requirements - the smallest chosen set of security requirements for inserting into defense profile. There can be dependencies between components.

1.8 Requirements for guaranteeing of achievable security

The structure of requirements for guaranteeing of achievable security is the same as the structure of functional requirements and includes classes, families, components and guaranteeing elements, and also levels of guaranteeing. Classes and families of guaranteeing represent such questions as development, configuration management, working documentation, maintenance of life cycle stages, testing, vulnerability estimation and other questions.

The requirements for guaranteeing of achievable security are expressed through the bank security functions evaluations. The evaluation of security function strength is executed at the level of separate defense mechanism, and its results allow defining relative ability of corresponding security function to resist identified threats. Based on the known potential of attack, security function strength is determined, for example, by categories “base”, “middle”, “high”.

Potential of attack is determined by examination of possibilities, resources and reasons of attacker.

It is suggested to use tabular consolidation of security guaranteeing levels. Guaranteeing levels have hierarchical structure, where every next level gives bigger guaranteeing and includes all requirements of previous one.

1.9 Forming list of requirements

List of information security system requirements, draft project, defense plan (technical documentation, TD) contains the set of enterprise information

environment security requirements, which can refer to the corresponding defense profile, and also contain requirements, formulated in explicit form.

In general, development of TD includes:

- clarification of defense functions;
- choice of architectural principles of construction of information security system (ISS);
- development of logical structure of ISS (exact description of interfaces);
- clarification of functions requirements for providing ISS guaranteeing;
- development of methods and tests program to confirm accordance to formulated requirements.

1.10 Evaluation of achievable security

On this stage the evaluation of level of bank information environment security guaranteeing is conducted. The level of guaranteeing is based on estimation, which allows trusting bank information environment after implementation of recommended measures. Base statements of methods must assume that the level of guaranteeing depends on efforts efficiency during safety assessment. The increase of assessment efforts assumes a lot of object information environment elements, which participate in the process of evaluation, and also expansion of projects types and implementation details description in the process of security system planning.

6 Conclusion

In this article possible methods of reorganization of corporate information security system of a bank is proposed. These methods are based on following components: clarification of primary purposes and tasks of information security, requires creation of the information security system model, contains the methods of analytics. Also, development of thorough methodology of bank information security risks analysis is necessary, as well as planning of the bank information security system.

Exact adherence of every component requirements guarantees reliable and continuous bank functioning.

References

ISO/IEC 15408-1:2009 (2009) *Information technology -- Security techniques -- Evaluation criteria for IT security -- Part 1: Introduction and general model* [Online], Available: http://www.iso.org/iso/catalogue_detail.htm?csnumber=50341 [15 Dec 2013].

ISO/IEC 27002:2013 (2013) *Information technology -- Security techniques -- Code of practice for information security controls* [Online], Available: http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?csnumber=54533 [1 Oct 2013].

ISO/IEC 17799:2005 (2005) *Information technology -- Security techniques -- Code of practice for information security management* [Online], Available: http://www.iso.org/iso/catalogue_detail?csnumber=39612 [1 Oct 2013].

Letter of NBU Informatization department № 24-112/365/ (2011) *Methodical recommendations for the implementation of information security management system and methods of risk assessment in accordance with the standards of the National Bank of Ukraine* [Online], Available: http://zakon4.rada.gov.ua/laws/show/v0365500-11 [03 Mar 2014].

Petrenko S. A. and Kurbatov V. A. (2006) *Information security policy*, Moscow: Publishing house DMK Press, (Information Technology for Engineers).

Petrenko S. A. and Simonov S. V. (2005) *Information Risk Management. Economically justifiable safety*, Moscow: Publishing house DMK Press, (Information Technology for Engineers).

Resolution of NBU (2010) N 474 *"On enactment of standards for information security management in the banking system of Ukraine."* [Online], Available: http://zakon4.rada.gov.ua/laws/show/v0474500-10 [28 Oct 2013].

SU guidelines NBU (2010) 65.1 Information security management system *2.0: 2010 "Methods of protection in banking. Code of Practice for Information Security Management " (ISO/ IES 27002:2005, MOD).* [Online], Available: https://kyianyn.files.wordpress.com/2010/12/nbu-27002.pdf [30 Oct 2013].

SU guidelines NBU (2010) 65.1 *Information security management system 1.0:2010 "Methods of protection in the business. Code of Practice for Information Security Management " (ISO/ IES 27001:2005, MOD).* [Online], Available: https://kyianyn.files.wordpress.com/2010/12/nbu-27001.pdf [30 Oct 2013].

PROCESS MANAGEMENT AND ITS IT SUPPORT

How Small Companies Can Improve their Software Development Processes for Gaining Competitive Advantage

Alena Buchalcevova[1]

Abstract. Small companies that develop software do have a significant influence on the economy, but most of them do not implement any international standards or models. To solve such difficulties, the ISO/IEC 29110 standard Systems and Software Engineering – Lifecycle Profiles for Very Small Entities (VSEs) is being developed by the ISO community. The structure of the standard is described as well as its key concept which lies in a development of VSE Profiles. By using these Profiles, very small companies have the chance to improve their processes in a clear and stepwise manner. Paper describes advantages of conforming to the standard and issues that the standard deals with. The initiatives aiming at a broader diffusion of the standard in the Czech Republic are presented. It is above all translation of freely available parts into Czech language, publication the standard in the form of easily accessible methodology and building an informational website about ISO/IEC 29110.

Keywords: Software Process Improvement, standard, small companies, certification, Czech Republic, diffusion

JEL Classification: M15

1 Introduction

The key role of software systems in today's society lies in contradiction to a success of software projects. According to several surveys (Johnson, 2006; Ambler, 2013), the ratio of successful software projects ranges to 60%, while the rest is categorized as challenged or failed.

Software Process Improvement (SPI) represents a way of improving a status of software development. International standards like ISO/IEC 12207 (ISO/IEC 12207, 2008) ISO/IEC 15289 (ISO/IEC 15289, 2006), ISO/IEC 15504 (ISO/IEC 15504. 2004), and ISO 9001 (ISO 9001, 2008) play an important role in SPI initiatives as companies are willing to show compliance with common business rules.

[1] Department of Information Technologies, Prague University of Economics, buchalc@vse.cz

However, according to several surveys (Analecto et al, 2004; Laporte et al, 2006) small companies consider implementation of international standards quite difficult as they lack sufficient resources in terms of number of employees, budget and time. To solve such difficulties, the ISO/IEC 29110 standard Systems and Software Engineering – Lifecycle Profiles for Very Small Entities (VSEs) is being developed by the ISO community.

In this paper the ISO/IEC 29110 standard is presented as an example of software and systems process improvement initiatives focused on small companies. Paper describes advantages of conforming to the standard and issues that the standard deals with. The initiatives aiming at a broader diffusion of the standard in the Czech Republic are presented.

2 ISO/IEC 29110 Standard Systems and Software Engineering – Lifecycle Profiles for Very Small Entities

Although very small companies that develop software have a significant influence on the economy, most of them do not implement any international standards or models like ISO/IEC 12207 or CMMI (Analecto et al, 2004; Laporte et al, 2006). Subsequently, these companies do not have any or very limited opportunities to be recognized as entities that produce quality software and thus are often cut off from contracts. Therefore the ISO/IEC 29110 standard is being developed. The term "very small entity" (VSE) was defined by the ISO/IEC JTC1/SC7 Working Group 24 and consequently adopted for use in the emerging ISO/IEC 29110 standard meaning "an entity (enterprise, organization, department or project) that has up to 25 people".

2.1 Structure of the Standard

At first Working Group 24 focused on developing a standard in the field of software engineering. Figure 1 shows the standard's structure. Part 1 Overview (ISO/IEC 29110-1, 2010) explains main concepts, terms and structure of the standard. Part 2 Framework and Taxonomy (ISO/IEC 29110-2, 2010) presents principles and mechanism of building VSE Profiles that represent a key concept of the ISO/IEC 29110 standard. As a starting point, the "Generic" Profile Group was defined which is applicable to a vast majority of VSEs that do not develop critical software. Within the Generic Profile

Group four VSE Profiles were proposed, i.e. Entry, Basic, Intermediate, Advanced. By using these Profiles, very small companies have the chance to improve their processes in a clear and stepwise manner.

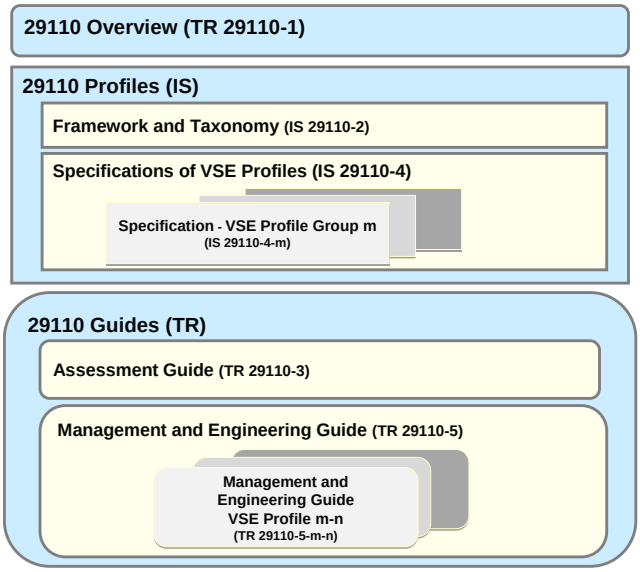


Figure 1 ISO/IEC 29110 Set of Documents (ISO/IEC 29110-1, 2010), Source: own

Part 3 Assessment Guide (ISO/IEC 29110-3, 2010) then defines the process assessment guidelines and compliance requirements needed to meet the goal of defined VSE Profiles. This part of the standard is used by certified assessors to perform a VSE assessment. Part 4 Specifications of VSE Profiles provides a mapping to the source standards and is useful for method developers and assessors (ISO/IEC 29110-4, 2010). Part 5 Management and Engineering Guide is intended for VSEs and comprises technical reports for each profile, e.g. Entry profile (ISO/IEC 29110-5-1-1, 2012), Basic profile (ISO/IEC 29110-5-1-2, 2011). First, the Basic Profile intended for a single project with no special risks or situational factors was developed and published. In this Profile, two processes, i.e. the Project Management process and the Software Implementation process are defined.

The purpose of the Project Management process is to establish and carry out the Tasks of the software implementation project in a systematic way, which allows complying with the project's Objectives in the expected quality, time and cost range. The purpose of the Software Implementation process lies in the systematic performance of analysis, design, construction, integration

and test activities within projects aimed at new or modified software products according to the specified requirements (ISO/IEC 29110-5-1-2, 2011).

As particular pilot projects of Basic Profile implementation in VSEs showed, this Profile was still for some companies difficult to implement. For this reason, the Entry Profile was developed (ISO/IEC 29110-5-1-1, 2012) which applies to six person-months effort or start-up VSEs. The Entry and Basic Profiles are published by ISO and can be utilized. The other two Profiles are still under development. The Intermediate Profile is intended for VSE which handles more than one project at a time, and therefore is aware of assigning project resources and monitoring projects to accomplish business objectives and customer satisfaction. Lastly, the Advanced Profile is proposed to supply business management practices.

To help VSE with an implementation of the Entry and Basic Profiles, a series of Deployment Packages were developed and offered free of charge (Deployment Packages repository, 2015). A Deployment Package acts as a detailed methodology that guides a company through the process of profile implementation. A typical Deployment Package includes process descriptions, activities, tasks, roles and products, templates, checklists, examples, reference and mapping to standards and models, and a list of supporting tools.

2.2 Current Development of the Standard

Resulting from a positive experience with ISO/IEC 29110 implementation in the field of software engineering a set of systems engineering standards for VSEs is being developed.

Within the software engineering area, Part 3 of the standard used for assessment and certification carries on with its elaboration. A standard for Conformity Assessment (29110-3-2) and also for Capability Assessment (29110-3-3) is being composed. Brazil has been the country to lead the development of an ISO/IEC 29110 certification process. Regarding an auditor role within the certification process, an ISO/IEC 29110 auditor should be competent in auditing techniques, have expertise in ISO/IEC 29110 and experience in systems or software development. For VSEs, such a certification should not be too expensive and long-lasting. This certification process has successfully been piloted in several Brazilian VSEs. The process took about 4 man-days of auditor's work. The first auditor course was

conducted in English in Dublin in November 2013 (Laporte and O'Connor, 2014).

Currently, the ISO/IEC 29110 standard is being restructured and renumbered to better correspond to a categorization of systems engineering and new methods and technologies such as agile development and cloud computing. The Working Group 24 has also initiated several activities in the area of services and considers developing a subset of the ISO/IEC 20000 standard for VSEs.

3 Initiatives towards a Diffusion of ISO/IEC 29110 Standard in the Czech Republic

Quality oriented process approaches and standards are still maturing and gaining acceptance in many companies worldwide. However, the status in the Czech Republic is worse. The survey conducted in 2006 and described in (Buchalcevova, 2009) showed that the use of agile methodologies and approaches in the Czech Republic was only at its starting point. More recent survey conducted at the conference WebExpo 2011 (Buchalcevova, 2013; Mittner and Buchalcevova, 2014) showed that while modern software development practices and methodologies especially agile are applied to a large extent, international or national standards and models are practically not implemented. However, the respondents indicated a belief that by using right methodologies, standards and tools it is possible to improve their software processes.

I personally believe that the use of international standards in companies in the Czech Republic represents a key factor in their competitiveness within the global market. Applying these standards enhance software management, enable meeting deadlines and budgets, achieving quality goals, managing employee training and turnover. Moreover, it attracts new customers and fulfills requirements of existing partners and reinforces partnerships and co-development in an international environment.

As a member of the working group WG24, I have participated in the ISO/IEC 29110 standard development since 2008. Thus, I have the opportunity to track how small companies in other countries such as Brazil, Mexico or Thailand widely implement the ISO/IEC 29110 standard largely supported by the governments. However, the Czech Republic lacks such

a government support aiming at improved process quality in systems and software development. Moreover, the government does not even require a certain level of these processes e. g. in government contracts. Thus, companies in the Czech Republic need to care themselves about quality of their processes and products.

As education of future developers is an important prerequisite for increasing process quality of software development in practice, I incorporated this standard into university courses at the Prague University of Economics on the undergraduate as well as graduate level. As key parts of the standard are available for free, it was able to translate them into the Czech language. We did it with the assistance of students taking the graduate course Software Process Improvement. Students also translated and updated all Deployment Packages. We developed website http://spicenter.vse.cz/ where all these resources are published. Moreover, two students within their diploma theses implemented Entry and Basic profiles in the Eclipse process framework composer tool and published them in the form of easily accessible methodology which is part of the website (see Figure 2).

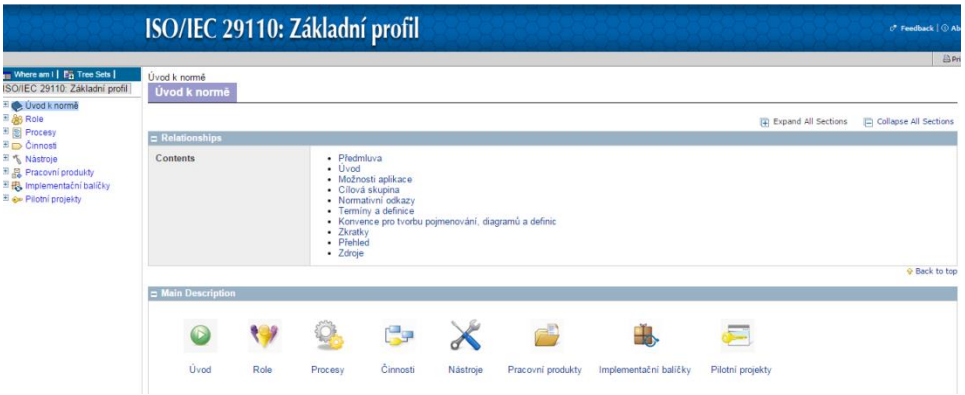


Figure 2 Basic Profile in EPFC tool, Source: own

In addition, we also translated the Wikipedia page about this standard into Czech which is accessible at http://cs.wikipedia.org/wiki/ISO_29110. I have also prepared a public course about the ISO/IEC 29110 standard opened for general public. Currently, the Faculty of Informatics and Statistics of the Prague University of Economics is in the process of building the Center

for Very Small Entities in the Czech Republic as a part of the netcenter for VSE – the global net of centers for very small entities.

4 Conclusions.

Although very small companies that develop software have a significant influence on the economy, most of them do not implement any international standards or models, as they lack sufficient resources in terms of number of employees, budget and time. The situation in the Czech Republic in the area of international standards implementation looks even less promising. To address this global issue, the ISO/IEC 29110 standard Systems and Software Engineering – Lifecycle Profiles for Very Small Entities (VSEs) is being developed by the ISO community. This paper described concept of the standard and its evolution and presented the initiatives undertaken towards a broader diffusion of the standard in the Czech Republic.

References

Ambler, S.W. (2013) 'IT Project Success Rates Survey Results'. *Ambysoft* [online]. Available at: http://www.ambysoft.com/surveys/success2013.html.

Anacleto, A. von Wangenheim, C.G. Salviano, C.F. and Savi R. (2004) 'Experiences gained from applying ISO/IEC 15504 to small software companies in Brazil', *4th International SPICE Conference on Process Assessment and Improvement*, Lisbon, Portugal.

Buchalcevova, A. (2009) 'Research of the Use of Agile Methodologies in the Czech Republic'. *In: Barry, C; Conboy, K; Lang, M; et al.(eds) Information Systems Development: Challenges In Practice, Theory And Education*. (51-64) DOI: 10.1007/978-0-387-68772-8_5

Buchalcevova, A. (2013) 'Software Process Improvement in Small Companies'. *In: Software Development and Object Technologies*. SDOT 2013. p. 45–52. 173 s. ISBN 978-80-86847-66-5.

Deployment Packages repository. (2015) [Online], Available: http://profs.etsmtl.ca/claporte/English/VSE/index.html [20 Sept 2015].

ISO 9001 (2008) Quality management systems — Requirements. Geneva: International Organization for Standardization (ISO).

ISO/IEC 12207 (2008) Systems and software engineering – Software life cycle processes. Geneva: International Organization for Standardization (ISO).

Preparatory Activities of the Project

Lenka Svrčinová[1], Jan Ministr[2]

Abstract. From the viewpoint of the solution provider, the current time can be characterized as more demanding in the field of software solution development. The causes of this situation are the following: a high number of existing competing solutions, the specification of the extent of solutions provided and a need for their fast implementation into the customer's environment. There are some risks connected to this complex process of the information system development. However, it is possible to eliminate them during the contract preparation process or project preparation stages. This article deals with procedures of a product manager who is in charge of an information system project both from the business and implementation viewpoint.

Keywords: product manager, software, contracts, case study, acceptance, entry analysis.

JEL Classification: D72, H43, O22

1 Introduction

The general description of information system project implementation represents a sequence of basic project stages (analysis, proposal, implementation, testing) which are processed and planned within a framework of various methodologies (agile, rigorous methodologies) - according to the methodology principles, rules and agreements (Danel et al., 2015). The preparation procedures which then have a significant influence on the overall IS project results are fundamental for the success of the project. The function of a product manager seems to be the key element to improve the quality of IS project preparation stages in software companies. The manager's task is to transform vague customer requests into a formalized shape which will serve as a basis for contract creation. (Ludík & Ráček, 2011). A product manager also needs to continuously coordinate activities of other company employees in the frame of the life cycle of the IS project development in accordance with the customer's changing needs which then leads to customer satisfaction during the IS implementation and operation.

[1] D3Soft, Sales department, Ocelářská 2969/12, 703 00 Ostrava – Vítkovice, Czech Republic, lenka.svrcinova@d3soft.cz

[2] VŠB-TU Ostrava, Faculty of EconomicsDepartment of Applied Informatics, Sokolská třída 33, 701 21 Ostrava 1, jan.ministr@vsb.cz.

2 Processes and levels prior to project implementation

If we look at the information system implementation process as a complex entity of process management, we can consider it in two levels whose structure is shown in the figure 1. The levels are as follows:

- Business level,
- Implementation level.

From the viewpoint of preparation procedures, this article will be mainly dealing with the former level:

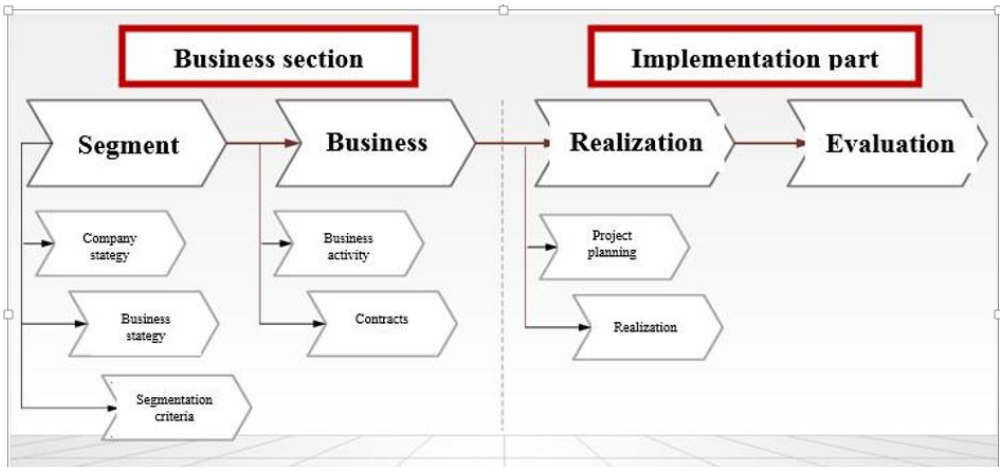


Figure 1 IT company activity, Source: own

2.1 Business level

The business process, which precedes all other stages and work on a project, is an often forgotten, but very important, level in the project realization process. The reason why this process is regarded with contempt is professional and physical separation of the business department and IS project implementation.

In general, it can be said that the business department respects the company's strategy and fulfils its vision which is defined by the owner or a shareholder. Strategy derives from the owner's viewpoint and always brings a certain value (financial, marketing or product). Company owners (business partners, shareholders) are therefore seen as the primary group

of interest which has a clearly defined interest in the company's existence and functionality (Janišová and Křivánek, 2013), as shown in figure 2.

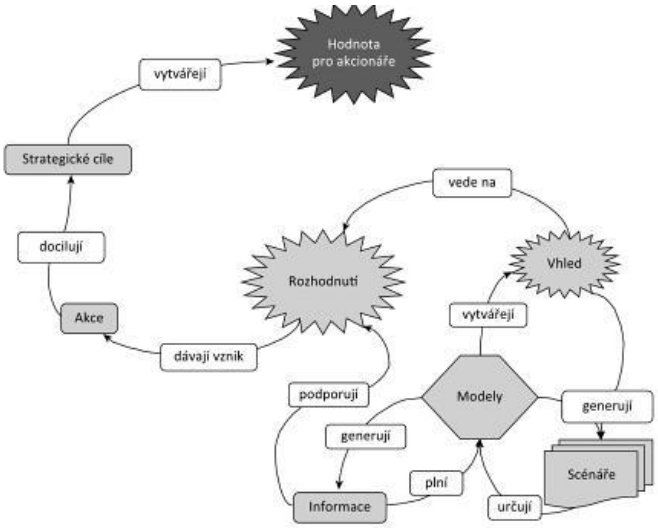


Figure 2 Dynamic model of shareholders value creation, Source (Janišová and Křivánek, 2013)

The process of business negotiation comprises of the following steps:

- Customer segmentation (tracking customers, suitability judgement),
  - Customer segmentation according to criteria,
- Acquisition (of potential and current customers),
  - Marketing campaign (product, company, etc.),
  - Price negotiation (implementation, service, discount, etc.),
  - Contract conclusion process (license, service and implementation contract),
- Product marketing presentations.

Some risks and problematic areas arise from the business process (Janišová and Křivánek, 2013):

- Misunderstanding of customer's core needs (core needs),
- Customer does not primarily solve 20% of key functions,
- Salesman does not know his product,
- Salesman does not understand client's requests and wants to sell a product by any means.

These problematic areas mentioned above have a negative impact on the relationship between the provider and the customer. The reasons for such an impaired relationship can be (Tvrdíková, 2015):

- The project extent was not clearly defined/understood - a difference between customer's and provider's project/solution understanding,
- Not meeting the project's schedule - the schedule corresponds to the original project's extent,
- Bad provider's negotiating position about development projects,
- Project budget increase - long implementation,
- Provider's employees demotivation - bonuses, crisis management and situation,
- Negative references of a provider.

2.2 Implementation level

In the case of business process failure, implementation, in effect, realizes a project different than originally required by a customer. Unfortunately, problematic areas which can harm the relationship between a provider and a customer can be found even in the implementation process (Hunka & Ministr, 2013):

- Implementation of an untested build/system version,
- Un-userfriendly solution,
- Insufficient code refactoring,
- Problematic task prioritization (support, implementation),
- Incorrect estimates.

3 Solution of problems arisen in the business level

The solution to avoiding unfavourable situations in the business process environment necessitates the role called Product manager/product specialist. An employee executing this role stands between business and implementation which results in his complex technology and product knowledge. Key characteristics of a product manager should be as follows (Oškrdal & Doucek, 2014):

- Product knowledge on a consultant level (customization, system setting),

- Business skills (acquisition, license, contracts, knowledge of product price),
- Complex product administration (development proposals, trends),
- Knowledge of competition and of its advantages/disadvantages (suggestions for new functions),
- Understanding of basic activities estimates when implementing requests (expenses vs. price),
- Knowledge of product technology background and development,
- Being informed about implementation department time availability.

A product manager takes part both in the business and implementation process:

- Market segmentation,
- Customized development with a customer - New demand from a customer,
- Commission realization with a customer,
- Marketing and product presentations.

3.1 Market segmentation

The original process of market segmentation relied directly on a salesman or marketing department. This resulted in high running costs of the business department and high costs per salesman.

A product manager executes the following activities in the segmentation process:

- Product - Salesman assignment,
- Providing a salesman with information and lectures needed,
- Definition of criteria for customer search according to a product and market,
- Competition list creation (advantages/disadvantages, prices),
- Salesman argumentation database.

3.2 Customized development with a customer

The activities of a product manager from the viewpoint of customized development and new commission realization can be divided into the following steps:

- Potential customer register - information background for implementation,
- Providing project/function impact estimates (work difficulty),
- Evaluation of further function/solution sale potential,
- Participating in a binding quotation creation for the customer,
- Entry analysis realization (quick analysis with customer),
- Project deadline and schedule guarantee.

3.3 Commission realization with customer

A product manager is integrated into the commission realization process with a customer and his proceedings are as follows:

- Realization and requirement list creation,
- Communication with customer,
- Solution proposal – choosing a suitable product,
- Process surveillance on realization along with the product manager,
- Regular check days with customer (version delivery, solution extent),
- Product manual creation (implementation difficulty, product description, references, product strengths and weaknesses).

3.4 Marketing and product presentations

Activities executed by a product manager from the marketing viewpoint:

- Product manual creation,
- Product list creation – better awareness of products within a team,
- Cooperation on product web presentations (descriptions, advantages, completion of SEO keywords etc.).

Respectively, a process which has been realized within business activities is accompanied by another control mechanism (by a product manager) whose task is to bring information from the implementation environment to the business one and vice versa.

5 Conclusion

In the context of the previous information, a utility comparison of a newly created product manager in the project preparation stage has been executed

in a given software company. The comparison has been done in the following areas:

- Project extent specification (contract vs. reality),
- Planning and meeting project schedule and deadlines,
- Planning and compliance with human resources,
- Acceptance procedure course,
- Customer satisfaction questionnaire.

Table 1 Product manager role utility evaluation, Source: own.

Metrics	Without PM	With PM
Accordance of project contract extent and delivery	60%	91%
Improvement of meeting contract deadlines	84%	89%
Improvement of adherence to allocation resources	78%	82%
Improvement of product quality level	79%	89%

The evaluation of a provider by a questionnaire represents provider-customer feedback which aims to find out customer's satisfaction with the delivered IS or to gain stimulus for improvement of specific activities and processes on the IS project provider's side. Based on this evaluation, we can conclude that product manager role integration into the preparation stages of the IS development process is very beneficial, as shown in Table 1.

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References

Danel, R., Kozel, R, Chlopecký, J.,Vilamova, Š., Piech,M. (2015) 'Information support for sales management in the company OKD a.s.' *Proceedings of the 11th International Conference on Strategic Management and Its Support by Information Systems 2015, SMSIS 2015*, Uherske Hradiste, Czech Republic, pp. 56-54.

Janišová, D. and a Křivánek, M. (2013) *Velká kniha o řízení firmy – Praktické postupy pro úspěšný rozvoj organizace*, Praha: Grada.

Ludik, T., Ráček, J. (2011). ‘Process Methodology for Emergency Management. In *9th IFIP WG 5 11 International Symposium on Environmental Software Systems (ISESS 2011), Brno, Czech Republic, pp. 302-309.*

Hunka, F., Ministr J. (2013) ‘Innovation in Use case Derivering‘. In *IDIMT-2013: Information Technology Human Values, Innovation and Economy*, Prague, pp. 105-112.

Oškrdal, V. and Doucek, P. (2014) *Praktické řízení projektů*, Praha: Oeconomia – nakladatelství VŠE.

Tvrdíková, M. (2015). ‘Innovation of complex information systems 2nd generation ERP at universities’, In *Proceedings of the 11th international conference on Strategic Management and its Support by Information Systems 2015*. Uherske Hradiste, pp. 484-492

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A Conceptual Model for REA

Jaroslav Ševčík[1]

Abstract. This article deals with the modeling of business processes based on the Resources Events Agents (REA) enterprise ontology. This ontology was extended by a transaction mechanism. The article describes a conceptual model for REA transactions. This model shows the main facts about the proper course of the transaction.

Keywords: Value-oriented modeling, business process, REA ontology, transactions, conceptual model.

JEL Classification: L14, L23, M11, 021

1. Introduction

Software applications based on the value-oriented modeling are able to provide a detailed overview of economic resources that have been exchanged or converted for other resources. The advantage is that this procedure also allows the calculation of economic resources on demand. Other current established procedures calculate the value at predetermined time intervals. The value-oriented modeling is perspective and promising idea to monitor the value of the exchanged or converted economic resources. These procedures and methodologies based on the value-oriented modeling do not become widely used. It is mainly because of the complicated status model, which focuses on states of exchanged (converted) resources and also due to lack of accurate declaration of basic concepts and relationships between them.

2. REA enterprise ontology

The Resources, Events and Agents (REA) enterprise ontology (Hunka, 2014) is a concept for creating enterprise infrastructure designs based on resource ownership and its exchange. REA is a powerful tool for business process modeling as it provides a set of benefits. It enables the user to create a robust domain specific model (Hunka & Ministr, 2013). REA model concepts are divided into two groups: operational level and policy level. Operational level forms the core of the model and describes the specific facts that can be observed. The operational level includes basic concepts: Economic Resource,

[1] VŠB - Technical University of Ostrava, Faculty of Economics, Department of Applied Informatics, jaroslav.sevcik@vsb.cz.

Economic Event and Economic Agent. It describes what happened. The policy level expands operational level by concepts showing various rules and standards. It describes what could or should happen. Policy level includes the semantic abstraction, such as contract, commitment, typification and more (Hrubý, 2006).

3. REA transactions

The REA model describes process in which an enterprise receives economic resources from other economic agents, and it gives resources to other economic agents in return. For the creation of an information system, we need to know how this exchange occurred. The original REA does not capture the coordination phase. Transactional states are missing for this phase. We can define the ontological frame, but we cannot watch and follow the steps of the ongoing business transactions. This fact is very limiting for practical usage.

There is an effort to fill this gap. The new state model was defined. This state model represents the internal states of the transactions. Determined states are derived from the states of interrelated transactions of REA business process. This work also proposes an extended transactional mechanism for value-oriented model of business processes based on the proposed state model. It is based on Design and Engineering Methodology for Organizations - DEMO (Dietz, 2006). The transactional model presents a view of the individual states of the transaction. There are basic form states: request, promise, production, demonstration and acceptance. Transaction mechanism consists of two transactions. An example is the purchase and payment.

4. Conceptual model

For the application of the proposed transaction mechanism is important to know all the relevant facts. These facts need appropriate representation at the conceptual level. For the application of the proposed transaction mechanism is important to know all the relevant facts. These facts need appropriate representation at the conceptual level. Object Role Modeling allows expressing conceptual model in terms of elementary facts, including restrictions and rules. This method uses the natural verbal expressions. It is used for effective communication between all persons in the development.

The conceptual model was created according to the procedure that is marked as Conceptual Schema Design Procedure (Halpin, 2006). The resulting model is extensive. For clarity, the model is divided into three parts. The first part consists of elementary facts about the contract. The second part describes facts about economic commitments. The last part describes the facts about economic events.

Basic facts about the contract are as follows. Each contract has increment commitments and decrement commitments. Commitment is a promise or obligation of economic agents to perform an economic event in the future. For example, line items on a sales order represent commitments to sell goods. Another fact is that the contract has a creation date and the date of closing. These facts are also important for the application transaction model. Figure 1 shows a conceptual model of the contract.

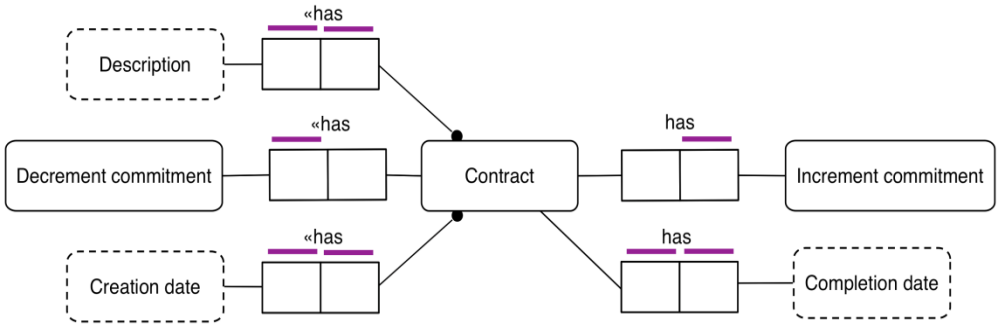

Figure 1 Main facts about contracts

The second part of the ORM conceptual model captures the facts on the commitment. Figure 2 illustrates these facts. Each economic commitment has its provider and receiver. There are a foreign agent and an own agent. The foreign agent has the role of receiver for decrement commitments. He is provider of increment commitments. The own agent has the role of receiver for increment commitments. This agent is provider of decrement commitments. Each commitment is linked with the reservation of a resource. One the same economic resource cannot be associated with increment and decrement commitments. Every economic resource has its unit price.

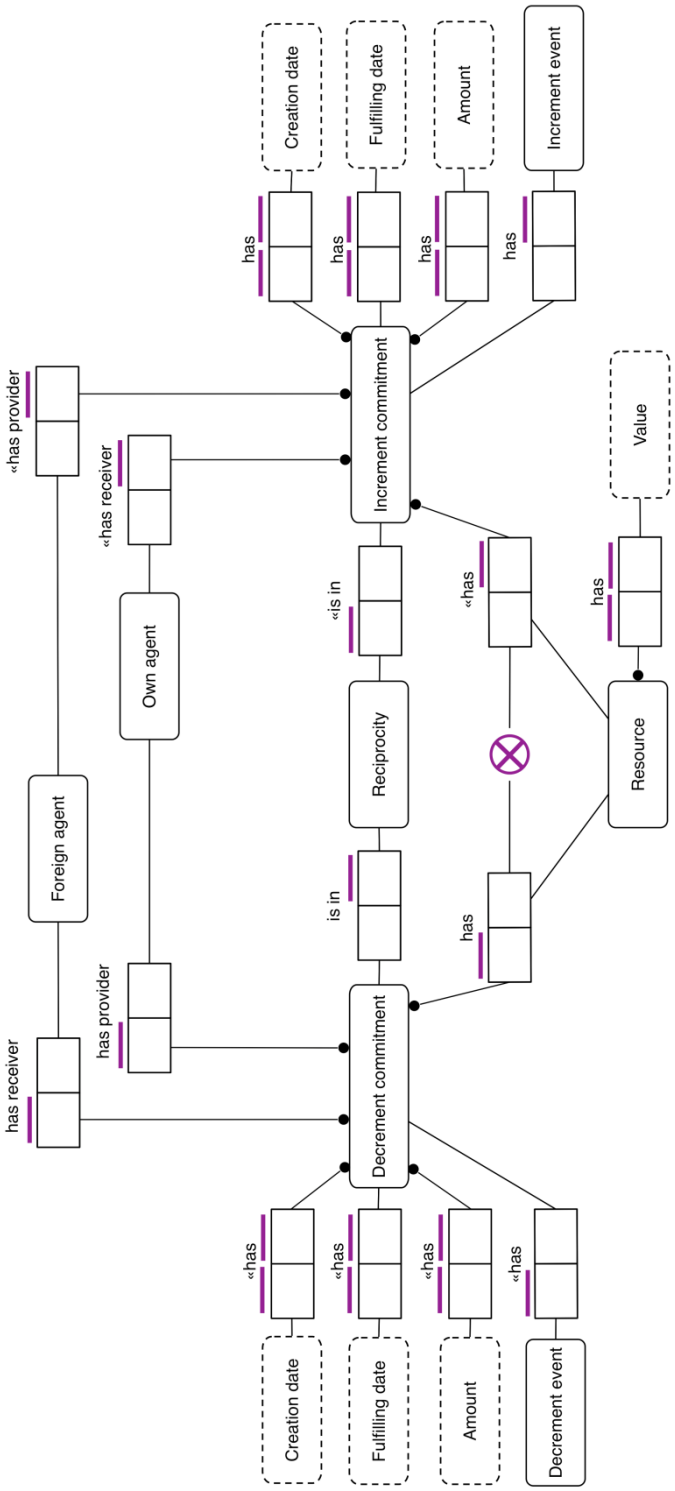

Figure 2 Main facts about commitments

Each commitment has a certain amount of resource units. The REA model is based on reciprocity. To each increment commitment there is one or more decrement commitments. Economic commitments are fulfilled through appropriate economic events. Commitments have the creation date and the fulfilling date for the right application of transaction mechanism. The last part of the conceptual model describes the facts of economic events. The economic event represents either an increment or a decrement in the value of economic resources that are under the control of the enterprise. Some economic events occur instantaneously, such as sales of goods; some occur over time, such as rentals, labor acquisition, and provision and use of services. This part is very similar to the previous section. Part of the commitments described the planned event. The third part describes the actual event.

5. Conclusion

This paper proposes a conceptual model for new transactional mechanism of the Resources Events Agents (REA) enterprise ontology. This approach enables to define an ontological framework to build an economic information system. Every system build under these conditions is able to control business processes in transactional way. The proposed framework can be used also as a validator of existing economic information systems. The conceptual model described in this article is part of the framework. This conceptual model has been validated in several applications. This model consists of a template for any system based on the REA ontology.

References

Dietz, J. LG. Enterprise ontology: theory and methodology. Berlin: Springer, c2006, xiii, 243 p. ISBN 3-540-29169-5.

Halpin, T. Object-role modelling (ORM/NIAM). In: *Handbook on architectures of information systems*. Springer Berlin Heidelberg, 2006. p. 81-103. ISBN 978-3-540-25472-0

Hruby, P.. *Model-driven design using business patterns*. New York: Springer-Verlag, c2006, xvi, 368 p. ISBN 3540301542.

Hunka, F., Ministr J. (2013) 'Innovation in Use case Derivering'. In *IDIMT-2013: Information Technology Human Values, Innovation and Economy*, Prague, pp. 105-112.

Hunka, F., & Zacek, J. (2014). Detailed Analysis of REA Ontology. In *Advances in Enterprise Engineering* VIII (pp. 61-75). Springer International Publishing

Data Boxes and Document Management System

Pavel Vlček[1]

Abstract. This article describes compulsory usage of data boxes, introduced throughout the Czech Republic by the act No. 300/2008 on electronic acts and authorized document conversion, offered to organizations a modern and flexible tool for authorized communication with governmental bodies on one side, but on the other side was requiring a high quality interconnection with documentation services (document management system) of the organization. The basic features of this concept are described from the point of view of its application as a modern tool for the organization's management.

Keywords: Data Box, the Act no. 300/2008 Coll., Czech POINT, e-Gon, Information System of Data Boxes (ISDB), The Document Management System.

JEL Classification: L14, L23, M11, 021

1 Introduction

The Data Boxes recently celebrated their sixth anniversary since their implementation in 2009. Therefore, there is a suitable moment to evaluate their development.

The article focuses on the evaluation of the data boxes and their implementation phases in the Czech Republic. Since 2009, when the implementation has started, the rapid growth of data boxes concept has been noticeable in EU countries. Denmark, Estonia and Austria are the most advanced countries in using data boxes system the Czech Republic ranks just behind these top countries.

In most European countries, the data boxes system is based on similar principles as in the Czech Republic. In all cases it is an isolated information system used for secure transport of data that, from the point of view of law, equals to a registered letter. In most countries, data boxes operation is in the hands of the national postal operator. Other similarities can also be found

- operation of data boxes is usually paid by fee-for-service system (i.e. for sending a data message)

[1] VŠB - Technical University of Ostrava, Faculty of Economics, Department of Applied Informatics, pavel.vlcek@vsb.cz.

- in most countries, so-called fiction of the delivery is applied (message is considered to be delivered in 10-days) and selected subjects are obligated to use the system as well.

2 Data Boxes

In the Czech Republic, the vision of data boxes occurred in 2005. The concept of data boxes was openly discussed on the political and professional level. Between years 2006-2008, several proposals for legal regulation of data boxes were made. In 2008 a crucial law on electronic format and authorized document conversion was accepted. The data boxes information system was launched in 2009, since this time it has been developing constantly.

2.1 The Document Management System

The Document Management Service System makes possible collection of all data about documents and files, including movement monitoring of documents in the organization. It is designed for full document management in the organization. The Document Management Service System must be fully comply with a current legislation and can be used as a powerful and effective instrument for ensuring the professional management of received and sent documents.

The Document Management System works equally to the analog and electronic documents. Therefore it is possible to collect both physical and electronic document as well as video or audio data. Data regarding individual documents are put into the system manually, by electronic entry or it is also possible to load data from other programs (systems). The system allows us to match requirements for proper receipt, recording, distribution, circulation, processing, preparation, signing, sending, depositing, and discarding.

For the purposes of connection to the system of data boxes, the data management service working exclusively with electronic documents is sufficient. Standard systems, as they are characterized above, can handle other file formats, thus there is no technical problem.

2.2 Technical Preparation

The crucial question of technical implementation was the choice of financing model ISDB, i.e. whether to choose an investment model or a model based

on service provision. According to many European countries the service provision model was chosen, when the state is responsible for the initial investment (and thus the risk on the project as well) and the service is paid only on the basis of the actual system usage fee for each transaction (in the case of IDS transaction fee must be paid for one sent message).

The national postal license holder, Czech Post, has been legally entrusted with the responsibility of being the system operator, the Ministry of Interior concluded contract for operating data box system services. Czech Post works as a system integrator. The major part of technical supplies is provided by means of Czech Post specialized subcontractors, which were chosen in a public tender.

On 19th December 2008 the Ministry of Interior signed the memorandum on cooperation with representatives of seven major manufacturers of electronic record management systems to prepare the technical part of the implemented Decree No. 300/2008 Coll. On the basis of the memorandum and thanks to the cooperation with manufacturers of record management systems, the technical specification for open communication between record management system and system of data boxes has been created. By July 2010, more than 50 other manufacturers and suppliers of information systems joined the memorandum.

The actual implementation of the data boxes system followed the timetable, on 1st May 2009, a pilot testing of ISDB was launched in selected offices and organizations, and since 1st June 2009 open source ISDB user interface has been launched for the purpose of system public testing.

The certain authorities and subjects were obligated to activate their data boxes till 1st July 2009. This event has attracted much media attention.

On the date, when data boxes system has been launched, the Ministry of Interior has started establishing compulsory data boxes for public authorities, legal entities and certain other entities mentioned in the Act. All entities that are obligated to have data box have received user names and passwords sent directly from the Ministry of Interior into their own hands.

The obligated subjects had time to activate their data boxes till 1st November 2009. After this date, which is defined by the Act, so-called legal fiction of the delivery came into force, regardless of whether an obligated subject has already joined its data box, or not. This actually means the beginning of data boxes operation.

3 Operation and Development of Data Boxes

Since the system has been launched, its further development is noticeable, the functionality of the system has been expanded, user-friendliness has been improved and simultaneously the legislative support had been updated.

3.1 Legislative Updates

The communication via data boxes is predominantly regulated by the following decrees. The context of the preparation and formation of major Acts is described in previous chapters focusing on the ISDB history in the Czech Republic.

3.2 Technical and Procedural Principles

Data box is defined as an electronic repository that is especially designed to delivery documents from public authorities to individuals, legal entities, individuals doing business and other public authorities. The tool also allows you to make a separate claim against public authorities and allows communication between individuals, legal entities and individuals doing business. According to the Act, the Ministry of Interior is responsible for data boxes administration and management, while the Czech Post works as the operator of the data boxes. From the user's point of view, the data box works like a typical e-mail box, the only exception is that the credibility and integrity of delivered messages are guaranteed.

Attached files form an actual message content that is sent to the addressee - timestamp and e-stamp form so-called data message "envelope". The actual content of data messages is not public. The size limit of a data message is 10 MB. The service guarantees the delivery of messages, whereas the time, when entitled person is logged into the system, is to be understood as the delivery time. The sender will receive information that the message has been delivered or whether the data box is unavailable or does not exist.

The organizer sends access data automatically to all obligated entities; e. g. after the establishment of a legal entity, and it is send as registered letter. The fiction of delivery is also applied in this process. Then the data box is accessed after logging in the very first time, or within 15 days after the access data delivery. So, if the data are delivered through the fiction, the data box can be in operation without logging the user in.

In the case of entities that are not obligated to establish their data boxes, the data boxes are created upon the request through the Czech POINT, contact points, using the form with a notarized signature send by mail or the request form can be signed electronically.

The data boxes of individuals may be lock up due to individual´s death, when there are restrictions on active legal capacity, or a restriction of personal freedom. If the box is locked up upon the request, it can be available again (if it has already been locked in the same year, to make it available again it is necessary to wait a year). Other types of data boxes can be cancelled in the case of dissolution of the entity or in the case of cancellation its function. In the case of death or the dissolution of entity the boxes are cancelled after 3 years.

3.3 Types of Data Boxes

We distinguish between the following types of data boxes:

- • Data box for individuals
- • Data box for individuals doing business
- • Data box for legal entities
- • Data box for public authority

4 Implementation activities

The core implementation activity is a software solution for electronic Document Management System, which has been built on proven technology and methodological foundations and provides a comprehensive platform designed for safe and transparent implementation of workflow documents.

The implementation also includes dealing with the impact of the Act no. 300/2008 Coll. on Electronic Acts and Authorized Conversion of Documents. It is necessary when solving these problems by the implementation, the information systems of the data boxes and The Document Management System (DMS) must be interconnected. By the functionality implementation of the so-called internal functionality can be achieved that the senders of data messages will send these documents directly to a specific workplace, with the result that these functionality significantly reduces the stress on mailroom department and also plays a significant role in the data confidentiality for all data sent to the final-recipient via document management service without intervention of mailroom department.

For successful implementation, it is suitable to make a process analysis. When processing workflow processes it is necessary to convert the process into the internal structure of the used software. Processes might be described by a graph, for example, it can be used standardized graphic recording of BPMN (Business Process Modelling Notation) or another tool (ARIS tools set, etc.). This recording of the process allows easier understanding of communication between data boxes and technical implementers of workflow process. It might be said that this part is the most demanding part of the implementation - the needs of data boxes should be correctly understand; and it is important to find out which characteristics of the process are crucial and which are not. Graphic recording does not always take into account all exceptional conditions that may occur during the process. As for example, it is possible to mention some problematical areas:

Connection of data boxes with the organizational structure – it often leads to the inability to deal with exceptional and emergency situations; there is a bureaucratization of the process and the overall efficiency of the system is reduced.

Connection of data boxes with the law documents - there is the emergency of a complex enlacement of rights, which means a reduction of the efficiency of the system - in exceptional situations, administrator intervention is required; and such intervention can cause reduction of safety.

5 Conclusion

The potential of data boxes is necessary to develop further in the Czech Republic. At first, it is crucial to widen number of possible areas where data boxes can be used. The system of data boxes has a number of opportunities:

- extensive use of ISDB for transfer of structured information in the electronic forms or in the other forms of structured data sets,
- promotion of access to the data boxes for businessmen and individuals via their electronic banking,
- tighter integration of data boxes and traditional postal services,
- creation of a national digitization centre,
- use of certified electronic identity of DB users to access other electronic portals, respectively, public administration services,
- • electronic elections using ISDB,

- preparation of interoperability of data boxes national systems within the EU.

Achieving the full potential of data boxes, on the other hand, carries many risks the special attention should be paid to. The main risk represents the fragmentation of the top architecture of the e-Government, premature slowdown of system adoption by new-users groups and the falling willingness to invest effort and resources into the conceptual technology development and the functionality of the system.

References

Halásková, M. and Halásková, R. (2012). 'The Assessment of the Expenditures of the Local Government on the Provision of Public Services in the EU.' Ostrava: EkF VŠB-TU Ostrava, vol. , no. pp. 140-149. ISSN 1803-3865.

Tesař, P., *Provozní řád informačního systému datových schránek (ISDS*).Verze k 21. 4. 2013. Praha: Ministerstvo vnitra ČR, 2013, 27 s.

Vlček, P. The Public Administration in the Czech Republic and Data Boxes. Puerto De La Cruz: WSEAS, 2011. ISBN 978-1-61804-056-55.

Vlček, P. (2011) Data Boxes and the Document Management System in the Public Administration. In *Strategic Management and its Support by Information Systems*, Čeladná, pp. 47-252.

MVČR. *ZÁKON č. 300/2008 Sb., o elektronických úkonech a autorizované konverzi dokumentů* [on-line], [cit. 2013-12-01]. Available: <http://www.mvcr.cz/soubor/sb098-08-pdf.aspx>

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