



Proceedings of the IT for Practice 2014
17th International Conference on
Information Technology for Practice

IT for Practice 2014

October 9-10, 2014, Ostrava, Czech Republic

Edited by

Jan Ministr

Milena Tyrdíková

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European University Information Systems - CZ

VŠB – Technical University of Ostrava, Faculty of Economics
Czech Society for Systems Integration – Moravian-Silesian Section
In Collaboration with Karel Engliš Foundation

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EUNIS CZ - European University Information Systems



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Czech Society for Systems Integration

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FOREWORD

Conference on Information Technology for Practice 2014

Welcome to the 17th IT for Practice Conference held at Faculty of Economics VŠB-Technical University Ostrava. This Conference (recently with international participation) has become a traditional meeting of IT experts coming both from the practice and academic spheres. IT providers and users meet at 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 European University Information Systems (EUNIS-CZ), and Czech Society for System Integration (ČSSI), in collaboration with Karel Engliš Foundation.

The aim of organizers is to establish a platform for exchange of knowledge and skills in IT innovation and their exploitation in the use and development of information systems.

This year of the conference is focused mainly on the following topics:

- IT management
- Mobile technology for business
- Information society and IT education

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

We wish you well-being in the solution of the problems in the changes world of IT and to establish new professional contacts useful for the solution of your specific problems.

On behalf of organizers,



Milena Tvrđíková October 2014

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IT MANAGEMET

Functional Infrastructure of E-Logistics in Smart Organizations

Piotr Adamczewski¹

Abstract. Practicing of dimensional modeling to solve business intelligence applications is most often performed on the selected relational DBMS, which can be a problem for students of economics at the Faculty of Economics, because a deeper knowledge of the DBMS is assumed. The basic software tool of economists is still Microsoft Excel. This article should demonstrate that can also Microsoft Excel be meaningfully used for dimensional modeling to solve business intelligence applications.

Keywords: business intelligence, dimensional modeling, Microsoft Excel.

JEL Classification: A23

1 Introduction

An increasing degree of global dependencies of business processes made modern market mechanisms be characterised by much dynamics of changes of the economic environment. The measure of its adjustment is the possibility of building competitive advantage of smart organizations with the use of, among others, such factors as knowledge or intellectual capital of the staff, which allow for the implementation of development strategies. The key role is played by advanced solutions in the scope of telecommunication and IT infrastructure based on ICT (Information and Communication Technology) in the scope of logistics process support for these organization by means of implementing organizational and IT solutions defined as e-logistics - cf. (Adamczewski, 2012b). This means broad applications of latest IT technologies for the support in logistics management of a smart organization e.g. in the scope of production, warehouse management or order service and for the support of its business surroundings (in particular procurement delivery chains and distribution). In a practical dimension IT technologies are made of the agglomerate of equipment and programme and organizational

- communication technologies (wired, wireless, hybrid),

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- technologies of data bases and warehouses,
- methods of automatic identification (bar codes, RFID),
- computer aided manufacturing (CAM),
- supply chain management (SCM),
- enterprise resource planning (ERP),
- customer relation management (CRM),
- supplier relation management (SRM),
- advanced planning systems (APS),
- product lifecycle management (PLM),
- manufacturing execution systems (MES),
- warehouse management systems (WMS),
- satellite location systems (GPS, Galileo, Glonass),
- advanced analytical and reporting systems (BI),
- data processing model (classic, cloud computing),
- IoT - Internet of Things.

These technologies constitute a kind of IT ecosystem enabling the implementation and effective operation of IT systems, e.g. ERP class (Enterprise Resource Planning) and BI (Business Intelligence) as smart organizations' attributes in economy based on knowledge.

2 The Essence of Smart Organizations

A smart organization is the one, the activity philosophy of which is based on knowledge management (Adamczewski, 2013a; 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 smart 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 smart organizations include, among others (Waltz, 2003):

- fastness and flexibility of operation,
- the ability to observe the environment,
- the ability to diagnose market signals early and react to changes in the 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 a smart 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 (Grajewski, 2012; Quinn, 1992). 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 IT 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 IT networks (most frequently the Internet is the technological platform) aimed at the coordination and integration of business partners in the supply chain.

3 ERP Systems in E-Logistics

In more and more complex economic conditions IT systems increasing the revenues and optimizing costs are highly appreciated. Therefore, ERP (*Enterprise Resource Planning*) class systems have been very popular for a long time, both in terms of customer service and in *back-office* areas not translating directly onto the processes of the sale of goods and services. A well configured ERP system may be the source of savings for any organization and, in addition, it allows for taking decisions faster and more flexibly. In the times of weak market organizational changes, resulting from the correct use of information on processes and business resources gathered by companies, may be the cheapest method of their development (Adamczewski, 2013a), (Adamczewski, 2012a; Wang, 2007).

Over the past years investment in ICT equipment has been growing very dynamically, which means that many enterprises managed to equip themselves with proper IT infrastructure, which may work efficiently for a few coming years. Thus, they can now focus on the purchase of business software, such as ERP. The basis for the achievement of success in business is the ability of planning and consistent implementation of business objectives. This task is even harder when an enterprise develops fast. ERP class system is an IT system integrating all aspects of the enterprise operation. Advanced ERP systems enable not only the gathering of data concerning on-going activities but, above all, their conversion into knowledge necessary for taking apt business decisions. In turn, the enterprises which already use the ERP system should invest in modules which will increase its capabilities. From amongst the most often indicated there are solutions for sales process management and purchasing management because they allow for standardizing the purchasing process and using the economies of scale, significant especially in case of organizations with dispersed infrastructure. It is also worth focusing on better use and development of modules streamlining the management of finance and functionalities in the scope of CRM (*Customer Relationship Management*), SCM (*Supply Chain Management*) and HRM (*Human Resource Management*). On the other hand, companies which go for brave competitive actions must have the tools enabling them to perform detailed analyses of information coming from the market (Adamczewski, 2013b; Magnier-Watanabe & Senoo, 2009).

The application of BI (*Business Intelligence*) tools allows for better recognition of customers' preferences and analysing sales results for the purpose of elimination of less profitable products and actions (Adamczewski, 2012a; Adamczewski, 2013b). Analyses created on the basis of information aggregated by ERP systems are often the basis for the majority of business initiatives in many companies. Even the simplest solutions, enabling the estimation of operational risk and the restriction of possible hazards resulting from problems in the organization, being within the framework of the common supply chain, may turn out useful as well. The economic crisis will contribute to the intensification of relations between companies focused within the framework of a supply chain, due to necessary exchange of services and integration of processes - this will contribute to the achievement of bigger benefits under the effect of synergy. The analysis of the company activity is the key element of strategic management. Having comprehensive knowledge, the organization may take apt decisions and, as a consequence, improve its competitive position. Owing to extremely fast access to valid data, the management board has the knowledge which allows for raising the effectiveness of particular departments of the company, and in a situation of high competition on a given market, the management-related decisions have impact on the market position.

ERP system should be adjusted to the organization's needs and the needs may vary depending on the size of the company and the nature of the branch. Smaller organizations, e.g. from MSE sector, namely small and medium enterprises, often need affordable tools giving access to the most important functions of business analyses. In such a case complete integration with the used office software, e.g. MS Office package or bar codes, is very useful. This facilitates the process of the registration and gathering of data on the level of all user of the system.

Robustly developing companies pay more attention to flexible and modern IT solutions with extensive analytical functions. Analytical modules should enable quick access to up-to-date data, reporting and comparison of the company's results. This means that ERP systems must be equipped with standard reports but also with easy reporting thereof due to the end user's needs. Moreover, obtaining access to contextual information important for various users should be a significant functionality of the system, as this

would guarantee coordinating everyday logistic actions with the general strategy of the enterprise.

Considering the implementation of a modern ERP system, one should take into account the changes that the organization is subject to, like the ones connected with its development, employment, growing demands, extending markets. Therefore, it is worth going for flexible systems which enable quick modification and extension with new components making it possible to adjust to individual expectations of a user. A well-thought decision concerning a selected ERP system will enable significant savings in the future when the company's needs in this respect increase. Thus the selected ERP system should be scalable enough and flexible. It should also be characterised by as simple operation interface as possible: preferably - it should be available by any search engine. Finally, it should be possible to be implemented quickly and allow for simple modifications without the necessity to interfere with source code. And this means that it should come from a renown and tested supplier which will guarantee not only a good product but also methodology of its efficient implementation and further development. In the period of growing tendencies of global economic crisis, and simultaneously expanding supply chains for modern functioning companies, relying on advanced IT solutions becomes an order of the moment.

New IT technologies, e.g. in the scope of automatic identification, wireless communication or satellite localization are facing a new challenge. Omnipresent fashion for SOA (Service Oriented Architecture), virtualization and WEB 2.0 may turn out one of the aspects of a project development well connected with business processes. It was already 1990s that showed clearly that without an ERP class system, there is no modern management in a company. Recent years indicate that traditionally understood ERP systems are not sufficient any more. Their core functionality was enriched with CRM (Customer Relationship Management), SRM (Supplier Relationship Management), SCM (Supply Chain Management) and PLM (Product Lifecycle Management) modules (Adamczewski, 2012a; Koronios.& Yeoh, 2010). Especially those last extensions are gaining importance. A product lifecycle management comprises the actions from the moment of the occurrence of a product idea to its withdrawal from the market. Its components include the preparation of the design concept, the preparation of the manufacturing technology, manufacturing management, documentation

management and customer order management. A significant element in PLM system is the operation of technical changes of products in the production and procurement processes. In case of high series production, with a large number of options, when customers can define their wishes regarding the product model and its equipment, the application of a product configurator is important. It allows for the creation of a product model, detailed documentation and lists of materials as well as cost estimation. This is possible owing to the cooperation with the packages of CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) class.

The latest ERP versions fully use latest IT technology solutions, including the aforementioned SOA concept. This service is understood as a separate functional module and it is treated on the principle of an IT solution element performing a specific task. The independence of such services allows for their use within the framework of any system platform and programming language. This gives unprecedented possibilities in the scope of flexibility of operation and development of IT solutions. Companies linked with one another with supply chains serve the flows of materials and raw materials, semi-finished goods and finished goods as well as information accompanying these processes. For the implementation of these tasks in an orderly and repeatable manner work flow systems are used and supported by SOA philosophy they allow for the realization of the Real-Time Enterprise so the one operating in real time. The objectives set for such solutions may be as follows - cf.:

- transaction management within the framework of branch supply chain,
- planning and performance of deliveries just-in-time,
- meeting the branch criteria of supply chain (monitoring of products at all phases of their manufacture),
- offering detailed profitability and customer service analyses along with flexible reporting.

In the opinion of IT branch analysts in Poland the importance of ERP class systems is growing in organizations functioning in a modern manner. This is expressed in, among others, the increase in the sale of these systems and the number of effective implementations. Past years clearly indicate that upon the computerization of internal logistics processes, companies focus on IT support of supply and sale channels and thus towards comprehensive e-logistics.

The increase in demand for ERP intended for various branches has been a distinguished tendency for the recent years. Enterprises want to work on solutions adjusted to their operation in terms of the branch specific nature. Entities from niche branches, very specialist or connected with a specific production process are interested in such solutions. For them knowledge and experience of a supplier relating to their branch are extremely important. However, the selection of a pre-configured system does not exclude the possibility of the implementation of modifications as it may always turn out that a given customer needs atypical functionalities.

Much demand for branch ERP has also been observed on the market. A customer, searching for such a solution, may expect that the majority of his/her requirements (and perhaps all of them) will be possible to be fulfilled within the framework of a standard solution. Having ready-made functions considering a given branch, the time and implementation costs may be reduced. A great advantage is the possibility of using the experience of the consultants, who most often performed many implementations in a given branch and who can give hints regarding interesting solutions during implementation

4 Directions of E-Logistics Technological Development

The development of advanced ERP systems creates demand for the support of the aforementioned IT analytical tools in the scope of business intelligence. These solutions translate into effective support of decision-making processes. More and more often the so-called Business Analytics is mentioned (Adamczewski, 2013b). It comprises the tools and applications for analyzing, monitoring, modelling, presenting and reporting data supporting decision-making processes. For this purpose data warehouses, operational analyses of supply chains, CRM analytical systems, extended financial analyses and company efficiency ratios are used. The strategic level of enterprises, basing on certain data aggregates, is users of such solutions. The problem of integration and synchronization of data is involved. The integration of data starts with the possibility of the use of many data sources - both by means of dedicated interfaces and with the use of standard mechanisms of ODBC (Open Data Base Connectivity) type. The sources of data may be the relational or hierarchical databases, structural files as well as ERP systems. These

connections should thus enable not only the readout of data but also its recording and converting. In case of most companies there occurs a case of many IT environments and access mechanisms should allow for reaching data located at various platforms (to the extent possible without the use of indirect files).

ERP systems are not subject to quick changes however there occur phenomena which may have fundamental impact on the application software of this class. They include:

- growing business importance of mobile solutions,
- increasing flexibility of ERP systems due to growing flexible connections with other applications and mobile equipment equipped with functions known from social media,
- more comprehensive use of the cloud computing model on the grounds of ERP systems, which is of substantial importance in case of MSEs (reduction of costs by up to 20% is the main motif),
- growing interest in branch ERP systems (they reduce the time and implementation costs), within the framework of which oriented solutions of a concrete problem with functionality limited to the operation of one business process (a few maximum) and quickly bringing return on investment occur,
- departing from functional modules to the benefit of the service of particular business processes which constitute, in IT dimension, the reflection of information services,
- the Internet of Things getting more and more common and in these solutions the smart class equipment for reading out the statuses in real time is used.

5 Conclusion

The demand for advanced telecommunication and IT technologies supporting logistics processes as basic elements of e-logistics will still grow because smart organizations - due to the essence of economic actions - are interested in optimum use of their resources for the achievement of maximum benefits from the capital invested. More and more comprehensive offers of ICT solutions on the Polish market allow the organizations to make choices depending on business needs and financial capacity and IT support of entire

supply chains is becoming not just a challenge of a competitive market but necessity in order to meet constantly growing requirements of customers in their effective service. At comparable production and information technologies, the sources of competitive advantage should be sought in aptly designed and effective e-logistics chains of smart organizations, which is getting particular importance with growing requirements of market mechanisms in the era of economy based on knowledge.

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Dictionary Writing System: Output and Editorial Modules

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Michaela Lišková⁵, Miroslav Virius⁶

Abstract. This paper focuses on a dictionary writing system called Alexis that is currently under development at the Institute of the Czech language of the Czech Academy of Sciences of the Czech Republic v. v. i. as part of a preparation of a new monolingual dictionary of the contemporary Czech language. At first, we explain motivation for development of a brand new DWS. We also discuss selected software technologies used for development of the DWS. Then we briefly describe structure of the system that consists of several modules that model key features of the dictionary such as lemma or list of entries. Special emphasis is put on output and editorial modules: we explain the relation between those modules, we demonstrate the process of correction of lemma and roles involved in the process. Finally, we present current status of development and planned new modules which include web interface or revision module.

Keywords: Dictionary writing system, editorial tool, web application.

JEL Classification: M15

1 Introduction

A new medium sized monolingual explanatory dictionary of the contemporary Czech language called ‘Akademický slovník současné češtiny’ is currently being prepared at the Institute of the Czech language of the Czech Academy of Sciences of the Czech Republic v. v. i. (Kochová, 2014). The work

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on the dictionary is based on the dictionary writing system (DWS). We have considered using one of existing commercial or open source systems such as iLex, Matapuna DWS, or DEB II which is also available for the Czech language. However, after some discussion, we have decided to develop a brand new system called Alexis (Barbierik, 2013). This decision gives the team full control over development and source code and allows to fully model the specific requirements of the lexicographers. On the other hand, development of entire custom system means lot of work.

At first, we will present general overview of the DWS and then we will focus on description of the system. We will describe list of entries module that represents macrostructure of the dictionary, then we will continue with editing module which represents microstructure of the dictionary. Finally, we will discuss relation between output and editorial modules. We will conclude the paper with current status of the project and we will present outlook into the near future.

2 Introduction

Alexis is a web application that implements the client-server paradigm. This greatly simplifies deployment of the system as it can be accessed from any device with web browser and internet connectivity. The server part is implemented mostly in the PHP language, as a storage the MySQL relational database is used. The database structure consists of approximately 100 tables built around the central table “heslo” that contains generic information about lemmas. The client side is based on combination of HTML 5 and CSS 3 technologies; logic is implemented using JS language with jQuery library. Development process is based around private GitHub repository with stable and development branches.

The Alexis system can be divided into several interconnected modules including administration module, list of entries, editing module, output module, and editorial tool.

2.1 Administration module

The administration module is mainly used to manage user accounts. Currently, there are four types of user accounts: administrator, editor, domain expert, and visitor. Editors can use all modules with exception of the administration

module, domain experts can only use output and editorial tools on attached list of lexical units, finally visitors can only view assigned lexical units. Moreover, the administration module can be used to edit predefined fixed item lists.

2.2 List of entries module

Each user needs to authenticate in order to work with system. If the authentication process is successful, the user is redirected to the list of entries module. This module represents macrostructure of the dictionary, it presents lexical entries with some basic information such as variants, status of the entry, dates of creation and last modification, or lexicographer. It is expected that the final version of dictionary will contain approximately 150000 lexical units, therefore the list is divided into pages. Additionally, entries can be searched or filtered. Using the Quick Search tool, user can search in almost any category. Depending on selected category, user is presented with text input field (e.g. when searching for particular variants of lemmas) or list of predefined values (e.g. when searching for word type). The search tool supports advanced features such as AJAX based auto-completion or wild cards. Moreover, list of entries can also be filtered with predefined filters that include filtering based on date of creation or on lexicographer associated with lemma. It is also possible to apply filter on results given by the quick search tool. However, most precise result can be achieved using the powerful xFilter tool. This tool is used to design complex search queries that combines subqueries with logical conjunctions ‘AND’ and ‘OR’. For example it is possible to design query that filters lemmas with Latin origin and which have active correction. Queries can also be saved for later reuse.

heslo	hom.	sl. druh	varianty	zpracovatel	vytvořeno	změněno	kor.
baba Jaga			baba jaga	kochova	29.02.2012	01.07.2013	✓ ✗
baba princmetálová			bába princmetálová	kochova	29.02.2012	10.10.2013	✓ ✗
bába	1	ž.	baba	kochova	29.02.2012	10.10.2013	✓ ✗
bába	2	ž.	baba	kochova	29.02.2012	09.09.2013	✓ ✗
bába Dymáková			baba Dymáková	kochova	29.02.2012	29.04.2013	✓ ✗

Nalezeno 5 záznamů. Stránka: 1 (1-5/5)
Položek na stránku: 15 30 50 100 500

Figure 1 List of entries module. Source: own.

2.3 Editing module

Editing module is used to create and edit information about lemma; it represents microstructure of the dictionary. From the users point of view the module is implemented as a large form that can be divided into four sections:

- Header section
- Variants section
- Meaning section
- Cross reference section

The header section serves for entering meta-information about lemma such as editor, date of last modification, state of the lemma, or lexicographers note. The lexicographers note often contains useful additional information about lemma, however it is not included in the printed output of the dictionary. Additionally, list of active corrections of given lemma is displayed in the header. In the variants section, lexicographers enter information about variants of lemma. As variants are often very similar, it is possible to create new variant as a copy of the last one. Each variant can be described with lot of details including word class, morphology, origin, pronunciation, thematic scope, or valence. In the meanings section, lexicographers edit meanings with exemplifications, synonyms, antonyms, or valences. Meanings can be reordered, added, or deleted. It is also possible to exclude particular meanings from the printed output. In the last section of the form, users can edit cross references to other lexical units.

Editing form consists from several types of widgets. Short textual information (such as notes) are edited using the text input field, longer text such as lexicographers note are represented with the multiline edit box. Structured text used for example in meaning definition is represented by WYSIWYG (What You See Is What You Get) editor. We also use custom fixed item lists widget that are used to select one or more values from list of predefined values (used e.g. for word class). Items in the lists can be edited by the administrator in the administration tool. If no item from predefined list is applicable, lexicographer can enter desired value into the “Other” field. System keeps statistic of these other values. If administrators detect that some value is frequently used, they can add it into the fixed list. We also use standard radio buttons (e.g. to select type of output or state of the lexical unit) and check

boxes (e.g. to check whether a meaning definition should be inherited from another lexical unit). More information about various widgets can be found in (Barbierik, 2013).

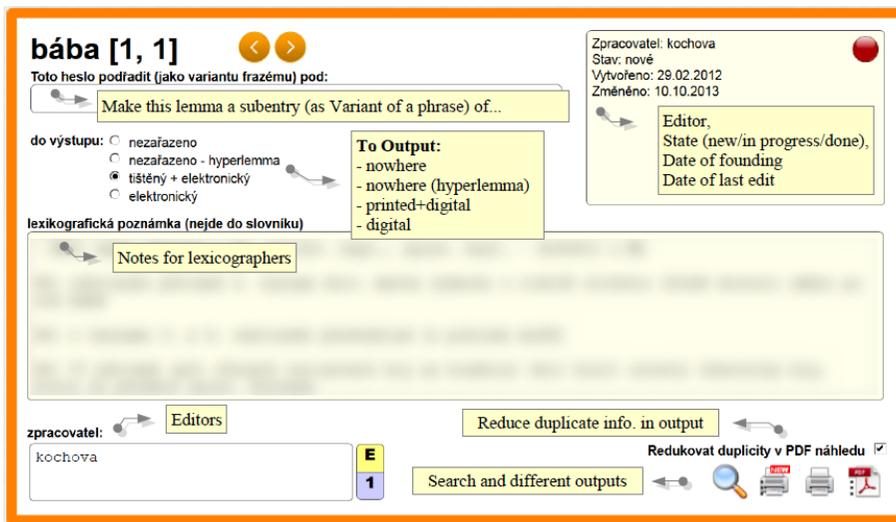


Figure 2 Header section of the editing module. Source: own.

Currently, a live preview of the lemma is being developed. From the editing module, the Quick Search tool can be launched. The current lemma can be sent directly to the output modules.

2.4 Output module

Output module can either be invoked from the editing module – in this case the currently edited lemma is displayed – or from the list of entries module – in this case, the currently filtered and selected entries are displayed. The module is based on complex rules that defines a way in which information describing the lemma is presented. Two main types of output are used: electronic and printed. Printed output is represented by document in portable document format (PDF); it cannot be edited and it displays lexical units in a way that will be used in the final printed dictionary. Several fields mainly from the header section such as lexicographers note are not included in the printed output. To generate PDF file, we use mPDF library for the PHP language. The electronic output is represented by interactive webpage with attached editorial modules. Additionally, output to MS Word format is used for internal communication between lexicographers.

Lexicographers may decide to exclude particular lexical units from the printed output (this mean that these units will not be included in the printed dictionary), some items can also be excluded even from the electronic output.

2.5 Editorial module

Editorial module is attached to the electronic output. By double clicking any item in the electronic output, a new correction dialog with given entry is displayed. Using this dialog, corrector can immediately apply the correction (and save changes directly to the database), or send the suggestion to selected editors with optional comment. In the second case, a pending correction is created and selected editors receive message in the list of active corrections module. The affected field becomes highlighted in the editing module and by clicking on it, a new dialog that allows to accept or reject the suggestion. If the suggestion is rejected, corrector who originated the correction needs to correct it and send it back to editors. At each stage, any other user may append comments to the correction. Each step is saved in the database, therefore it is possible to review the entire history of the correction process.

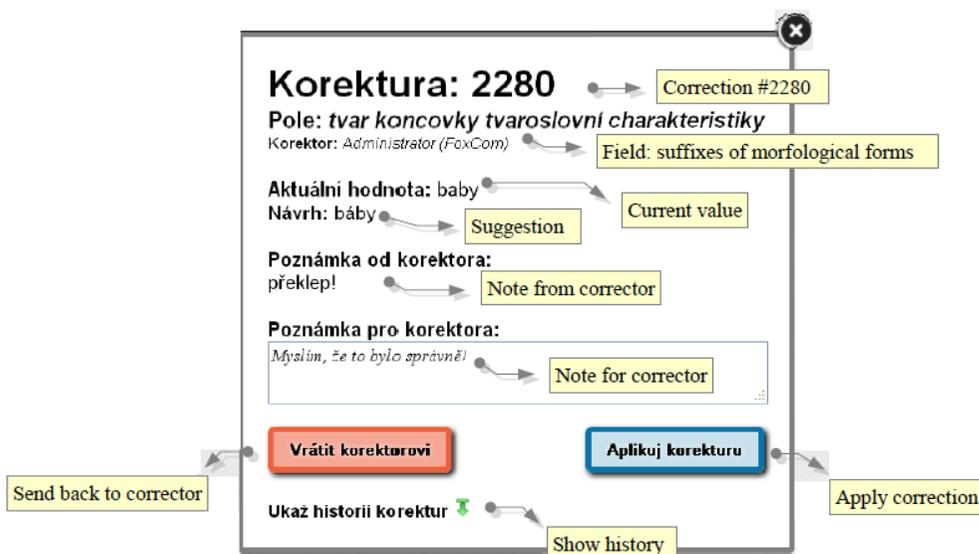


Figure 3 Returned correction dialog box. Source (Barbierik, 2014)

Above mentioned domain expert user role has only privilege to view assigned lemmas (e.g. lemmas related to chemistry) and to use editorial module on these lemmas.

3 Conclusion and outlook

The main modules of the system are already implemented and Alexis is now used by lexicographers on daily basis. Currently, approximately 15000 of lexical units are already entered into the database. The final version should be completed until the end of year 2016, it will contain several new advanced modules. In the nearest future, we will focus on implementation of the automatic processing of lemmas and public web interface. The source code of the final version will be published under some open license.

Acknowledgements

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Methodology of implementing Multi Agent Systems to support organisation creativity

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Abstract. The main purpose of this paper is to present an idea of a multi agent approach to support organisation creativity. To demonstrate this approach the methodology of implementing of a multi agent to support organisation creativity is described. The structure of this paper is organized as follows: first, we present agent technology. Next, the methodology of implementing agent systems (Gaia) and author's methodology to support organisation creativity are presented in detail followed. Finally, we summarize the key points of the research.

Keywords: Organisation creativity, Multi Agents Systems, Gaia methodology.

JEL Classification: M15, O32

1 Introduction

In modern, unstable and complex environment enterprises more and more frequently find it important to be able to adapt quickly, which is a foundation of their success. Even leading theories of management and best practices that are applied individually may turn out to be insufficient. On the other hand, market leaders try to utilise this complexity to obtain some benefits. In such dynamic circumstances it might be appropriate to employ an approach that involves selection of specific processes that originate from different already verified theories of management, economics and informatics, and their wise integration that would allow for receiving one and whole creation. Because the received creation comes from concrete (and frequently verified) theories, it may turn out to be effective on the market. What, specifically, enables leading organisations to use complexities in today's environment and to encourage attractiveness and innovativeness in their business models, customer service, products and services? One of the concepts that allows for reaching the above may be found in the theory of organisation creativity.

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According to IBM Global CEO Study 2010 (IBM Creativity, 2010 - IBM Creative Leadership research attempts better understanding how to foster creativity in the whole organisation), an ability of creative leadership is one of the most important attributes to be used to improve market position of any enterprise. On the basis of the research conducted by IBM, it is possible to conclude that 78% of HR managers are not effective while promoting cooperation and while sharing their knowledge. According to IBM, creativity is some resource for innovation. In other words, innovation is some realisation of creativity. However, in spite of well-recognised value of creativity, it is frequently believed to be some obligation to manage risk and control operations or some obstacle in management.

Since there are some fears related to introduction of the creative organisation theory into an enterprise, it would be good to delegate selected business processes and procedures that are realised normally by employees (whose knowledge and experience might turn out to be insufficient) to intelligent and predictable 'creations'. It seems that this role would be perfectly taken by information systems that are characterised by their elements of intelligence, perception and autonomy.

2 Agent Technology

The concept of the agent in information systems dates back to the seventies of the twentieth century, when studies on programs called "intelligent" were undertaken. The idea of an autonomous object - an interactive actor was presented in 1977 by Hewitt (Hewitt, 1977). A new trend of research on agents appeared around 1990 and it concerned the development of the theory and design of architectures of different types of agents, as well as the ability to communicate between them (Nwana, 1996).

The agent is an entity that performs some actions in a particular environment and is aware of the emerging changes. Moreover, it can react to such changes (Poole, Mackworth, 2010). The agent has a set of goals, certain capabilities to perform actions, and some knowledge (or beliefs) about its environment (Wang, Wang, 2005). In addition, Thomsen (Thomsen, 2002) describes the agent as "a solution-oriented ensemble of capabilities including natural language processing, autonomous reasoning, proactive computing, discourse modeling, knowledge representation, action-oriented semantics, multimodal interaction, environmental awareness, self awareness,

and distributed architectures”. IBM (IBM, 2012), in turn, defines intelligent agents as “software entities that carry out some set of operations on behalf of a user or another program, with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of user’s goals and desires”.

It has already been pointed out that the capacity of an intelligent agent is limited by its knowledge, its computing resources, and its perspective (Simon, 1957). Therefore, it is required forming communities (agency) of agents. These communities, based on a modular design, can be implemented, where each member of the agency specializes in solving a particular aspect of the problem. The agents must be able to interoperate and coordinate with each other in peer-to-peer interactions (Rudowsky, 2004). This idea of the agents operation is nowadays described as a multi-agent system. A multi-agent system can be defined as a loosely coupled network of entities that work together to solve a problem that cannot be solved by an individual agent (Olszak, Bartuś, 2012). These entities can show self-organization and complex behavior, even if the individual agent’s strategies are simple (Bologa, Bologa, 2011). Multi-agent system is a network of agents that are reasoning (problem solvers) and cooperating, communicating and negotiating to achieve a specific task. Individual agents are able to adapt their behavior to the changing environment in which they work (Weyns, 2010). Agents are usually attributed with such characteristics as: adaptability, openness, stability and scalability (Weyns, 2010; Bordini, at al., 2007). When characterizing a multi-agent system, it is stressed that (Sycara, 1998; Weyns, 2010): each agent has incomplete information or capabilities for solving the problem and, thus, has a limited viewpoint; there is no global control system; data is decentralized; and computation is asynchronous.

A good example of agents’ co-operation is a teamwork in which a group of autonomous agents cooperate, both to develop their own individual goals, as well as for the good of the whole system (Ferber, 1999; Lesser, Abdallah, 2007; Bellifemine, at al., 2007).

The following characteristics of the agent technology lead to the conclusion that this technology can be widely used in business. Particularly, it provides some extension and alternative to support organisation creativity with flexible, distributed, and intelligent features.

3 The Gaia methodology

Methodologies of implementing the MAS system (Multi Agents System) that are suggested in the relevant literature are relatively complex. Gaia methodology is one of them (Generic Architecture for Information Availability). Gaia was published by Wooldridge M, Jennings N. and Kinny D. in 2000 (Wooldridge, Jennings, Kinny, 2000). Using Gaia, these authors wanted to encourage designers and programmers of agent systems to create complete agent systems more eagerly. Using Gaia methodology, a designer moves from abstract notions towards more concrete ones. Each subsequent move introduces greater complexity of realisation, thus some space for possible MAS applications to be implemented while satisfying needs gets more specific. Stages of the analysis and construction should be treated as a process of elaborating a more and more detailed MAS model. Major stages that are used in Gaia are presented in the following Figure.

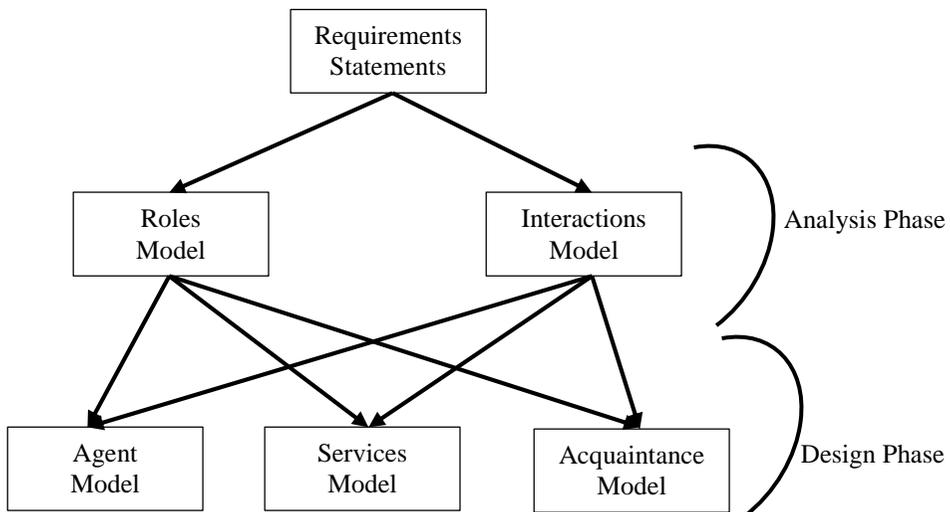


Figure 4 The basic steps in the methodology of Gaia, Source: Zambonelli, Jennings, Omicini, Wooldridge, 2000.

These include the following (Zambonelli, Jennings, Omicini, Wooldridge, 2000):

- Analysis phase: Roles Model and Interactions Model;
- Design Phase: Agent Model, Services Model and Acquaintance Model.

4 Author's methodology of using MAS in organisation creativity

On the basis of the overview of existing methodologies of designing and implementing multi-agent systems and the research experiment, the author's own methodology to be used while implementing MAS systems in organisation creativity is suggested. This methodology is aimed at acquiring new resources of information by MAS in order to satisfy needs of organisation creativity – the MASTCIDS (MultiAgentSystemToCreateIdeaDataStore) methodology. Major stages that are used in author's methodology MASTCIDS presented in the following Figure.

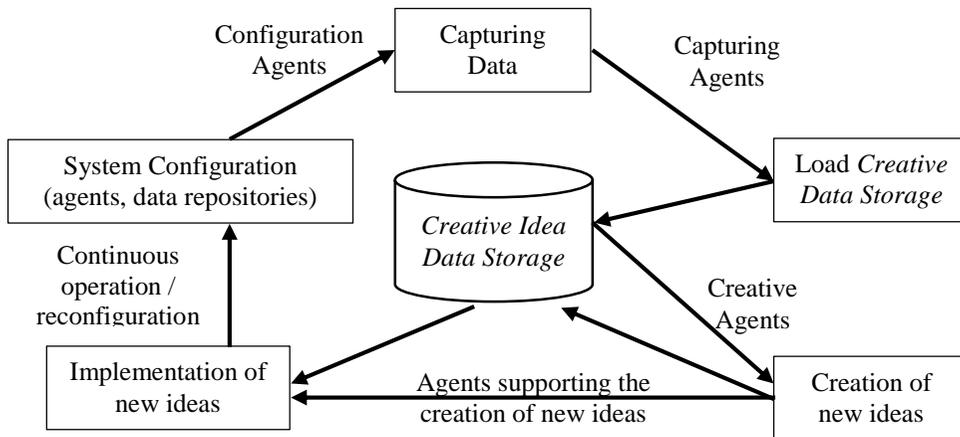


Figure 5 Methodology MASTCIDS model. Source: own.

At the first stage of implementing the MASTCIDS multi-agent system, as before, it is recommended to clearly define realistic objectives of the very system. These objectives include identification of sources to be used to acquire data and models of data profiles. Results of data acquisition are supposed to depend on individual features of particular agents and their interactions. First stage in the sequence of MASTCIDS implementation involves identification of areas that might be used to acquire new ideas. Therefore, it is recommended to clearly define nature of data that may contribute to improvement in organisation creativity.

Next stage involves configuration of particular agents and a data repository that would all be used to store acquired data by particular data agents. This also involves methods / mechanisms to be used while feeding this data into the system. In case of structuralised data, this is a relatively simple

task. However, in case of unstructured data (that, e.g., comes from www sites or social media), this may turn out to be a difficult problem. At this stage, it is important to configure agents from the perspective of optimisation of their communication with their settings and mechanisms of searching and acquiring data from different sources. Similarly, as in case of simulation, definition of particular agents and verification of their interactions are also time consuming tasks at the stage of intelligent agent application. Some challenge to be met at this stage is to define an agent that would be able to interact (cooperate, coordinate and negotiate) with other agents in order to search for interesting data, acquire such data successfully and store the data in question in appropriate data repositories. Subsequently, it is necessary to carry out tests of individual agents and, simultaneously, to verify correctness of the whole system understood here as a complex solution. These tests are meant to verify correct access to data, interactions with MAS and its settings and realisation of the task delegated in order to obtain new data in a data repository (Creative Data Store).

If tests are successfully completed, it is necessary to initiate the very operation of the MASTCIDS system, i.e. to monitor sources of data in compliance with configuration and to download data to feed the Creative Data Storage. Apart from data downloaded, it is also recommended to store metadata that is generated during this process.

Parallel to tasks related with acquiring and recording collected data, agents who create new ideas start their work. Their actions should involve the following: (1) creating new ideas, (2) developing employees' creativity, (3) developing products and (4) monitoring and examining the impact of the environment on a given enterprise.

The last stage of the MASTCIDS methodology calls for implementation of created ideas. Realisation of this task should be delegated to appropriate agents who are supposed to stimulate organisation creativity, thus supporting a relevant user. This stage is supposed to develop organisation creativity, inter alia, by means of: (1) assessing and validating new ideas, (2) sharing results in the whole organisation and in the MAS system and (3) implementing created ideas in activities undertaken by organisations in form of products, processes and procedures.

It is assumed that as a result of implemented new ideas another iteration of the whole methodology may (and even should) take place.

MASTCIDS methodology contains informal rules that describe tasks to be delegated to agents of the relevant group to create ideas and to develop a data repository. For instance, the following tasks are attributed to agents who model creation of new ideas: (1) on the global level – tasks of building a new model of knowledge and skills of creativity; (2) psychological tasks of modelling creative properties; (3) interactions of users and the system of registering tasks; (4) identifying errors of users' tasks and their reasons; (5) a task of creating a model of complete creativity.

5 Conclusions

Although the world of science and practice undertakes continuous attempts at utilising MAS in different activities (e.g. in business and simulations), it is difficult to demonstrate adequate MAS-based methodological support of development of organisation creativity. Regardless of the fact that the general approach to methodology of MAS implementation may be based on software engineering methods, in case of organisation creativity MAS have to be characterised by particular properties. These properties must be taken into consideration designing, implementing and developing systems in question.

Suggested MASTCIDS methodology aims at identifying elements (of the MAS system) of stages of actions that are important in case of organisation creativity. It seems that using MASTCIDS to implement MAS will positively influence numerous processes that are observed in any organisation, including creative processes and sharing ideas and knowledge.

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Software Tools in Operations Research

Blanka Bazsová¹

Abstract. Operations research provides many possible problem solving methods applicable in a wide spectrum of situations. They can be successfully applied in companies that struggle with the production effectiveness. The goal of this paper is to describe existing and available software support options in the Operations Research which are used by students at VSB-TU Ostrava, Faculty of Economics, and to underline significance of its application in the specific groups of tasks. The paper demonstrates how to solve a specific structure problem with an application of a model of the structural analysis and use of Microsoft Excel as a supporting software that can measure and monitor effectiveness of the production in the company when implementing information technology at the same time. The author of this paper listed other software tools used for teaching purposes in the Operations Research class at the universities in the Czech Republic.

Keywords: Operations research, specific groups of tasks, software tools, model of structural analysis, Microsoft Excel

JEL Classification: M15, I21, I23, L30

1 Introduction

An emphasis in the current trends is based on a computation of data input and adding descriptive statistics/outcomes formatted in graphs and charts. The same holds true in the operation research and leads decision making managers to search for appropriate software tools that could map and simplify the solving process to make it easy to manage and control. The final users are typically students and managers as part of the problem solving groups of the Operations research. Some economists approach this idea with an increasing reluctance to learn something new, whereas managers are hesitant to be more innovative and unconventional. The students often argue that the theory is boring, mathematics is difficult and not comprehensive. A feedback given by these users is important for teachers who can monitor a development of new opportunities in the software support area and apply appropriate software tools related to data analysis used in Operations research.

What can users expect from the software support:

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- Easy to understand,
- Quick results,
- Option to stop the program at any time,
- Select multiple various problem groups,
- Advanced Graphic Designs,
- Option to choose data results

2 Operations Research and its methods

Operations research represents the way of a team work where a group of experts' works together to resolve a complex problem that can be economical, technical, organizational, or strategic related (Habr and Vepřek, 1979). Operations research is based on the traditional system methods, specifically on the system analysis and synthesis. It can help managers to be objective in their decision making process in the organization and thus improve and streamline their management. The use of any software support is the advantage for manager. He can find the decision quickly and can get more options.

The goal of the Operations research is to find and select an optimal solution alternative (or a few optimal solutions) for any specific problem based on a set of defined economical standards (Drdla and Rais, 1995).

Operations research applies a sequence of steps/procedure for any kind of problem solving process. It helps managers to improve in problem solving process and thus strengthens their leadership skills and decision making process in the organization. The Operations research is based on the mathematical model, which is an important attribute that is used for solving specific groups of problems by using specific set of methods defined. Any experienced manager would not be able to work without use of these methods.

When making decision in regards to which software tool to apply, it is important to define what the important tasks for each user are. In the literature currently available on the market, different authors provide different classifications of these methods. There are 12 following groups of tasks according to Řezáč (2009):

- Mathematical programming
- Dynamic programming

- Structural analysis
- Game theory and strategic behavior
- Network Graphs
- Sequence solving methods and tasks
- Correlation, regression and multivariable analysis
- Queuing theory
- Inventory methods
- Methods of maintenance
- Simulations techniques
- Heuristics methods

3 Software tool with use of Quantitative Systems for Business Plus

QSB, the Quantitative Systems for Business Plus, is a part of the learning materials prepared for students attending the Operations Research class at VSB-TU Ostrava, Faculty of Economics. It was the first software in use for an application of the problem solving process in the Operations research. The authors of the program are Yih-Long Chang and Robert Sullivan. The system works under Microsoft DOS and has a requirement of licensing. It is a simple software written in English language containing the following models:

Models of Optimal Method: The use of such method is mostly in production, e.g. cutting and mixture problems, resulting in a selection of the optimal path/solution. The software provides graphical map for each solution.

Network models: Performs an analysis working with CPM (Critical Path Method)

One of the advantages of the SW QSB environment is a data entry in the system while the system selects appropriate models and processes the data. This system can be used for situations dealing with a linear programming which requires application of the Simplex method based on advanced and time-demanding calculations that can take a fraction of time if the software does the calculations instead. The system is able to display alternative solutions. The surveys collected from students at the Faculty of Economics emphasize a positive side that the software itself is very

comprehensive and easy to understand. However, the fact that it does not allow the users to use a mouse can create an issue.

Table 1 Positive and negatives feedbacks by using QSB (Source: designed by author)

Positive Feedback	Negative Feedback
Easy to understand	Knowledge of English
Easy input of initial data	No functionality of mouse
Logical format of Final Results/outcomes	Outdated graphics
	Limited to 1 criteria on per entry
	Cannot resolve a complex problem

The software has gone through a transition with a main goal to be compatible with Microsoft Windows which helped to overcome some errors caused by working under DOS.

The product win QSB can be now downloaded and installed to all computers with a capacity of 736 kB RAM and higher.

The WinQSB is based on working with icons in various groups of problems. It uses the solved network modeling, project scheduling problems, dynamics problems, linear and integer programming problems, optimizations problem, inventory problems, non-linear problems, queuing system simulation, quadratic and integer quadratic programming and problems based on Markov process.

4 Software tools with use of Microsoft Excel

Microsoft Excel system is suitable for dealing with models of structural analysis and linear programming methods. Models of structural analysis are static models reflecting a structure of production activity at specific time. The data input is in the form of a table that contains 4 quadrants. The structural models are able to calculate changes between deliveries to different companies within 2 years. The following table demonstrates an example of a situation

solved by a model of structural analysis. There are 3 different production fields in the company shown in the first column of the table. The second column reflects a consumption of each production field. The third column represents deliveries to the clients and the fourth column calculates total production (thousand CZK).

	A	B	C	D	E	F
1	Table 1:					
2	Production field	Consumption			Deliveries	Total production
3		1.	2.	3.		
4	1.	0	160	20	20	20
5	2.	0	0	50	150	20
6	3.	0	0	0	400	40
7						

Figure 6 The Model of structural analysis in a company with use of Excel.
(Source: own)

Table 1 in the figure 1 represents an example of how the model of structural analysis can be useful for calculating the total production each year if there are some changes in the amount of deliveries and/or consumption due to new terms and conditions in the contracts with consumers. The final results for each year are referenced in the above table. Deliveries in the first production field are 80 000 CZK higher than in the previous year, deliveries in the second production field are 50 000 CZK more than in the previous year, and deliveries in the third production field are 200 000 CZK more than in the previous year.

The differences in the total production can be calculated as:

$$X = B \times Y \tag{1}$$

where

$$B = (E - A)^{-1} \tag{2}$$

and

$$a_{ij} = \frac{x_{ij}}{x_j} \tag{3}$$

The finding the optimal solution with use of MS Excel is quick because of the mathematical functions. The results are displayed in the following figure 2 (table 2):

Table 1:		Consumption			Deliveries	Total production
Production field	1.	2.	3.			
1.	0	160	20	20	200	
2.	0	0	50	150	200	
3.	0	0	0	400	400	

E	$a_{ij} = \frac{x_{ij}}{x_j}$		
1	0	0	0
0	1	0	0
0	0	1	0

$(E - A)$	Y			$X = B * Y$
1	-0,8	-0,05	100	350
0	1	-0,125	200	275
0	0	1	600	600

$B = (E - A)^{-1}$		
1	0,3	0,15
0	1	0,125
0	0	1

Figure 7 An example of a situation solved by a model of structural analysis with use of Excel (Source: designed by author)

5 Other software tools

The multi functionality and easy to use features of MS Excel, in addition to customized graphical solutions and data outputs are the most critical reasons

for its compatibility with many other applications. Frontline Solver (2012) is produced by Frontline Solver – developer MS Excel and implemented for optimization and simulation of all models – linear, non-linear, integer, and quadratics. What'sBest is offered by Lindo Systems Inc and designed to build linear, non-linear, and integer models (Lindo Systems Inc., 2012b). Lingo is able to solve linear, non-linear and integer models including optimization (Lindo Systems Inc., 2012). Lindo API is designed to create models for optimization (Lindo Systems Inc., 2012). Classic Lindo is appropriate for building models for business that use linear and integer models (Lindo Systems Inc., 2012). The above mentioned software tools are used at University of Prague and Západočeská University Plzeň for problem solving situations.

6 Conclusion

The above referenced software tools are relatively user-friendly and have ability to simplify the calculations associated with a use of models of the Operations research. Managers' decision concerning a purchase of a specific software depends on their expectations for how sophisticated the software should be, their decision making process, budget restrictions, frequency and application of the software in the company. For example, Win QSB can benefit managers when searching for multiple options, variable measurements techniques in a complex environment. Whereas Microsoft Excel software can be easily customized and is a good solution for companies in a dynamic environment with constantly changing demands of the customers. Microsoft Excel seems to be the most comprehensive program support implemented in conjunction with many problem solving methods of the Operations Research.

Working with the software tools What'sBest, Lingo, Lindo API and Frontline Solver is the advantage for students and because it is a free version available.

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Reporting Tool for the Data Acquisition System

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Abstract. In this paper, we focus on the new DAQ system that is being developed for the COMPASS experiment at CERN. From the hardware point of view, the system consists of FPGA cards that perform data multiplexing and event building and standard servers that are used for event readout, control, and monitoring. From the software point of view, the system consists of several types of processes that are deployed in heterogeneous network environment. We present tools called Message Logger and Message Browser that have been implemented for the purpose of monitoring. Each process in the system can generate message describing their state; these messages are collected and stored by the Message Logger which is a graphical tool used to browse and filter these messages. In order to improve performance of reporting tools, we also analyze some database optimization techniques. Finally, we present results of performance tests.

Keywords: Monitoring, data acquisition, distributed system

JEL Classification: M15

1 Introduction

Modern high energy physics experiments strongly depend on data acquisition systems that collect large amount of data produced by detectors. We focus on the new data acquisition system of the COMPASS experiment at CERN. In order to be able to quickly resolve incidents in the system, it is necessary to implement reporting facility.

At first, we briefly introduce the scientific program of the experiment, then we analyze data acquisition system of the experiment, at first from the hardware, then from the software point of view. We describe processes involved in the system and DIM library that is used to implement communication between nodes. The DIM library extends the client-server paradigm with a concept of a name server. We present monitoring tools

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Message Logger and Message Browser. We conclude with results of the performance tests.

2 The COMPASS experiment at CERN

COMPASS is a high energy particle physics experiment with fixed target, situated on the SPS (Super Proton Synchrotron) M2 beamline. The scientific program of the COMPASS experiment was approved in 1997 and it studied the structure of gluons and quarks and the spectroscopy of hadrons using high intensity muon and hadron beams. COMPASS is currently running in its second phase called COMPASS-II (Magnon et al, 2012) covering the studies of the Drell-Yan effect, the Primakoff scattering, and the Deeply Virtual Compton Scattering (DVCS).

2.1 The Hardware of the Data Acquisition System

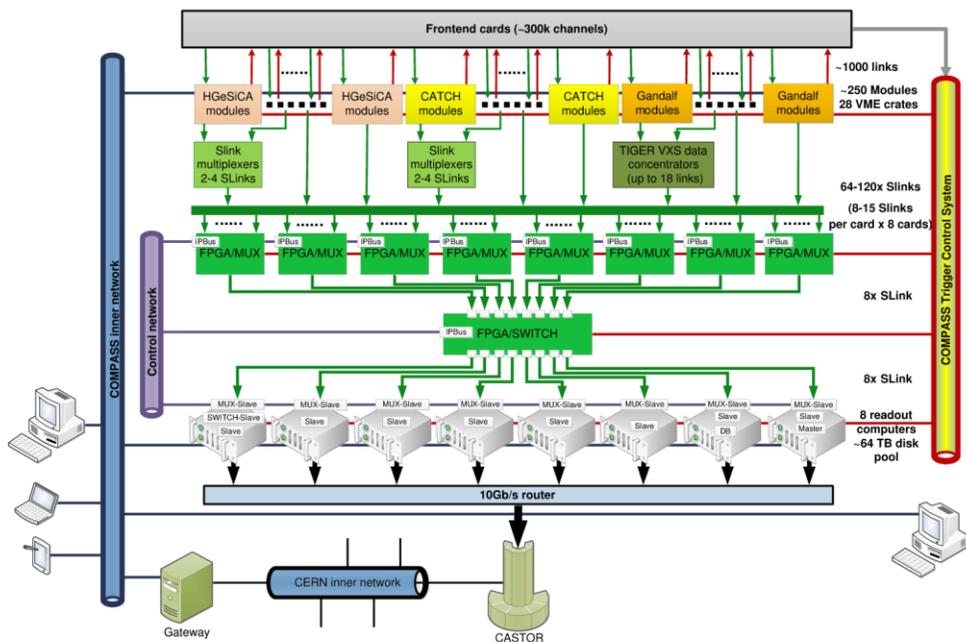


Figure 1 The new hardware setup. The PFGA modules perform buffering and balancing the data flow and complete the event building. Source: own.

The hardware of the old Data Acquisition consists of several layers. The frontend electronics (in the first layer) captures signals directly from the detectors and converts them to digital values. There are approximately 250000 of these channels. The data from the frontend electronics is processed

by CATCH and GeSiCA VME modules into subevents, all coordinated by the Trigger Control System. Subevents are then transferred via the S-Link optical interface into 32 readout buffer (ROB) server machines that provide load balancing during the whole SPS supercycle. The cycle is approximately 30-40 seconds long, whereas the spill with particles has duration about 10 seconds. Subevents are then moved to the event building servers that complete the final events.

Due to increasing amount of collected data, the old DAQ structure becomes insufficient. The obsolete parts are being replaced with new modern equipment. The frontend electronics and CATCH and GeSiCa modules remain intact. However the buffers and event building servers are replaced with modern FPGA (Field Programmable Gate Array) cards performing hardware event building and load balancing. In order not to affect any further data processing, the output of the new setup will remain unchanged. The scheme of the new setup is shown in Figure 1. The new setup is easily scalable (for possible upgrades in the future), more efficient, and with sufficient performance.

2.2 The Hardware of the Data Acquisition System

The old DAQ setup was using modified DATE (Data Acquisition and Test Environment) software package originally developed for the LHC experiment ALICE (Anticic et al, 2005). It has been decided that new software will be developed. It is inspired by DATE, nevertheless it is more lightweight and thus easier to use and to maintain. According to (Bodlák, 2012; Nový, 2012), the newly developed software package consists of five main types of processes:

- Master process – a Qt console application. It is the most important component. It contains almost all application logic. It serves as a mediator between Slave processes and GUI.
- GUI – a Qt GUI application designed for controlling and monitoring of the whole DAQ. It send commands to the Master. Master sends back monitoring data about hardware controlled by Slaves. GUI can run in many instances, only one has the rights to change configuration and to execute control commands, the others are only allowed to monitor the status of DAQ.

- Slave process – an application that controls and monitors the custom hardware. It is controlled and configured by the Master. It informs the Master about the state of the hardware it is deployed on.
- Message Logger - a console application that receives informative and error messages and stores them into the MySQL database. It is directly connected to the Master and to the Slave processes via the DIM service
- Message Browser - a Qt GUI application that provides an intuitive access to messages from the system (stored in the database) with an addition of online mode (displaying new messages in realtime). Equipped with filtering and sorting capabilities, it is able to run independently from the whole system in case of emergency.

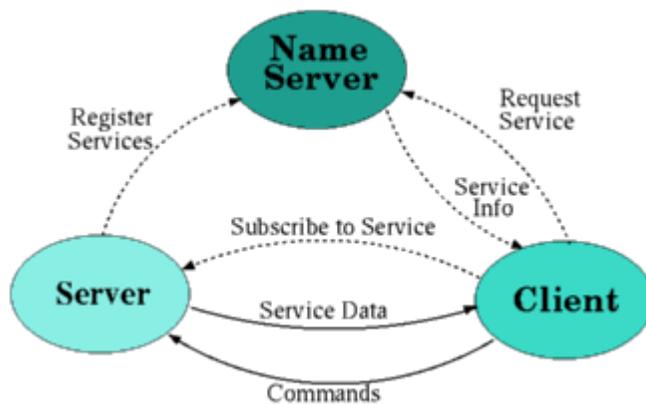


Figure 2 The interaction of DIM components. Source: (Gaspar 2000)

DIM communication library

DIM library (Distributed Information management) is a communication tool originally developed for the Delphi experiment at CERN. It is based on the client/server paradigm that is extended by DNS (DIM Name Server). A service is a basic communicational tool of DIM. Service transfers a set of data from server to client. Servers publish their services to the DNS and clients can subscribe to them. Clients obtain data from the services either periodically or when the service content is updated. Clients can send commands to the servers and thus control them in this way. Communication between nodes of the new DAQ is based on DIM library. The interaction of the DIM components is shown on Figure 2.

Reporting tools

Message Logger

Message Logger is a console application that serves for gathering and storing informative and error messages from the other nodes of the DAQ. It relies on the DIM library to secure communication with the master and the other nodes (it subscribes to all “INFO” services available in the system). If a relevant message arrives, it is stored into the MySQL database (Tomsa 2014).

Message Browser

The Message Browser is a GUI (Graphical User Interface) application developed using Qt framework. Its purpose is to display both messages already stored in the MySQL database by the Message Logger and the currently incoming messages. It offers rich and intuitive filtering and sorting options. It is intended as a replacement of the infoBrowser application from the DATE software package used in the old COMPASS DAQ setup. The screenshot of the Message Browser application can be seen on Figure 3.

The Message Browser is based on the standard model-view-controller software architecture. Model is represented by the underlying data structure containing all messages fetched from the database and received via the “online” part. The view is a table in the graphical interface displaying those messages. Controller stands for the filtering mechanism, allowing only the messages meeting the chosen criteria to be displayed.

Upon startup, the application loads messages from the MySQL database from the last 24 hours (this time period might be refined later) with maximum amount of 1000 messages. User can adjust the settings once the application is started. Then it tries to subscribe to the same services as the Message Logger does. If it succeeds, it begins to receive informative and error messages from system as they supervene. Therefore it is not necessary to poll the database periodically for new messages. It is worth mentioning that it does not overtake the job of the Message Logger of storing the messages into the database. If the Message Browser is unsuccessful in connecting to the DIM services (that probably means the whole system is down), the database-related part is still untouched and working. This approach allows efficient usage of system

resources (no unnecessary polling), while ensuring independence from the rest of the system (Tomsa 2014).



Figure 3 UI design of the Message Browser application. Source: own.

The database

The database needed for the logging system is a part of the database for the new DAQ for the COMPASS experiment. The main table Message_log contains following attributes:

- **Id** - an unique identifier of the table records (primary key)
- **process_id** - identifier of a process which reported the error (it is a link to one of the tables in the DAQ database)
- **run_number** - number of the run during which the error occurred
- **spill_number** - number of the spill during which the error occurred
- **event_number** - number of the event during which the error occurred
- **text** - text of the error
- **severity** - severity of the error
- **stamp** - time stamp of the error

As this table is expected to be the largest table inside the DAQ database, several optimization steps were performed in order to increase the speed

of retrieving the data. The table uses a MyISAM storage engine which is optimized for environments with heavy read operations. The rest of the DAQ database uses an InnoDB storage engine because of its foreign key support in order to maintain the referential integrity on the database side. There is only one foreign key in the Message_log table (the process_id attribute) and thus the referential integrity is to be kept only programmatically - i.e. inside tools which insert or modify the table data.

As the Message browser applications provides the possibility of advanced filtering of the table data, several indices should be created on some columns in order to increase the speed of data retrieval especially during ordering the data by one of the columns. So far only stamp column has an index because the time of the error is the most important information in terms of filtering. More indices will be probably defined in the future after additional requirements on the advanced filtering are defined.

Performance test

The browser has been tested for the speed of loading messages from the database. It was set to load 100, 200, 500, 1000, 2000, 5000, 10000, 20000, and 50000 messages from the database, each set was loaded 100 times in a row. Two times have been measured. The time that was consumed by storing the messages into the inner data structure in the Browser, and the time it took to complete the whole task of loading the given amount of messages 100 times (including the loading from the database, updating the filter model, etc.) Each test was rerun at least 10 times. The averaged time is drawn in Figure 4. The time needed only to store the messages grows linearly with the amount of messages, whereas the total time is not so strictly linear. With higher amount of messages selected from the database, there is some loss of time in the increased overhead required to process such amounts of data. Average time to load 100 messages is roughly 2.88ms, the storing part takes only 1.17ms.

All tests were run in virtualized 64-bit SLC 6.5 Linux with 2GB of RAM and 2 cores available in Virtualbox, hosted in Ubuntu 14.04 64-bit. The used processor is Intel Core i5-2410m (2 core, 4 threads, 2.3-2.9 GHz).

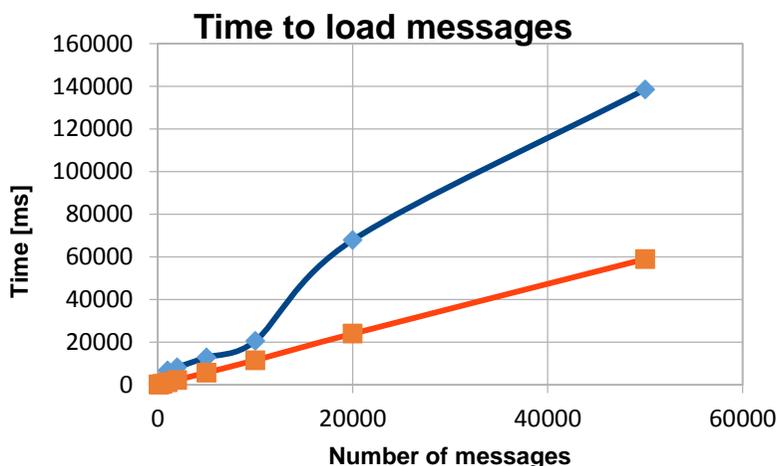


Figure 4 Time of ms to load 100 times the given number of message. The lower line describes time needed only to store the messages, the upper line shows the total time. Source: own.

3 Conclusion

Message Logger and Message Browser are useful tools that will be used on the daily bases during data taking shifts. First tests shows that the tools meet given performance tests. Monitoring system is ready to be deployed when data taking resumes in autumn 2014. Depending on the requirements of operators, we will fine tune database indices in order to assure smooth operation.

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The Financial Support Management of Foreign Economic Entities

Oleksiy Druhov¹, Maksim Hlushchenko²

Abstract. The article reveals the nature of the proposed classification of foreign economic entities, and identifies essential characteristics of the mechanisms of their financial support. The obtained more accurate results are needed to improve the existing mechanisms of financial support for foreign economic entities and to develop new ones.

Keywords: entity, financial needs, mechanisms, financial interests, foreign economic activity

JEL Classification: G15, M15

1 Introduction

Foreign economic activity of economic entities requires diversification and differentiation of forms of its financial support. Domestic and foreign scholars paid a lot of attention to the development of foreign economic activity (Georgiadi, 2009), (Hrebelnyk, 2004), but the critical analysis of scientific literature has shown that problems of the financial support mechanisms formation for economic entities were paid little attention. First of all, on the theoretical level the problem is that there is no adequate classification of foreign economic entities in terms of their financial needs and there is no clear identification of the essential features of mechanisms of their financial support. Building up classification of foreign economic entities and identifying essential features of mechanisms of their financial support is the starting point for the improvement of the existing and creation of new theoretical and methodological provisions to find opportunities to satisfy the financial needs of foreign economic entities.

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2 Building up Classification of Foreign Economic Entities

Considering behavioral and process scientific and methodical approach

O. Grebelnyk classifies entities of foreign economic activity by levels:

- 1) micro level (level of individuals and legal entities) - businesses, organizations, exporting or importing goods, items, services;
- 2) the mesolevel (the level of national, sectorial and regional associations) - ministries and agencies directly involved in the regulation of foreign economic relations (Ministry of Economy of Ukraine, the National Bank of Ukraine, Antimonopoly Committee of Ukraine, the Interdepartmental Commission on International Trade, Trade and Industry Chamber of Ukraine, etc.);
- 3) macro level (state level) - the government and the parliament;
- 4) meta level (level of establishing foreign economic priorities in the process of international regional integration). This is especially true of collaboration of government bodies at the stage of setting up and development of integration associations;
- 5) mega level (level of international associations and organizations). This is particularly the General Agreement on Trade and Tariffs (GATT), the World Trade Organization (WTO), the International Chamber of Commerce, United Nations Conference on Trade and Development (UNCTAD), the Customs Cooperation Council, and others.

By their capacity foreign economic entities are divided into natural and legal persons. Entrepreneurs, employees, tourists, ie those who are directly involved in carrying out this type of activity belong to natural persons. Legal persons include companies of different legal forms, corporations, associations, etc. (Georgiadi, 2009), (Hrebelnyk, 2004).

By the way of appropriating the results of the activity foreign economic entities can be grouped as follows: the state, but not only state regulators, but also inter-state and international organizations; owners, that is, direct founders of businesses and employees working under contracts of foreign economic activity (Georgiadi, 2009), (Hrebelnyk, 2004).

Significant contribution to the classification of foreign economic entities was made by V. Kozyk, L. Pankova, Ya. Karpjas O. Hryhorjev and A. Bosak,

L. Strovskyy who specified the entities of foreign economic operations considering commercial transactions they perform (Zaruba, 2009): entities that carry out foreign trade transactions (import-export, re-export and re-import, countertrade transactions, barter transactions, transactions that involve the seller to sell goods, offered by purchaser, purchase of obsolete products, supplies for replenishing, counter-trade transactions within the industrial cooperation, organizational forms of foreign trade operations); entities that do lease transaction; entities that perform operations of international trade in scientific and technical knowledge and experience; entities that trade engineering and technical services; entities that perform consulting operations; entities that perform operations on maintenance and provision of spare parts for machines and technical equipment.

The summary of the critical review of the literature (Drozdova, 2002), (Kozyuk, 2004) and our own theoretical study made it possible to develop the classification of foreign economic entities (Table 1).

3 Building a Financial Support Mechanism for a Foreign Economic Entity

Mechanism of financial support for a foreign economic entity belongs to abstract objects. In terms of physical-and-mechanical approach it is an intangible object that can not be identified in time and space. Formation of such a mechanism is due to its idealization and generalization. The American philosopher Ch.Pirs back in the nineteenth century proved that it is easier to reveal the essence of abstract objects intuitively using specified examples than rationally by means of dialectics [Charles S. Peirce, 2010] Nevertheless, it should be admitted that intuitive approach is acceptable for studying new, previously unknown phenomena at the early stages of their research. In addition, the use of intuition for the analysis of abstract objects is not advisable, if these objects are created by specific individuals or groups of individuals to achieve individual, collective or public purpose. Although mechanisms of financial support of foreign economic entities are abstract objects that are not devoid of subjectivity their formation is a result of the objective needs of foreign economic entities that are caused by the influence of objective economic laws.

Table 1 Classification of foreign economic entities, Source: own.

Classification features	Types of entities
By levels	Foreign economic entities of micro level; Foreign economic entities of mezolevel; Foreign economic entities of macrolevel; Foreign economic entities of meta level; Foreign economic entities of mega level
By capacity	Foreign economic entities that are natural persons; Foreign economic entities that are legal persons;
By way of appropriating the results of foreign economic activity	The state, as state regulating bodies, and also as a member of inter-state and international organizations; owners, that is, direct founders of businesses and employees working under contracts of foreign economic activity
By performed commercial transactions	Foreign economic entities that carry out foreign trade transactions; foreign economic entities that do lease transaction; foreign economic entities, entities that perform operations of international trade in scientific and technical knowledge and experience; entities that trade engineering and technical services; entities that perform consulting operations; entities that perform operations on maintenance and provision of spare parts for machines and technical equipment.
By organizational forms of trade and brokerage	Foreign economic entities that are commercial enterprises; foreign economic entities that are commission enterprises; foreign economic entities that are agent enterprises; foreign economic entities that are brokerage companies.
On the basis of affiliation capital and its control	Foreign economic entities, whose formation and control over capital takes place in Ukraine; foreign economic entities, whose formation and control over capital takes place outside Ukraine; foreign economic entities, whose formation and control over capital takes place on a mixed basis.
On the basis of roles performed in foreign economic activity	Foreign economic entities that act as controllers and regulators of foreign economic activity; foreign economic entities that act as a court in the field of foreign economic activity; entities that act as entrepreneurs.
By the content of the financial interests	Foreign economic entities that act as investors or recipients; foreign economic entities that act as lenders or borrowers; foreign economic entities that act as sellers or buyers.
By the nature of the financial needs	Foreign economic entities that are in need of financial resources; foreign economic entities that are in need of guarantees of financial institutions for implementing certain foreign transactions.

Considering the above mentioned it is necessary to identify the nature of the financial support mechanism for foreign economic entity in terms of its purpose, components and order of their interaction. Based on the method

of content analysis as a tool of abstraction, we can state that the studied financial support mechanism is different from other similar mechanisms because it is formed solely for foreign economic entities. Foreign economic entities are one of the elements of this mechanism that characterizes its specificity, scope, and defines the selection and conditions of using financial support tools. As foreign economic entities are one of the key features of the object in question, we will consider their role in the mechanism of financial support. In the previous paragraph it was mentioned that foreign economic entities are in need of financial resources as well as in guarantees of financial institutions for implementing certain foreign economic transactions. With this in mind, foreign economic entities can act as those who need finance or those who satisfy these needs. Their interaction is based on certain financial interests, which arise, the method of their implementation depends on the legal environment, market conditions, the place of a particular economic entity in the market.

Foreign economic entities often take different roles during the execution of business operations. Under some market conditions they can be donors of investment resources, under different conditions - recipients. In addition, the economic entities that deeply diversify cash flows and business partners often simultaneously play the role of both investors and recipients. With this in mind, we conclude that creation of specific ways of financial support for a foreign economic entity takes place under the influence of the objectives of foreign economic entities, which are formed on the basis of their financial needs and interests (Fig. 1).

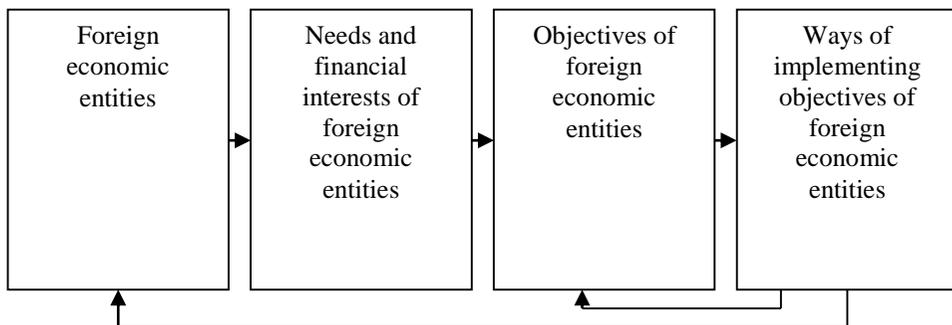


Figure 5 Interrelations between the constituent elements of the basic mechanism of foreign economic entities financial support, Source: own

Among the ways to achieve the objectives of foreign economic entities bank guarantees (an additional tool to ensure the financial interests

of the parties in contractual relationship) occupy a special place. Bank guarantees are monetary liabilities of the bank to the beneficiary to pay him money in case of the principal default and factoring operations (the process of assigning the factoring company (bank) the outstanding debt claims (invoices and bills) that arise between the contracting parties during the sale of goods and services under terms of commercial credit, combined with the elements of accounting, information, marketing, insurance, legal and other services) and forfaiting operations (method of providing medium-term financing of export transactions that involves sale of debt claims under foreign trade contracts to some lending institutions (forfeiter) while providing sufficient security (Kozyuk, 2004), the use of these operations significantly expands the diversity of mechanisms of financial support for foreign economic entities.

Fig. 1. presents the basic mechanism of financial support for foreign economic entities. It is called basic, because the components are identified only in general terms without specifying the list of foreign economic entities, their financial needs and interests, objectives and methods of their implementation.

Building up of the concrete mechanisms of financial support for foreign economic entities should be done in terms of foreign operations they perform (foreign trade, rent, international trade in scientific and technical knowledge and experience; trade in engineering and technical services; consulting operations; operations on maintenance and provision of spare parts for machines and technical equipment), taking into account the specific conditions of foreign trade contracts of specific foreign economic entities and their role in these contracts (exporter or importer).

4 Conclusions

Building up classification of foreign economic entities and identifying features of the mechanisms to meet their financial needs is done to improve the existing and create new theoretical and methodological provisions on searching opportunities to satisfy the financial needs of foreign economic entities.

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Forecasting AUD/USD Exchange Rate with RBF Neural Network Combined With Evolutionary Approach and Unsupervised Learning

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Abstract. In this paper, authors apply feed forward artificial neural network (ANN) of RBF type into the process of forecasting the future value of AUD/USD currency pair. Except for the standard RBF, authors also test the customized version of this NN combined with other techniques of the ML. They add the evolutionary approach into the ANN and also combine the standard algorithm for adapting weights of the ANN with an unsupervised clustering algorithm called Kmeans. Finally, all of these methods are compared and contrasted.

Keywords: neural network, RBF, time series, finance, AUD/USD, genetic algorithm, Kmeans

JEL Classification: C13, C45, D81, G32

1 Introduction

Even though statistical time series forecasting started in the 1960s, the breakthrough came with publishing a study by Box and Jenkins (1976) where authors integrated all the knowledge about autoregressive and moving average models. From that time ARIMA models have been very popular in time series modelling for long time as O'Donovan (1983) showed that these models provided better results than other models used in that time. However, in 1982, Engle (1982) showed that using ARIMA models in financial modelling is not correct as these series usually have conditional variance instead of constant. Therefore, he suggested ARCH (autoregressive conditional variance) models for financial modelling.

However, more and more techniques of machine learning (ML) have started to be incorporated into the process of time series forecasting. One of reasons was the study of Bollershev (1986), where he proved the existence of nonlinearity in the financial data. One of the first ML techniques applied into

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time series forecasting were artificial neural networks (ANN). As ANN was an universal approximator, it was believed that these models could perform tasks like pattern recognition, classification or predictions (see Anderson 1988 and Hertz 1991). Today, according to some studies such as Gooijer and Hyndman (2006), ANNs are the models having the biggest potential in predicting financial time series. The reason for attractiveness of ANNs for financial prediction can be found in works of Hill et al. (1994), where authors showed that ANNs works best in connection with highfrequentional financial data. While first applications of ANNs for financial forecasting, used the simplest feed forward ANN (perceptron) (see White 1988), nowadays it is mainly RBF (Orr, 1996) that is used for this as it showed to be better approximator than the perceptron (Marcek, 2004).

In the first section of this paper, basics of RBF, GA and Kmeans are briefly discussed. We then describe the methodology used for our experiments. In the end, results are presented.

2 Machine Learning Models and Methods

2.1 Radial Basis Neural Network

Radial Basis Function (RBF) neural network is an upgrade of multilayer perceptron network (MLP). The name comes from the name of its activation function. Generally, RBF is any real-valued function whose values depend only on the distance from the origin or from some other point c , called a center. Any function ϕ that satisfies this property is a radial function. The norm is usually Euclidean distance.

Moreover, before providing predictions, the neural network must be adapted to approximate the data. Hence, the function defined in Eq. 1 must be minimal:

$$E(w_t) = \sum_{x_t, y_t \in R_{train}^k} (G(x_t, w_t, v_t) - y_t)^2. \quad (1)$$

When E minimal, one can say the neural network represented by the function $G(x_t, w_t, v_t)$ is adapted to approximate the real function F . Implementation of $G(x_t, w_t, v_t)$ include two parts: counting of the neuron potential and activation of the neuron. Here lies the biggest difference between

MLP and RBF –different functions for activating hidden neurons are used. RBF network uses radial basis function of Gaussian type instead of sigmoid function for activating neurons in hidden layer which is used at perceptron. The Gaussian function is defined for j^{th} hidden neuron (where σ_j^2 is the variance of j^{th} neuron and u is the potential of the neuron) as

$$\psi_1(u^j) = \exp(-u_j / 2\sigma_j^2) = \exp(-\|x - w_j\|^2 / 2\sigma_j^2), j = 1, 2, \dots, s. \quad (2)$$

Finally, the network output for RBF neural network is counted as follows:

$$y = \psi_2\left(\sum_j v_j \psi_1(\|x - w_j\|)\right) = \sum_{j=1}^s v_j \exp(-\|x - w_j\|^2 / 2\sigma_j^2) \quad (3)$$

2.2 Genetic Algorithms

GA, which are ML algorithms for optimization, are stochastic search techniques that guide a population of solutions towards an optimum using the principles of evolution and natural genetics. Basic operators include reproduction, crossover and mutation.

Adopted from biological systems, genetic algorithms are based loosely on several features of biological evolution (Montana and Davis, 1989). They require five components (Davis, 1987):

- A way of encoding solutions to the problem on chromosomes. In the original GA an individual chromosome is represented by a binary string. The bits of each string are called genes and their varying values alleles. A group of individual chromosomes are called a population.
- An evaluation function which returns a rating for each chromosome given to it.
- A way of initializing the population of chromosomes.
- Operators that may be applied to parents when they reproduce to alter their genetic composition. Standard operators are mutation and crossover.
- Parameter settings for the algorithm, the operators, and so forth.

Given these five components, a GA operates according to the following steps (Montana and Davis, 1989):

- Initialize the population using the initialization procedure, and evaluate each member of the initial population.
- Reproduce until a stopping criterion is met. Reproduction consists of iterations of the following steps:
 - Choose one or more parents to reproduce. Selection is stochastic, but the individuals with the highest evaluations are usually favored in the selection.
 - Choose a genetic operator and apply it to the parents.
 - Evaluate the children and accumulate them into a generation. After accumulating enough individuals, insert them into the population, replacing the worst current members of the population.

When components of the GA chosen appropriately, the reproduction process will generate better children from parents, converging finally on results close to a global optimum.

2.3 Kmeans algorithm

Kmeans, which belongs to a group of unsupervised learning methods, is a nonhierarchical exclusive clustering method based on the relocation principle. It creates the optimum decomposition of objects into the previously defined number of clusters. The method produces exactly k clusters so that the characteristic function used for clustering would be minimal. The most common type of characteristic function is location clustering. The characteristic function is then computed as the distance between the given object and a centroid (the centre of the cluster). The most common distance function is Euclidean. After decomposition of objects into clusters, new centroids are then counted. The process is repeated until the minimalization function E defined in Eq. 4 converges

$$E = \sum_{j=1}^k \sum_{i=1}^n \|x_i^j - c_j\|^2 \quad (4)$$

where $\|x_i^j - c_j\|$ is the Euclidean distance between the input (x_i) and center of the nearest cluster c_j . In our experiments, we used the adaptive version of Kmeans [9] where coordinates of the centroids were adapted after every input vector according to the following formula

$$c_{j'} = c_{j'}^* + \eta(x_i - c_{j'}) \quad (5)$$

3 Hypothesis

Scientists try to incorporate other methods into RBF network in order to better its outputs. For example Rivas et al. (2004) use GA for creating „Evolving“ RBF – i.e. to automatically find the ideal number of hidden neurons. So the first hypothesis to be tested is that a combination of the standard RBF with unsupervised learning method can be used to achieve better accuracy of the RBF neural network. Since (Kohonen, 1995) demonstrated that non-hierarchical clustering algorithms used with ANN can perform better results of the network, we will incorporate Kmeans into the RBF so as to find out whether this combination can produce the effective improvement of the standard RBF in the domain of financial time series.

Moreover, in recent years GA have become a popular optimization tool. Therefore, the standard backpropagation (BP) (which is very often considered a weakness of RBF) will be substituted by the GA as an alternative learning technique in the process of weights adaptation.

4 Experiment and Methodology

Data and Model Validation

We used daily close price of the AUD/USD currency pair. The interval was from 10/31/2008 to 10/31/2012, i.e. 1044 daily observations. The data was downloaded from the website <http://www.global-view.com/forex-trading-tools/forex-history>. Due to model validation, data were divided into two parts. The first part included 912 observations (10/31/2008 to 4/30/2012) and was used for model training. The second part (5/1/2012 to 10/31/2012) counting 132 observations, was used for model validation by making one-day-ahead ex-post forecasts. These observations were not incorporated into the model training, so parameters of the model were not changing anymore. The validation was done to find out the prediction power as there was an assumption that if the model can handle to predict ex-post data, it will also be able to perform real (ex-ante) predictions.

Box-Jenkins Analysis

Box-Jenkins analysis was performed to make a comparison between standard statistical models and our neural network models. For statistical modelling Eviews software was used. By analyzing autocorrelation and partial

autocorrelation function of the second differences we found out that there was a strong moving average dependency between random parts of the model. Therefore, the model was identified as MA(1). By analyzing residuals and squared residuals using Ljung-Box test and ARCH test (Engle, 1982) we found out that ARCH effect was present in residuals. Due to that, the residuals were modelled by GARCH(1,1) model. We used Marquardt optimization for finding the optimal values of GARCH parameters; initial values of parameters were counted using Ordinary Least Squares and these values were then by iterative process consisted of 500 iterations. Convergence rate was set to 0.0001. Finally, we tested standardized residuals with Ljung-Box Q test to confirm there were no significant coefficients in residuals of the model. The assumption was confirmed, so according to statistical tests the model was correct. The final model is

$$y_t = -0,997453\varepsilon_{t-1} + e_t \sqrt{h_t} \quad (6)$$

$$h_t = 0,00000155 + 0,042624\varepsilon_{t-1}^2 + 0,934399h_{t-1} \quad (7)$$

RBF Neural Network

We used own application of RBF network implemented in JAVA with one hidden layer where we tested from three to ten processing neurons to achieve best results of network. For every model, only the result with the best configuration is stated. We used the identity function as an activation function for the output layer too. The weights of network were initiated randomly – generated from the uniform distribution $(0,1)$. As for the BP, the learning rate was set to 0.001 to avoid the easy imprisonment in local minimum. The number of epochs for each experiment with BP was set to 5000 as this showed to be a good number for backpropagation coverage. The final results were taken from the best of 5000 epochs and not from the last epoch in order to avoid overfitting of the neural network.

As we used nonstandardized data, we analyzed original series for autocorrelation. As there was a strong dependence on the previous day (0,996) we used just one network input - the previous observation. Except for this, we also tested AR(3) process as the inputs into network.

Kmeans algorithm

We used Kmeans in the phase of non-random initialization of weight vector w performed before the phase of network learning performed by backpropagation. Cluster coordinances were initiated as coordinances of randomly chosen input vector. After, every input vector was assigned the nearest cluster. When done, the coordinates of clusters were recounted. This cycle was repeated 5000 times and the learning rate for cluster adaptation was set to 0.001. The number of clusters was set to the number of hidden neurons.

Genetic algorithm

Our own implementation of the genetic algorithm we used for weight adaptation. The chromosome length was set according to the formula: $D * s + s$, where s is the number of hidden neurons and D is the dimension of the input vector. A specific gene of a chromosome was a float value and represented a specific weight in the ANN. The whole chromosome represented weights of the whole network. The fitting function for evaluating the chromosomes was the mean square error function. The chromosome with the best MSE was automatically transferred into the next generation. The other individuals of the next generation were chosen as follows: by tournament selection (size of the tournament equalled to 100) 100 individuals were randomly chosen from the population. The fittest of them was then chosen as a parent. The second parent was chosen in the same way. New individual was then created by the crossover operation. If the generated value from $(0,1)$ was lower than 0.5, the weight of the first parent at the specific position was assigned to the new individual. Otherwise, the new individual received the weight of the second parent.

The mutation rate was set to 0.01. If performed, the specific gene of a chromosome was changed to a random value. The size of the population and the number of generations was set accordingly to the settings of BP. In BP, there were 5000 cycles of the forward signal propagation plus 5000 cycles of backward error propagation. In GA we used the size of the population equalled to 1000 and 10 as the number of generations.

5 Results and Discussion

We used MAPE (Mean Absolute Percentage Error) numerical characteristic for assessing models. The result of a given model is from the best neuron configuration (in every model we tested number of hidden neuron from 3 to 10 to find the best output results of the network). Experiment for every model configuration was performed 12 times; the best and worst results were eliminated and from the rest the mean and standard deviation were counted.

Table 1 Final results of AUD/USD ex-post predictions on validation set

model	regressor(s)	optimization	mean MAPE ^{#1}	sd ^{#2}
ANN (Customized RBF)	autoregressive (3)	BP	0,590767	0,046866
		Kmeans + BP	0,619732	0,001801
		GA	0,531798	0,036285
	autoregressive (1)	BP	0,479299	0,018072
		Kmeans + BP	0,472272	0,002773
		GA	0,471471	0,002496
ARIMA+GARCH (0,2,1)+(1,1)	moving average (1), conditional variance (1)	Marquardt optimization	0,471019	–

Seeing in the table 1, our hypothesis were confirmed. The RBF network combined with Kmeans or GA for weights adaptation provided significantly better results than the original RBF. Moreover, besides lower MAPE error, another advantage of using GA or Kmeans upgrade is the consistency of predictions that can be seen in the standard deviation of results.

When comparing weights adaptation via GA and Kmeans plus BP, the results are almost the same. However, GA has a bigger potential to perform even better forecasts as there are more parameters needed to optimized. Additionally, BP, even though used with Kmeans, seemed to reach its global minimum as even with the higher number of epochs (we tested 10000) the results were almost the same. The strength of Kmeans is the speed of convergence of the network. Without Kmeans, it took considerably longer time to achieve the minimum. If the Kmeans was used for setting the weights, the time for reaching the minimum was much shorter. So following from that, in many cases it is not necessary to interpolate the output value by radial functions, it is quite sufficient to use one function for a set of data (cluster), whose center is considered to be a center of activation function of a neuron and the values of centroids can be used as an initialization values of weight vector

w . The advantage is that lower number of epochs is supposed to be used for network training. Moreover, Kmeans is also simple to implement. However, one must bear in mind that it is efficient only in the domain of non-extreme values. Otherwise, other non-hierarchical clustering algorithms must be used.

As for GA, the convergence is also considerably faster than at BP. In addition, GA does not have the same problem with scaling as BP as it generally improves the current best candidate monotonically. It does this by keeping the current best individual as part of their population while they search for better candidates. Moreover, supervised learning algorithms suffer from the possibility of getting trapped on suboptimal solutions. GA are generally not bothered by local minima. The mutation and crossover operators can step from a valley across a hill to an even lower valley with no more difficulty than descending directly into a valley. The disadvantage of using GA in the ANN is that it demands to set up a lot of parameters.

Important to note, this paper did not focus rather on comparing the ML techniques between themselves and not on comparison with statistical models. The parameters of these algorithms were set to the comparable scale and the results of these algorithms are not the optimal values as of statistical models. For example, there is a reasonable assumption that if we used more than ten generations in the process of forming weights of ANN via GA, predictions would be more accurate. However, in that case the comparable part between GA and BP would be lost.

6 Conclusion

In this paper we performed financial time series predictions with RBF neural network. We used AUD/USD data which was later divided into training set and validation due to model checking. Except for a standard ANN of the RBF type, we also combined an unsupervised learning method called Kmeans and GA into the RBF in order to achieve better accuracy of the network. Both of the algorithms were used in the process of adapting weights of the network. The reason for incorporating other algorithms into the network was that the BP is considered a weakness of the RBF. Some of the drawbacks of BP include scaling problem, complexity problem, slow convergence, convergence to a local minimum etc. Therefore Kmeans algorithm was used in the phase of non-random initialization of weight vector w before the phase of network

learning. Moreover, we also eliminated the BP in the second part of our experiment and used GA instead. The final comparison of the selected methods for weight adaptation was performed and both of these upgrades showed to be helpful in the process of creating better forecasts and should be definitely used instead of the standard BP.

Acknowledgements.

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Fuzzy Approach to Business Process Modeling

Frantisek Hunka¹, Jarmila Zimmermannova²

Abstract. REA (resource-event-agent) ontology is a value modeling ontology that distinguishes the future events (something that is planned) and events that happened or have happened. It occurred many times that the planning characteristics of the resources (future events) are breached in comparison with the delivered (real) characteristics of the resources (real events). The problem how to properly evaluate the difference between resource characteristics is a decision making problem, which utilizing the fuzzy decision making formalism could provide more applicable results than utilizing traditional approaches. The paper shortly describes the principles of REA ontology with regard to the planning and operational activities. Then it elucidates decision making process utilizing fuzzy approach. Finally, the paper proposes solution of the described problem.

Keywords: REA ontology, fuzzy-decision making, business process

JEL Classification: L15, L23, M11, O22

1 Introduction

The aim of the enterprises is to produce a value. To describe and model activities inside an enterprise the business process modeling paradigm is utilized. The business process modeling formalism can used a large number of different methodologies that provide rules and guidelines to create a final model. One of the business process modeling formalisms is a value modeling approach that is close to the economical view of the enterprise. In general, a business process is a collection of related activities and events to produce is specific product or service. Typical business process consists of activities and events. Every business process should be measured to ensure optimal results for customer e.g. in terms of *quantity*, *quality*, *price* and *delivery time*. In practice, these indicators can be expressed as a difference between planned feature of the resource and the real feature of the delivered resource. The planned indicators or properties of the resource are frequently to some extent breached and it is really difficult to properly make a decision how

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substantial the differences in the resource characteristics are. The two valued classical logic does not provide adequate tools. In addition, the decision making process should allow for all spectrum of differences between planned and delivered characteristics of the economic resources. The choice ‘yes’ indicates that the breached features would be accepted, the choice ‘no’ means that there will be a discussion between both business partners (supplier, receiver) result of which will be solving the not precise fulfillment of the planned conditions. The real situation is more complex because it has to evaluate all differences between the planned (ordered) resource characteristics and the delivered resource characteristics. Of course, different features of the resource can have different values in decision process.

From a general point of view, the most important characteristics of economic resources are the *amount of goods*, *the quality of goods*, *the price of goods* and *the time of shipment*. The fourth characteristic may be better expressed as *the shipment delay*. Of course, the most prompt to breach the planning values is the amount of goods. On the other hand, the quality of goods may also play an important role as well as the price of the goods. The importance of the shipment delay characteristic can dramatically increase even up to the uselessness of the delivered resources. The importance of this characteristic can be relatively easily modelled by the proper shape of the corresponding fuzzy set.

The structure of the paper is as follows: Section 2 defines the basic REA enterprise ontology structure. Section 3 identifies the key planning concepts and relations between them. The structure and application of fuzzy decision making is examined in Section 4. Section 5 is dedicated to uncertainty in business process modeling and Section 6 concludes the paper.

2 REA Enterprise Ontology

REA (Resources, Events and Agents) enterprise ontology is a methodology for creating enterprise infrastructure designs based on resource ownership and its exchange (Geerts and McCarthy, 2006; Hunka at al, 2011). REA enterprise ontology originated from accounting information systems but was gradually developed into full fledge tools for information system development.

The most important part of REA ontology is an REA value model that describes individual business processes. REA value model is further

specialized as an exchange or a conversion process. The whole REA value model is divided into two levels: the operational level and the policy level. The 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, Economic Event and Economic Agent.

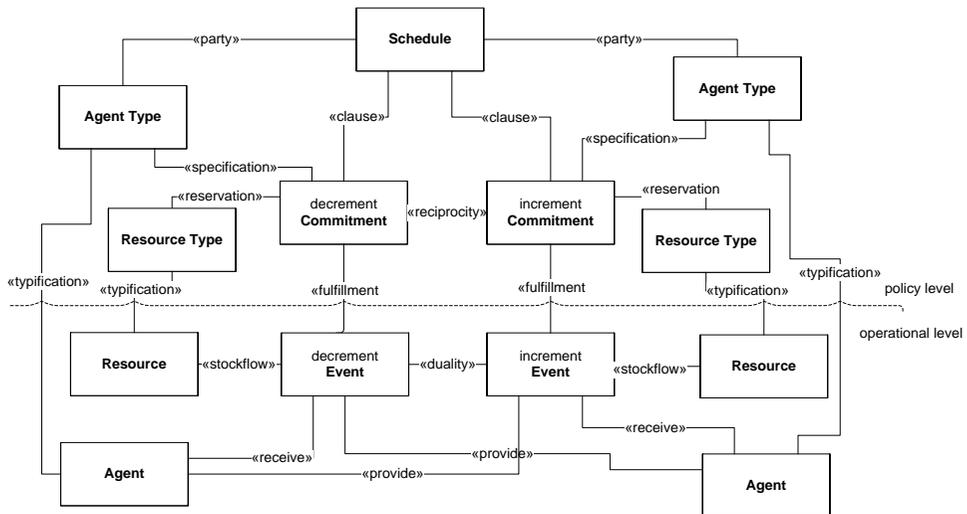


Figure 1 General structure of business process on REA model level.

Source: own.

The operational level describes what has happened. The policy level expands the operational level by the concepts and relationships that enable to describe what could, should or will happen. It contains mechanisms for expressing rules and standards as well as concepts dealing with the planning activities. Fig. 1 shows the general structure of the REA value model.

Economic resource is a basic economic entity that company wants to plan, monitor and control. Economic agent is an individual or organization capable of having control over economic resources, and transferring or receiving the control to or from other individuals or organizations. Economic event represents an exact time or a time interval, during which the value of economic resources have changed their values. If a value of the economic resource increases it is an increment economic event. If a value of the economic resource decreases it is a decrement economic event. Examples of economic events are work unit, using of services and renting.

Commitment and contract are in our approach the most important concepts at the policy level of the REA value model. Commitment is a promise or an obligation to perform economic event in the future. For example, line items on a sales order represent commitments to sell goods. Contract is a collection of increment and decrement commitments and terms. Contract can create additional commitments and can specify what should happen if the commitments are not fulfilled.

3 Planning Activities

REA ontology uses two basic concepts for planning and performance of the business activities. These concepts are an economic *commitment* and an *economic event*. An economic commitment is a promise or an obligation to perform economic event in future. We distinguish increment commitment and decrement commitment, which are related by reciprocity relationship. Commitment includes scheduled attributes.

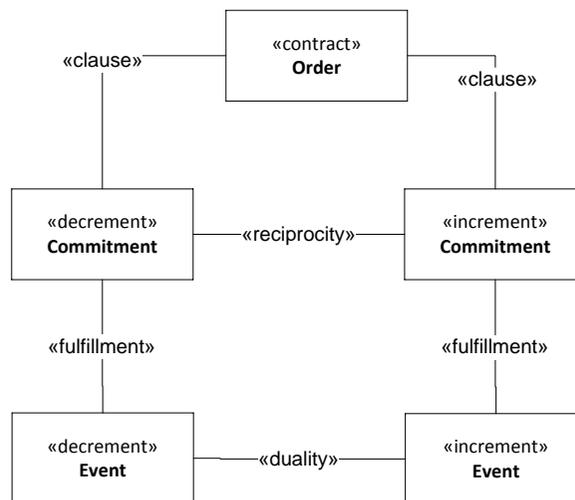


Figure 2 Core concepts of planning in the REA exchange process

Economic event represents a current time or a time period, during which transition either of resource ownerships or state of resources happens. Similarly to the commitment entity, we distinguish an increment or decrement event in relation to the value of economic resources. Increment events and decrement events are related by duality relationship. Unlike a commitment, an event has real attributes. Commitments and events are related by a fulfillment relationship. Traditionally, this relationship

is either unfilled or fulfilled. There are restrictions on this relationship. Every increment commitment must be linked to increment economic event. Every decrement commitment must be linked to decrement event. Fig. 2 illustrates the entities and the relationships between them.

The fulfillment relationship that relates the planning activities to operational activities is expressed in two states – unfilled and fulfilled and of course cancel. There are no possibilities to express other states. It does not reflect the real needs. As was mentioned, the planned and actual value may differ. It happens frequently that amount of planned resource is not exact equals to the amount of the delivered resource. The similar situation is also with other characteristics of resource such as quality, price and time of delivery. With the crisp values that are generally used it is difficult to decide to which extent the shipment was fulfilled or unfilled. We need to decide if the commitment is fulfilled. There are a number of inaccuracies and deviations that worth similar treatment. These decisions must make by expert. Fuzzy expert system could address both the uncertainty of the resource characteristics and the fact that more characteristics of resource is to be taken into account.

4 Fuzzy Decision-Making

Generally, fuzzy approach can be applied whenever there is a vague or not precise relation between different entities. The fulfillment relation that relates the commitment entity to event entity can represents such vague relationship.

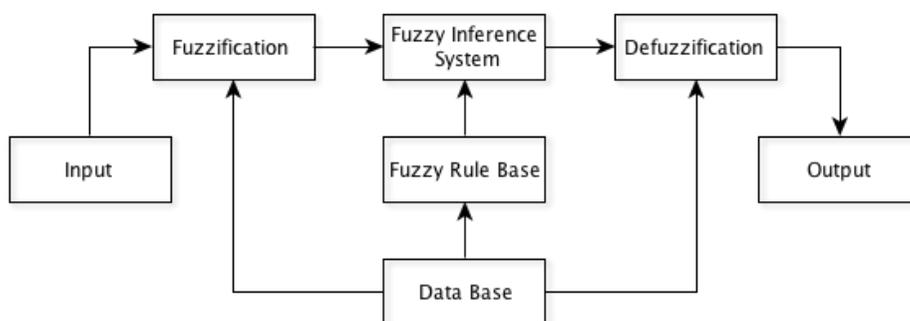


Figure 3 Fuzzy decision-making system

The solution to these problems is to design a fuzzy decision making system (expert system). The implementation of the fuzzy approach could provide better and far more practical evaluation of the fulfillment relation. A

fuzzy decision-making system that would perform these activities generally consists of five main components (Zimmermann, 1987; Deb and Bhattacharyya, 2005), see Fig. 3. The components of a fuzzy decision-making system are as follows:

- Fuzzification,
- Fuzzy rule base (Decision rules),
- Data base,
- Fuzzy inference system,
- Defuzzification.

Fuzzification represents a module that converts input values into linguistic values. Linguistic values are represented by fuzzy sets, thereby making them compatible with the fuzzy set representation in the rule base. This is conversion into natural language. Sometimes, fuzzification is preceded by a normalization step (Sousa and Kayman, 2002). Normalization maps the input values into a suitable range constituting the normalized universes of discourse used in the rule base.

Data base - this component contains membership functions of the input and output fuzzy sets. A membership function has information on the shape and the location in the universe. This membership functions are designed by the experts and can be adjusted during the checking out to meet the user's requirements.

Fuzzy rules base represents a module that contains a relation described in fuzzy terms. The set of all control rules constitutes the rule base. It is based on implementing expert knowledge in the form of IF-THEN control rules. Formula 1 shows structure of the basic rule.

$$IF x_1 \text{ is } A_{1(i)} \text{ AND } x_2 \text{ is } A_{2(i)} \text{ AND } \dots \text{ AND } x_n \text{ is } A_{p(i)} \text{ THEN } y \text{ is } B \quad (1)$$

The antecedent contains the input variable $x_1, x_2 \dots x_n$ and the linguistic values $A_1, A_2 \dots A_p$. The linguistic values are determined by fuzzy sets. The consequent contains output variable y and linguistic value B . Fuzzy rule base and Data base used to be together and are called Knowledge base.

Fuzzy inference system is utilized for progressive evaluation of the all rules and aggregates these results into one fuzzy set.

Defuzzification represents a module that converts fuzzy expressions into crisp (no fuzzy) values by using various methods. Sometimes this value must be denormalized (Sousa and Kayman), i.e., the values of the control output must be mapped onto their physical domains.

Creating an expert system requires modification of REA concepts in planning. Modified concepts must be capable of persistence. This expert system is created using LFLC 2000 (Linguistic Fuzzy Logic Controller) (Dvorak et al., 2003). It is a software tool for creating, debugging, and testing of knowledge bases consisting of IF-THEN rules.

5 Identifying Linguistic Variables and Defining a Rule Base

Firstly, suitable linguistic variables have to be identified. Linguistic variable is a term introduced by Lofti A. Zadeh. He defined a linguistic variable as a linguistic expression instead of numeric value. In the process of identifying linguistic variable it would be beneficial to identify basic linguistic variable which may be further specialized by linguistic variable modifiers. The reason for this is that the basic linguistic variables can provide a basic classification while the linguistic variable modifiers can be applied on each basic linguistic variable and thus extends expressivity for the domain experts who would address defining of the rule base. Example of the basic linguistic variable expressing the difference between the ordered feature of the resource and the real feature of the delivered resource can be: *Zero, Small, Medium* and *Big*. Example of linguistic variable modifiers can be: *Very very roughly, Typically, Rather, Very roughly, Quite roughly, Roughly, More or Less, Very, Significantly, Extreme*.

By the combination of the basic linguistic variables and modifiers domain experts can assign specific linguistic variables to every parameter related to invoice. Every parameter domain can be described in this way, for example: the difference between ordered and delivered quantity is very small, quality of delivered goods is very small, the difference between planned price and invoice price is zero, shipping delay is very roughly small.

The further step is to define the rule base of the expert system. Proposed expert system realizes decision making process. The core of the expert system is the knowledge base containing the rules. Expert system utilizes the fuzzy

rules to make decisions regarding to the input linguistic values. Fuzzy rules are the core concept of the fuzzy sets and fuzzy modeling application. In general, fuzzy IF-THEN rules are utilized in the form presented in previous section.

Base on this form we can establish a rule base and perform a logic deduction:

$$R_1 := \text{IF } (x \in A_1) \text{ THEN } (y \in B_1) \text{ AND} \quad (2)$$

$$R_2 := \text{IF } (x \in A_2) \text{ THEN } (y \in B_2) \text{ AND}$$

$$R_3 := \text{IF } (x \in A_3) \text{ THEN } (y \in B_3) \text{ AND}$$

$$R_4 := \text{IF } (x \in A_4) \text{ THEN } (y \in B_4)$$

The fulfillment relationship that associates commitment entity to event entity is many times slightly breached which brings about problems how to evaluate this relationship. Firstly, we identify the resource attributes candidates suitable for fuzzy decision system. The most prominent attribute is by all means the attribute amount. By our experience, this attribute used to be mostly breached. The other less important attributes are quality, price and time of shipment. These attributes differ in their character and of course their importance. All these factors have to be taken into account in the knowledge base creation.

The other important point is that the importance these attributes will be different with different kind of resources. However, we can use the ability of the fuzzy knowledge base to be “adapted” to different environments. It means that the rule base of the knowledge base can be the same for different resources but it will differ in the data base. In this case, the data base represents the shape and the placement of the fuzzy sets within the universe. By this approach, a number of different data bases can be created and each of them will represent a particular case.

6 Conclusion

The goal of the paper is to present integration of uncertainty into business process modeling. REA value modeling approach is utilized as an underlying framework. The uncertainty pertains to the fulfillment relationships relating the commitment entity to the event entity. Actually, it concerns the planned

characteristics of the resource and the real (operational) characteristic of the delivered resource, which may be in some aspects breached. The implementation itself requires identification of linguistic variables and setting up a rule base by a domain expert. The distinction between a rule base and a database makes it easy to adopt this system to a slightly different environment where the linguistic variables can have to some extent a different meaning. Proposed solution enables to follow more characteristic features of the resource entities and it aims at making the decision making process more versatile.

Acknowledgements

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Tasks for an Intelligent System with Temporal Knowledge Base, Supporting Organizational Creativity

Maria Mach-Król¹

Abstract. The paper is devoted to the tasks to be fulfilled by an intelligent system with a temporal knowledge base, which is planned to support organizational creativity processes. This creativity has to be perceived in the context of organization's dynamics, because it depends on situational changes, and is composed of processes. Therefore, while discussing the question of computer support of organizational creativity, the temporal aspects have to be taken into account.

The main goal of this paper is an attempt for formulating postulates concerning the tasks of a temporal intelligent system, if it is to efficiently support the creative process of an organization. Therefore, the motivation for supporting organizational creativity with an intelligent system having a temporal knowledge base is presented, the existing computer solutions aimed at supporting this area is discussed, and finally the tasks of the intelligent temporal system are pointed out in the context of dynamic organizational creativity.

Keywords: organizational creativity, intelligent system with temporal knowledge base, time.

JEL Classification: O31, D83

1 Introduction

Organizational creativity is a relatively new concept in the theory of management, which partially arose on the ground of knowledge management.

There are many definitions of organizational creativity, but it is commonly perceived as a team, dynamic activity, responding to changing features of organization's environment, a team process – see e.g. (Unsworth, 2001), (Andriopoulos & Dawson, 2014).

The organizational creativity is therefore to be perceived in the context of organizational dynamics, because it depends on the situational changes and

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is composed of processes. Therefore while discussing the question of computer support for organizational creativity, the temporal aspects may not be omitted.

Such a way of formulating this problem – underlining its dynamic aspect – justifies a proposal of using an intelligent system with a temporal knowledge base, as a tool supporting creation and development of organizational creativity, which is understood as organizational asset (Krupski, 2011; Sirmon, et al., 2011).

By the system with a temporal knowledge base we will understand (slightly modifying the definition given in (Mach, 2007) an artificial intelligence system, which explicitly performs temporal reasoning. Such a system contains not only fact base, rule base, and inference engine, but also directly addresses the question of time. For an intelligent system to be temporal, it should contain explicit time representations in its knowledge base – formalized by the means of temporal logics – and at least in the representation and reasoning layers.

The main aim of the paper is an attempt of formulating the tasks for a temporal intelligent system, if it is to efficiently support the creative process in an organization.

The paper is organized as follows. In section 2 the motivation for supporting organizational creativity by a system with a temporal knowledge base is presented. Section 3 is devoted to a general discussion on computer support of creative processes. The next section presents tasks for an intelligent system with a temporal knowledge base, in the context of dynamic organizational creativity. The last section contains concluding remarks.

2 Motivation

While discussing the use of any computer tool, one has to take into account first of all the features of the domain to be supported. This applies also to systems with a temporal knowledge base and their application in supporting organizational creativity.

Some elements that justify the use of an intelligent tool with direct time references, may be found in the definitions of organizational creativity:

- (Woodman, et al., 1993) and (Shalley, et al., 2000) claim that the effects of organizational creativity encompass ideas and processes – which in our opinion should be referred to as *creative knowledge*. The knowledge is to be codified and stored in a knowledge base, and because it is a changing knowledge, the knowledge be should be a temporal one;
- In the definition given by (Amabile, 1996) the author points out that organizational creativity is more heuristic than algorithmic in nature (p. 33) – therefore it is not possible to use classical analytical tools, because heuristic tasks lack of algorithmic structure, they are complex and uncertain (Aggarwal, 2001, p. 6);
- (Unsworth, 2001) suggests that ideas born during creative processes (that is, the creative knowledge) must be adequate to the situation (p. 289). Therefore they have to change *dynamically*, because the situation of organization also constantly changes;
- The changeability, dynamics, and process nature of organizational creativity, which justify its codification in a temporal knowledge base, are stressed in definitions given by (Martins & Terblanche, 2003), (Alvarado, 2006), (Hirst, et al., 2009), (Baer, 2012), (Basadur, et al., 2012);
- (Andriopoulos & Dawson, 2014) point out that organizational creativity must be analyzed on individual, group, and organizational levels. This justifies the use of a knowledge base: if the creativity (its effects) is to penetrate between the levels, to support collaboration, a system with a temporal knowledge base enables such penetration;
- The justification for using temporal formalisms for codifying of creative knowledge may be found in the definitions given by (Mumford, et al., 2011), and (Mumford, et al., 2012), where authors point the badly structured nature of creative problems. One of temporal formalisms' advantages is the possibility to formalize unstructured problems.

While reading many authors' discussions on the essence of organizational creativity, one sees that this is primarily team activity. As it has been said above, the effect of this activity may be referred to as “creative knowledge”, which itself generates new ideas, concepts, and solutions. To do so, the creative knowledge must be first codified, and next

disseminated. This justifies the use of a knowledge base system. But the creative knowledge changes in time, due to several reasons.

First, organizational creativity is a *process*, therefore its effects are subject to change. Moreover, the process encompasses solving problems that also change, because the organization's environment changes (Mach, 2007, p. 13-15), (Czaja, 2011, p. 150, 176).

Second, each knowledge – including the creative one – changes simply with the passage of time, with the flow of new information about objects (van Benthem, 1995).

Third, organizational creativity is linked with dynamics, which can be seen e.g. in the assets approach to this creativity or in the requirement of adapting creative knowledge to situational context.

The assets view of organizational knowledge and creativity the dynamics is expressed by a constant improvement of these assets to keep up with the changes in organizations and their environment – see e.g. (Krupski, 2011). In this way organizations adapt themselves to changes (Sirmon, et al., 2011). Such an adaptation occurs in time, therefore organizational creativity is connected with temporality. Moreover, assets must be developed up, therefore organizational creativity and its artifacts are dynamic.

The efforts of capturing assets' dynamics may be seen in such areas, as assets' approach, dynamic econometrics – see e.g. (Jakubczyc, 1996) or dynamic economics – see e.g. (Adda & Cooper, 2003). But these are solutions aimed only at codification and analysis of quantitative phenomena. Knowledge – including the creative one – is of qualitative nature, therefore to codify, to analyze, and to reason about it qualitative tools are needed. One of such tools is temporal logic, which enables to formalize qualitative knowledge, and also considers time. This tool is used to formalize knowledge in temporal knowledge bases. The detailed discussion on different temporal formalisms may be found e.g. in (van Benthem, 1995), (Klimek, 1999) or (Fisher, et al., 2005).

All the above leads to conclusion that a knowledge base system is not enough to support organizational creativity, because classical knowledge bases do not support time. Therefore in this paper we propose the use of a temporal knowledge base system, as defined earlier. Such system is able to perform the

tasks arising from the characteristics of organizational creativity and its artifacts.

3 Computer support for creative processes

In section 2 the main characteristics of organizational creativity, that justify the use of systems with temporal knowledge base were pointed out. It is then necessary to discuss, what specific tasks should such a system perform.

Authors describing computer support of creative processes (but not yet organizational creativity) postulate some features of a computer tool for this task. For example Proctor (Proctor, 2002, p. 264) claims, that a computer tool should:

- facilitate the movement between stages of creative problem solving,
- provide mechanisms stimulating creative thinking – e.g. collect ideas, create maps of connections between these ideas, etc.,
- provide structure for supporting creative process, e.g. facilitate problems' classification.

Similarly, R. L. Glass postulates the following functions of computer systems supporting creative processes (Stanek & Pańkowska, 2010, p. 37):

- facilitate brainstorming,
- recombination of ideas,
- assign ranges to ideas, according to different criteria,
- identify interdependences.

Other authors enumerate also such tasks, as providing “if-then” analysis, data and processes visualization, dissemination of creative process' effects, enabling a human-computer dialogue to solve problems (Lubart, 2005).

In the context of the above, specific attention has to be paid to such tasks of a system with temporal knowledge base:

- collecting of ideas and showing of relationships between them – because this constitutes a temporal knowledge, which can be formalized with temporal logics,
- problems' classification – which may be conducted by a properly designed temporal reasoning engine,

- identification of interdependences and “what-if” analysis – these are classical temporal reasoning tasks,
- a human-computer dialogue during the creative process – this is a classic task for an expert system, and systems with temporal knowledge base are a specific subset of expert systems.

If we consider characteristics of organizational creativity, resulting from its definitions and different approaches (e.g. assets approach, process approach), the following tasks for a system with temporal knowledge base may be formulated:

- a system with the temporal knowledge base should serve as an advisory tool in the process of organizational creativity, understood as a cognitive process, focused at problem solving. The system should help to analyze organization’s situation, to codify both situational and creative knowledge, and to reason about changes of both types of knowledge, especially the situational one, because this kind of knowledge governs the activities of creative teams, therefore influencing the process of generating creative knowledge;
- among the factors influencing organizational creativity there is the effective system of communication (Andriopoulos, 2001). The system with a temporal knowledge base, thank to codification of creative knowledge, should enable an easy knowledge access and knowledge dissemination. And having the possibility to analyze situational knowledge and its changes, such a system will facilitate so-called scenario analyzes, thus stimulating the development of creative knowledge, in response to organization’s situation;
- similar tasks are linked with the fact, that one of the features of creative organization is “the easy and common access to tall kinds of assets needed to perform creative activities, e.g. to information assets” (Szwiec, 2005) p. 13. A system with temporal knowledge base should enable: access to situational knowledge, access to creative knowledge, situational analyzes, forecasts of the development of creative knowledge;
- the system should take the time aspect into account, both in the context of changes of organization’s situation (which determines the process of organizational creativity), and in the context of changes of assets having the form of creative knowledge;

- the system should aid in the development of organization's dynamic capabilities, and mainly the adaptive capability, understood as the capability of adjusting itself to changes in the environment as well as adjusting the assets to environmental requirements – see e.g. (Wang & Pervaiz, 2007). The temporal system is of adaptive nature by definition, so it should adjust and update its knowledge base(s) to the changes in environment, in situation, in knowledge, thus being independent from human's errors and speeding up the process of reflecting in the representation layer the mentioned changes.

The above list of tasks may be extended in the context of not only organizational creativity, and creative knowledge, but in a more general context of capturing changes in organization's situation, which affect the processes of organizational creativity (Unsworth, 2001). The next section of the paper is devoted to this question.

4 Tasks for the system with temporal knowledge base in the context of dynamic situation of a creative organization

The system with a temporal knowledge base should enable a complete analysis of organization's situation in order to adjust properly the directions of organizational creativity. The "complete" analysis means analysis, that enables: placing situations in time, information on past, present and anticipated changes, which is linked with historical analysis, analysis of current trends, and analysis of future changes. Also the causal relationships between phenomena in organization's environment must be taken into account, because their analysis is means of their proper assessment. Such an analysis enables quicker decisions on organizational creativity directions, also the probability of accurate decisions will raise. Generally speaking, the analysis of organization's situation should be a temporal one, that is analysis diverted onto past, present, and future changes of the domain, placed explicitly in the temporal context, where time is a crucial dimension. From this definition follow other characteristics of temporal analysis, enumerated earlier, e.g. explicit and direct account of causal relationships in the analyzed domain.

In the perspective of organizational creativity, the intelligent temporal analysis encompasses:

- representation of changing phenomena linked with organization's situation,
- representation of both qualitative and quantitative phenomena,
- analysis of current situation,
- tracking situation's evolution,
- capturing of causal relationships,
- analysis of future changes in situation.

The tool for such analysis should enable:

- representation of time – discrete and/or dense (depending on the nature of phenomena being analyzed),
- representation of causal laws that link actions and/or phenomena with their effects, conditions under which action may be performed, complex actions and procedures,
- representation of organizational creativity processes, including parallel and conditional ones,
- analysis of anticipated changes,
- reasoning on what will happen or what may happen.

Organization's situation is never deterministic, therefore is not easy to apply classic analytical tools (Aggarwal, 2001). This results mainly from the fact that situation is generally difficult to be represented algorithmically – it lacks algorithmic structure, and is linked with uncertainty, and the tasks of its analysis is multidimensional and complex.

Organizational creativity, and creative knowledge both are of qualitative nature, thus they have to be represented and reasoned on also in a qualitative manner. Qualitative reasoning, and qualitative representation enable among others (Gatnar, 1994):

- modeling with incomplete information,
- possibility of using even bad quality data,
- simulating human reasoning and perception.

Creative knowledge, as a product of organizational creativity processes, is a heterogeneous knowledge. This results from several reasons.

First, organizational creativity is a team process (Woodman, et al., 1993), thus each member of a team, each subgroup may generate his own „part” of creative knowledge.

Second, organizational creativity is present on different organizational levels (Andriopoulos & Dawson, 2014), also generating separate fragments of creative knowledge.

Third, organizational creativity refers to solving different problems (Mumford, et al., 2011), each of which has different characteristics and structure, resulting in heterogeneity of solutions.

Therefore, the system with temporal knowledge base has to take this heterogeneity of creative knowledge into consideration, by performing the following tasks:

- a proper representation of creative knowledge fragments, considering their diversity and temporal aspects. This task is needed for a full formal account of knowledge resulting from creative processes in organization, depending on organizational situation and problems to be solved;
- unification of representations for a further, more general reasoning. The aim of this task is to provide a general view of organizational creativity, thus enabling reasoning on it. The integration process should be performed in a way that the system has also access to information on knowledge fragments, in order to reason in detail;
- performing historical analysis, examining changes in time of organizational creativity artifacts, current diagnosis, and analysis of anticipated changes – that is, enabling of temporal analysis.

While creating the system with temporal knowledge base, supporting organizational knowledge, the following questions should be taken into account:

- construction of representational layer in order to properly represent organizational creativity artifacts, and knowledge on organization's situation;
- construction of creative knowledge base(s) manipulation mechanism, enabling coherence, reliability, and topicality of this knowledge;
- construction of inference mechanism that will be capable of performing analytical tasks described above, and that will enable the use of codified creative knowledge.

The direct questions of building the system are out of the scope of this paper.

5 Concluding remarks

Organizational creativity is a complex, dynamic, and unstructured process that needs a specific computer support. A tool used for this task must enable a proper account of time and a possibility of formalizing temporal creative knowledge. Therefore it is necessary to define concrete tasks for the system supporting organizational creativity. In the paper an attempt for formulating such tasks has been done, taking into consideration the features of organizational creativity, the creative knowledge, and the processes of its generation.

The next research steps will concern such questions, as analysis of existing computer solutions in the context of the formulated tasks, building a system with temporal knowledge base, analysis of the circumstances for using such a system, methodology of implementing the system, and measurement of efficacy of the implemented computer solution.

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Modelling and Forecasting of WIG20 Stock Index

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Abstract. We examine the ARIMA-ARCH type models for the volatility and forecasting models of Polish WIG20 stock indexes based on statistical (stochastic), machine learning methods and an intelligent methodology based on soft or granular computing and make comparisons with the class of RBF neural network and SVR models. To illustrate the forecasting performance of these approaches the learning aspects of RBF networks are presented. We show a new approach of function estimation for nonlinear time series model by means of a granular neural network based on Gaussian activation function modeled by cloud concept. In a comparative study is shown that the presented approach is able to model and predict high frequency data with reasonable accuracy and more efficient than statistical methods.

Keywords: Time series, classes ARCH-GARCH models, volatility, forecasting, neural networks, cloud concept, forecast accuracy granular computing.

JEL Classification: C13, C45, D81, G32

1 Introduction

Over the past ten years academics of computer science have developed new soft techniques based on latest information technologies such as soft, neural and granular computing to help predict future values of high frequency financial data. At the same time, the field of financial econometrics has undergone various new developments, especially in finance models, stochastic volatility, and software availability.

This paper analyses, discusses and compares the forecast accuracy from nonlinear models which are derived from competing statistical and Radial Basic Function (RBF) neural network (NN) specifications. Our motivation for this comparative study lies in both the difficulty for constructing of appropriate statistical Autoregressive/Generalised Conditionally Heteroscedastic (ARCH-GARCH) models (so called hard computing) to forecast volatility even

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in ex post simulations and the recently emerging problem-solving methods that achieve low solution costs (soft computing).

In economics and in particular in the field of financial markets, forecasting is very important because forecasting is an essential instrument to operate day by day in the economic environment. In companies, medium and small enterprises, selecting an appropriate forecasting algorithms or methods is important in terms of forecast accuracy and efficiency. Therefore, it is important to search available information technologies to get optimum forecasting models.

The paper is organized in following manner. In Section 2 we briefly describe the basic methodology of ARIMA (Autoregressive Integrated Moving Average), ARCH-GARCH (Generally Autoregressive Conditionally Heteroscedastic) models. In Section 3 we present some RBF type models and models based on SVM (Support Vector learning Machine) learning for financial data. Section 4 analyses the data, builds statistical and RBF NN forecasting models. Section 5 puts an empirical comparison and assesses predictive accuracy of developed models. Section 6 briefly concludes.

2 Econometric, ARIMA and some arch-garch Models for Financial Data

The econometric approach adopted from early days of econometrics is referred to as “AER” or Average Economic Regression (see Kennedy 1992 and Holden 2011) is concerned with the functional form of the multiple regression model in the form

$$y_t = \beta_0 + \beta_1 x_{1t} + \dots + \beta_p x_{pt} + u_t \quad (1)$$

where x_{it} represent a series of independent variables, β_0 regression intercept, β_i partial regression coefficients, for $i = 1, \dots, p$, u_t random error term, for $t = 1, \dots, N$.

In many cases economic theory do not give the assumption above the functional form of the model, or the assumption of independent errors and hence independent observations y_t is frequently unwarranted. If this is the case, forecasting models based on AER may be inappropriate. Box and Jenkins

(1970) developed a new modeling approach based on time series analysis and derived from the linear filter known as AR or ARIMA (AutoRegressive Integrated Moving Average) models. The fundamental aim of time series analysis is to understand the underlying mechanism that generates the observed data and, in turn, to forecast future values of the series. Given the unknowns that affect the observed values in time series, it is natural to suppose that the generating mechanism is probabilistic and to model time series as stochastic processes. An ARMA(p, q) model of orders p and q is defined by

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_q \varepsilon_{t-q} \quad (2)$$

where $\{\phi_i\}$ and $\{\theta_i\}$ are the parameters of the autoregressive and moving average parts respectively, and ε_t is white noise with mean zero and variance σ^2 . We assume ε_t is normally distributed, that is, $\varepsilon_t \sim N(0, \sigma^2)$. ARIMA(p, d, q) then represents the d th difference of the original series as a process containing p autoregressive and q moving average parameters. The method of building an appropriate time series forecast model is an iterative procedure that consists of the implementation of several steps. The main four steps are: identification, estimation, diagnostic checking, and forecasting. For details see Box and Jenkins (1970).

The first model that provides a systematic framework for volatility modelling is the ARCH model was proposed by Engle (1982). Bollerslev (1986) proposed a useful extension of Engle's ARCH model known as the generalized ARCH (GARCH) model for time sequence $\{\varepsilon_t\}$ in the following form

$$\varepsilon_t = v_t \sqrt{h_t}, \quad h_t = \alpha_0 + \sum_{i=1}^m \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^s \beta_j h_{t-j} \quad (2)$$

where $\{v_t\}$ is a sequence of IID (Independent Identical Distribution) random variables with zero mean and unit variance. α_i and β_j are the ARCH and GARCH parameters, h_t represent the conditional variance of time series. Nelson (1991) proposed the following exponential GARCH model abbreviated as EGARCH to allow for leverage effects in the form

$$\log h_t = \alpha_0 + \sum_{i=1}^p \alpha_i \frac{|\varepsilon_{t-i}| + \gamma_i \varepsilon_{t-i}}{\sigma_{t-i}} + \sum_{j=1}^q \beta_j h_{t-j} \quad (3)$$

The basic GARCH model can be extended to allow for leverage effects. This is performed by treating the basic GARCH model as a special case of the power GARCH (PGARCH) model proposed by Ding, Granger and Engle (1993):

$$\sigma_t^d = \alpha_0 + \sum_{i=1}^p \alpha_i (|\varepsilon_{t-i}| + \gamma_i \varepsilon_{t-i})^d + \sum_{j=1}^q \beta_j \sigma_{t-j}^d \quad (4)$$

where d is a positive exponent, and γ_i denotes the coefficient of leverage effects [6]. Detailed procedure for parameter estimation of these models and investigate response investigation of equity volatility to return shock for WIG20 time series can be found in Seda (2011).

3 Soft Computing Models

In this section we briefly introduce two models belonging to soft computing methods: the RBF NN and SVR model. The first model show a new approach of function estimation for time series modeled by means a granular RBF neural network based on Gaussian activation function modeled by cloud concept (Cloud Activation Function - CAF – see Li (2008)). We proposed the neural architecture according to Figure 1.

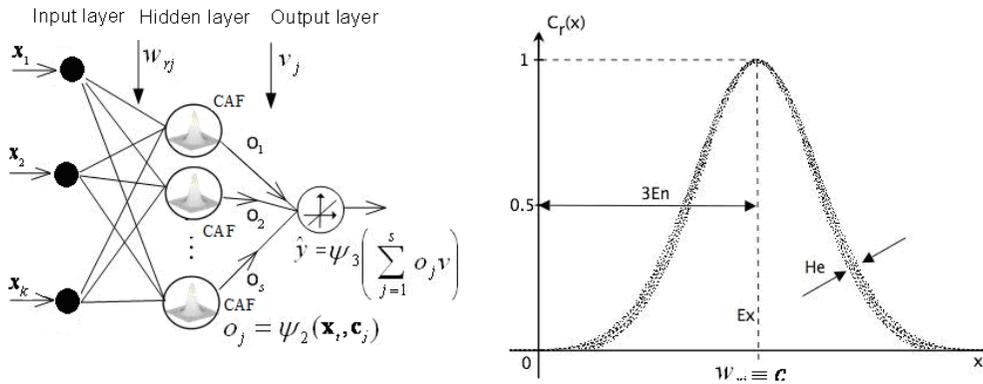


Figure 1 RBF neural network architecture (in the left). Cloud Activation Function (right). Source: own.

The RBF network computes the output data set as

$$\hat{y}_t = G(\mathbf{x}_t, \mathbf{c}, \mathbf{v}) = \sum_{j=1}^s v_{j,t} \psi_2(\mathbf{x}_t, \mathbf{c}_j) = \sum_{j=1}^s v_j o_{j,t}, \quad t = 1, 2, \dots, N \quad (5)$$

where \mathbf{x} is a k -dimensional neural input vector, \mathbf{w}_j represents the hidden layer weights (parameters), ψ_2 are radial basis (Gaussian) activation functions, v_j are the trainable weights (parameters) connecting the component of the output vector \mathbf{o} . Weights can be adapted (estimated) by the error back-propagation algorithm. 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 the learning rule has the form

$$v_{j,t} \leftarrow v_{j,t} + \eta o_{j,t} e_t, \quad j = 1, 2, \dots, s, \quad t = 1, 2, \dots, N \quad (6)$$

where the term, $\eta \in (0,1)$ is a constant called the learning rate parameter, $o_{j,t}$ is the output signal from the hidden layer.

We also replaced the standard Gaussian activation (membership) function of RBF neurons with functions (see Fig. 1 right) based on the normal cloud concept (see [10] p. 113). Cloud models are described by three numerical characteristics: expectation (Ex) as most typical sample which represents a qualitative concept, entropy (En) and hyper entropy (He) which represents the uncertain degree of entropy. Then, in the case of soft RBF network, the Gaussian membership function $\psi_2(\cdot/\cdot)$ in Eq. (5) has the form

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

where En' is a normally distributed random number with mean En and standard deviation He , E is the expectation operator. For details see Marček et al (2008) and Vapnik (1986).

Nonlinear SVR is frequently interpreted by using the training data set $\{y_k, \mathbf{x}_k\}_{k=1}^N$ with input data $\mathbf{x}_k \in \mathfrak{R}^N$ and output data $y_k \in \mathfrak{R}$ as follows

$$f(\mathbf{x}, \mathbf{w}, b) = \sum_{i=1}^N \mathbf{w}_i \varphi_i(\mathbf{x}) + b \quad (8)$$

where $\varphi_i(\mathbf{x})$ are called features (the input data are projected to a higher dimensional feature space). In order to perform SVM regression one optimizes the cost (empirical risk) function

$$R_{emp} = \frac{1}{N} \sum_{i=1}^N |y_i - f(\mathbf{x}, \mathbf{w})|_e \quad (9)$$

which leads to solving of the quadratic optimization problem. More information can be found in Vapnik (1986).

4 Building a statistical vs. soft computing prediction model for WIG20 values

To build a forecast model the sample period, we divided the basic period into two periods. First period (as the training data set) was defined from January 2004 to the end of June 2007, i.e. the time before the global financial crisis or pre crisis period, and the second one so called post crisis period (validation data set or ex post period) started at the beginning of July 2007 and finished by the March 8, 2012². Visual inspection of the time plot of the daily values of WIG20 index (see Fig. 2). The daily time series depicted in Fig. 2 exhibits non-stationary behavior. However, as was confirmed by ADF test (see Tab. 1) its first differencing become stationary.

Table 1 The results of ADF test applied to the WIG20 time series values

ADF test	t-statistics	<i>p</i> -value
Original WIG20 time series values	-1.881134	0.3415
WIG20 time series (first differences)	-45.55257	0.0001

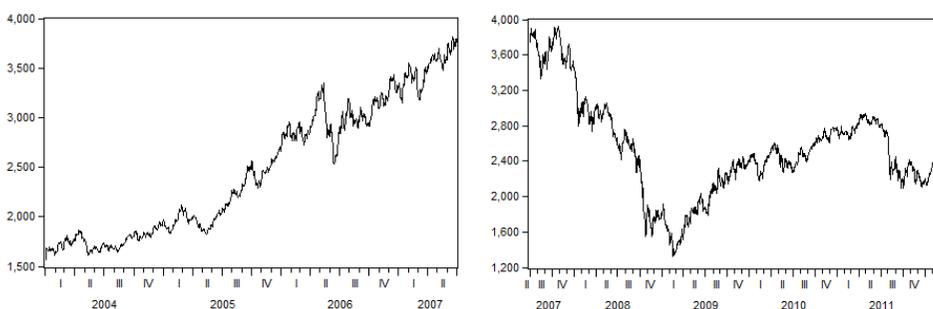


Figure 2 Time series of the daily closing prices of WIG20 index. Left period (1.2004 – 6.2007), right period (7. 2007 – March 8, 2012).

Input (independent variables) selection is crucial importance to the successful development of an ARIMA/ARCH–GARCH model. Potential inputs were chosen based on traditional statistical analysis: these included the BUX indices and lags thereof. The relevant lag structure of potential inputs

² This time series can be obtained from <http://www.wse.com.pl>.

was analysed using traditional statistical tools, i.e. using the autocorrelation function (ACF), partial autocorrelation function (PACF). According to these criterions the ARIMA(1,1,0) model was specified as follow

$$\Delta y_t = \xi + \phi_1 \Delta y_{t-1} + \varepsilon_t \quad (10)$$

where Δ is the difference operator defined as $\Delta y_t = y_t - y_{t-1}$. Estimated parameters of specified ARIMA(1,1,0) model are reported in Tab. 2.

Table 2 Estimated mean (Eq. 11) for BUX values.

Coeff.	Value	St. dev.	p-value	D-W
ξ	3.938362	5.899953	0.5045	1.994470
ϕ_1	0.047107	0.019045	0.0134	

As we mentioned early, high frequency financial data, like our WIG20 time series, reflect a stylized fact of changing variance over time. An appropriate model that would account for conditional heteroscedasticity should be able to remove possible nonlinear pattern in the data. Various procedures are available to test an existence of ARCH-type model. A commonly used test is the LM (Lagrange Multiplier) test. The LM test assumes the null hypothesis $H_0: \alpha_1 = \alpha_2 = \dots = \alpha_p = 0$ that there is no ARCH. The LM statistics has an asymptotic χ^2 distribution with p degrees of freedom under the null hypothesis. The ARCH-LM test up to 10 lags was statistically significant of the mean equation (10). For calculating the LM statistics see for example [4].

For estimation of the parameters of GARCH type model the maximum likelihood procedure was used and resulted into the following variance equation:

$$h_t = \alpha_0 + \sum_{i=1}^m \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^s \beta_j h_{t-j} = 675.0 + 0.125 \varepsilon_t^2 + 0.854 h_{t-1}. \quad (11)$$

Furthermore, to test for nonlinear patterns in WIG20 time series the fitted standardized residuals $\hat{\varepsilon}_t = e_t / \sqrt{h_t}$ were subjected to the BDS test. The BDS test (at dimensions $N = 2, 3$ and tolerance distances $\varepsilon = 0.5, 1.0, 1.5, 2.0$) finds no evidence of nonlinearity in standardized residuals of the WIG20 time series. Next, the variance model given by Eq. (11) was re-estimated considering that the residuals follow a Student's distribution, and after GED. The model with the lowest value of AIC fits the data best. Table 3 presents AIC, log likelihood functions (LL) in all cases.

Table 3 . Information criteria and log-likelihood functions for re-estimated asymmetric variance models.

Model:	PGARCH	EGARCH	Distribution
Criteria			
Period: 1.2004 - 6.2007			
AIC	9.5853	9.3838	Student's
LL	-4353.294	-4353.642	
AIC	5.5728	5.5717	GED
LL	-4347.636	-4348.162	

As we can see in Table 3 the smallest AIC has just the EGARCH(1,1) with GED distribution. After these findings we re-estimate the mean Eq. (10) assuming that the random component ε_t follow EGARCH(1,1) GED. The final estimated prediction model has the form

$$\Delta y_t = 2.0492 - 0.0462_1 \Delta y_{t-1} + \varepsilon_t \quad (\text{GED}) \quad (12)$$

Actual and fitted values of WIG20 index calculated according to model (12) are shown in Figure 3. The granular RBF NN was trained using the variables and data sets as the ARIMA(1,1,0)/GARCH(1,1) model (10). In G RBF NN, the non-linear forecasting function $f(\mathbf{x})$ was estimated according to the expressions (5) with RB function $\psi_2(\cdot)$ given by Eq. (7). The detailed computational algorithm for ex post forecast RMSE values and the weight update rule for the granular network. The fitted vs. actual EUR/USD exchange rates for the validation data set are graphically displayed in Figure 4 (in middle).

The prediction of WIG20 values for the post-crisis period was also done by SVR model using *gretl software*³. *Gretl software* is the implementation of Vapnik's Super Vector Machine for the problem of pattern recognition, regression and ranking function. The fitted vs. actual values of the WIG20 time series for the validation data set (post-crisis period) are graphically displayed in Figure 4 right.

³ See <http://gretl.sourceforge.net>

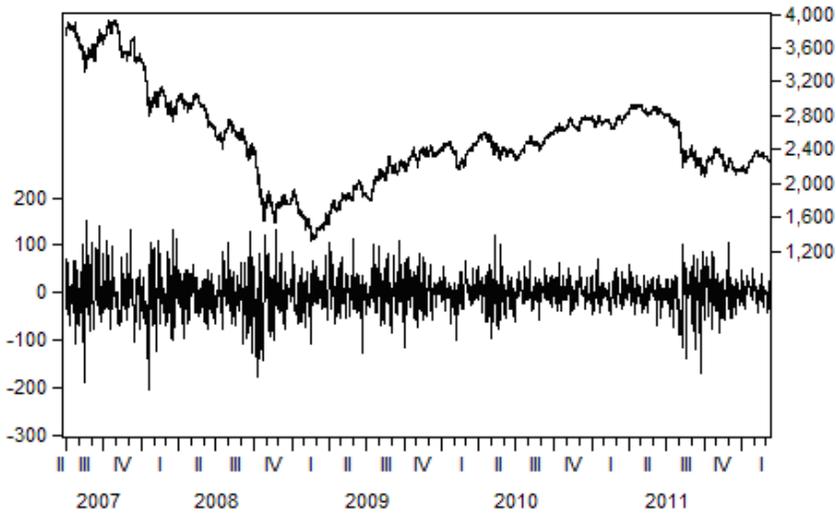


Figure 3 Actual and fitted values of the WIG20 index. Residuals are at the bottom. Actual time series represents the solid line, the fitted vales represents the dotted line (statistical approach).

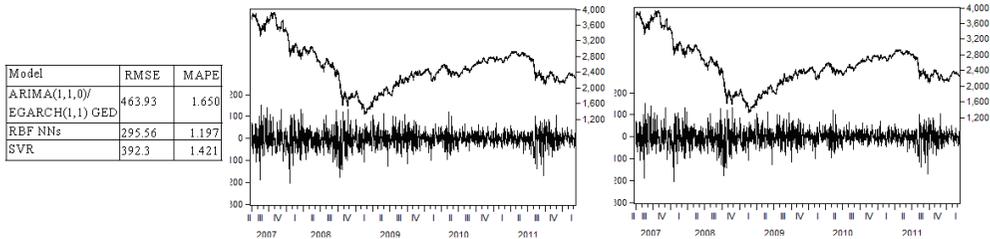


Figure 4 Table in the left presents the summary statistics of each model based on RMSE and MAPE calculated over the validation data set (ex post period). Actual and fitted values of the WIG20 index for G RBF NN (in middle)) and for SVR model (right). Residuals are at the bottom. Actual time series represents the solid line, the fitted vales represents the dotted line.

5 Empirical Comparison and Discussion

Table in Fig. 4 on the left presents the summary statistics of each model based on RMSE and MAPE calculated over the validation data set (ex post period). This table shows the results of the methods used for comparison. The best performing method is G RBF NN followed SVR. A comparison between latest statistical and intelligent methods shows that intelligent prediction methods outperformed the latest statistical forecasting method. Further, from table in Fig. 4 left it is shown that both forecasting models used are very accurate. The development of the error rates on the validation data set showed a high inherent deterministic relationship of the underlying variables. Though promising

results have been achieved with all approaches, for the chaotic financial markets a purely linear (statistical) approach for modelling relationships does not reflect the reality. For example if investors do not react to a small change in exchange rate at the first instance, but after crossing a certain interval or threshold react all the more, then a non-linear relationship between Δy_t and Δy_{t-1} exist in model (10).

6 Conclusion

In managerial decision-making, risk and uncertainty are the central categories based on which the effects of individual variants are assessed, and subsequently the final decision is chosen from several variants. In the present paper we proposed two approaches for predicting the BUX time series. The first one was based on the latest statistical ARIMA/ARCH methodologies, the second one on neural version of the statistical model and SVR.

After performed demonstration it was established that forecasting model based on SVR model is better than ARIMA/ARCH one to predict high frequency financial data for the BUX time series.

The direct comparison of forecast accuracies between statistical ARCH-GARCH forecasting models and its neural representation, the experiment with high frequency financial data indicates that all investigated methodologies yield very little MAPE (Mean Percentage Absolute Error) values. Moreover, our experiments show that neural forecasting systems are economical and computational very efficient, well suited for high frequency forecasting. Therefore they are suitable for financial institutions, companies, medium and small enterprises.

The results of the study showed that there are more ways of approaching the issue of risk reducing in managerial decision-making in companies, financial institutions and small enterprises. It was also proved that it is possible to achieve significant risk reduction in managerial decision-making by applying modern forecasting models based on information technology such as neural networks developed within artificial intelligence. In future research we plan to extend presented methodologies by applying fuzzy logic systems to incorporate structured human knowledge into workable learning algorithms.

Acknowledgement

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The Effect of Standards on Corporate Informatics Management

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Abstract. This article describes selected management standards used in corporate informatics and outside this field and analyses their interactions and substitutability. The authors focus on selected characteristics of the standards.

Methodologies and standards, even if they are not designed for information technologies, are frequently used in the area of information technologies. The prerequisite for a company satisfied with its corporate informatics is that the corporate informatics delivers services meeting the requirements of business service users in terms of quality and price.

The analysed standards have common characteristics and in many areas they overlap. This assertion applies in particular to the standards ITIL, CobiT and ISO/IEC 26000, which cover all levels and areas of corporate informatics management and can be used, in part, to manage a company as such.

Keywords: Management Standards, Corporate ICT, ITIL, CobiT, ISO/IEC 26000, Quality Management.

JEL Classification: M1410, M150, M11, M12, O32, L86.

1 Introduction

The current situation in the area of management methodologies and standards is characterised by their great number and heterogeneity. This fact creates problems with differing or ambiguous terminologies, individual methodologies and standards overlapping in meaning, and, in some cases, their inconsistency.

Methodologies and standards, even if they are not designed for information technologies, are frequently used in the area of information technologies.

The prerequisite for a company satisfied with its corporate informatics is that the corporate informatics delivers services meeting the requirements of

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business service users in terms of quality and price (Dorcak and Delina, 2011). One approach that leads to the attainment of this goal is the implementation of internal control systems, or frameworks, which control all the important parameters of the services being rendered and compare them with the expectations of business customers. (ISACA, 2007). The adoption of these controls is closely related to the implementation of IT performance management systems controlling an enterprise and its informatics (Hanclova and Ministr, 2013; Hanclova et al, 2014; Doucek, Pavlicek and Nedomova, 2011). In the implementation of such systems it is necessary to ensure that the controls are proactive and not reactive, as this is the only way to take remedial measures in a timely fashion (Lagsten and Goldkuhl, 2008; Kalina, Smutný and Řezníček, 2013).

2 Management methodologies and standards

The company-wide management methodologies and standards examined in this article influence the design, operation and management of corporate informatics and not only them. There are many standards published by ISO/IEC (International Organization for Standardization/International Electrotechnical Commission). In the context of the objectives and intents of this article we pay attention to four selected areas. Their selection was based on:

- their relation to corporate informatics and the design of corporate information systems,
- the current emphasis of company-wide demands for their implementation in companies,
- their influence on and relation to financial management,
- their relation to product and service quality assurance provided by corporate informatics.

1.1 ISO 9000 – Quality Management

The standard ISO 9000 – Quality Management – is one of the most common quality management standards. The importance of this standard stems from the time of its existence and number of revisions. The standard ISO 9000 is being extended and supplemented by other supporting standards that focus on

specific conditions. A representative of such supporting standards is for example ČSN ISO/IEC TR 10000.

The salient characteristics of the standard ISO 9000 are eight principles (addressed areas):

- customer focus,
- leadership,
- involvement of people,
- process approach,
- system approach to management,
- continual improvement,
- factual approach to decision making,
- mutually beneficial supplier relationships.

If a company implements a process quality management system according to the standards of the ISO 9000 series, it should not be expected that this step will automatically assure quality. The outcome of an implementation of the standards should be, however, a reduction in poor-quality production and hence higher-quality products, customers' increased confidence in the organisation and improved corporate culture and economic metrics.

- **ČSN EN ISO 9000:2006 – Quality Management System – Key principles and vocabulary:** This part of the standard is dedicated to the terminology and principles which should be applied in the introduction and operation of a quality management system.
- **ČSN EN ISO 9001:2010 – Quality Management System – Requirements: A Quality Management System** according to ISO 9000 is based on a definition of requirements and criteria which must be satisfied if a company wishes to obtain certification based on this standard. With regard to information technologies, we can take as an example a defined and documented custom software development process.
- **ČSN EN ISO 9004:2010 – Management of Sustainable Success of an Organisation – Approach to Quality Management:** This part of the standard ISO 9000 is devoted to continual improvement which should be the objective of every company. Improvements

should be effected in particular in the performance of an organisation and in customer satisfaction.

- **ISO IEC 9003:2014 – Quality Management System for Software Products and Services.** This standard extends the standard quality management system with the specifics of software products and services.

The standard identifies certain requirements that every software product should meet in terms of quality, improvement, and documentation.

1.2 ISO/IEC 20000 – IT Service Management

The standard ISO/IEC 20000 is based on the standard BS 15000 and is harmonised with the process approach set out by the British Office of Government Commerce (OGC) in the library ITIL (IT Infrastructure Library). The first version of the standard was published at the end of 2005.

The prime objective of the standard ISO/IEC 20000 is effective management of IT services.

The Czech Normalisation Institute says that: *“ISO/IEC 20000 advocates the adoption of an integrated process approach to effective deliveries of managed services in order to meet the requirements of business and of customers. If an organisation is to function efficiently, it must identify and manage a number of interconnected activities. An activity that uses resources and is managed in order to transform inputs into outputs can be regarded as a process. An output from one process frequently constitutes an input for another process.”* (CNI, 2006)

The standard is intended for companies that deliver as part of their economic activities IT outsourcing services, and to companies wishing to outsource their IT in the form of services. In this case the requirement for the ownership of an ISO/IEC 20000 certificate by a prospective supplier increases the likelihood that prospective suppliers will approach services similarly, as well as requirements for individual service parameters, such as availability. The standard is based on key processes, from reporting, budgeting and accounting, at the level of IT service management, to security management of information, suppliers, changes, and distribution.

Key processes addressed in the standard are shown in Figure 1.

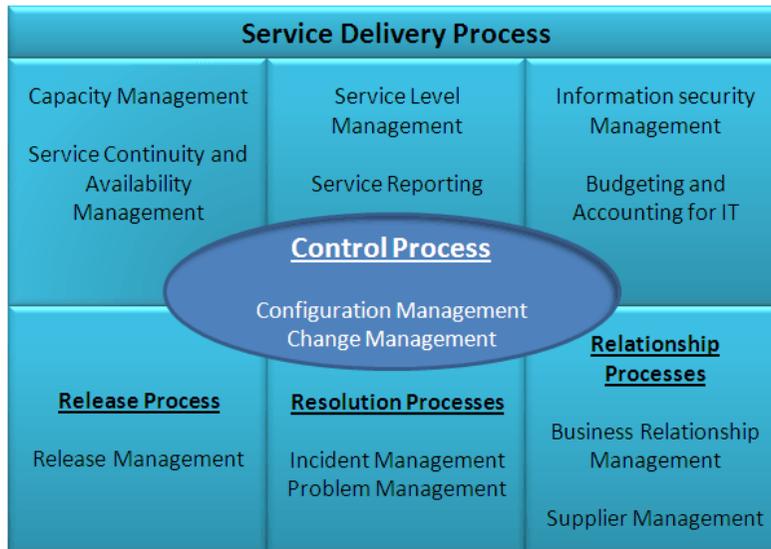


Figure 5 Model of ISO/IEC 20000 Standard,
Source: Šebestová and Sedláček, 2007; CNI, 2006.

This standard is important for companies aiming to prove to their customers that they have a defined and described a corporate IT service management system. This is attested by certification.

The standard ISO/IEC 20000 is structured into two parts:

- **ČSN ISO/IEC 20000-1 Information Technologies - Management Services – Specification,**
- **ČSN ISO/IEC 20000-2 Information Technologies - Management Services – Set of Procedures.**

The first part, Management services – Specification, is intended for assessment and certification of the quality of IT services. The second part, Management Services – Set of Procedures, serves as guidance for the implementation of a functional corporate management system in line with the requirements of the standard ISO/IEC 20000.

The proposed model may be provided in the form of services. For this reason the model must comply with this standard and it must be possible to set the individual parameters for the operation of the model as a service, and its availability.

1.3 ISO/IEC 26000 – Social Responsibility

The standard ISO/IEC 26000 - Social Responsibility, which was published in the Czech Republic in 2011 as ČSN ISO 26000 ‘Guidance on social responsibility’, aiming to foster in companies the awareness of social responsibility for their behaviour and operations, which should increase their share in sustainable development and the adoption of this trend in a company as such (Hanclova and Doucek, 2012). Perception of responsibility is structured into three broad areas:

- social responsibility,
- economic responsibility,
- responsibility for the impact of the company’s economic activities on the environment.

The standard comprises recommendations and guidance facilitating understanding and implementation of the core principles of social responsibility in a company’s internal processes. In addition to the recommendations and guidance, it contains guidance for integration of socially responsible behaviour. A key element of the standard is care for sustainable development (Delina and Drab, 2010).

The core areas covered by ISO/IEC 26000 are expressed in the following figure.



Figure 6 Seven Core Areas of ISO/IEC 26000, Source: CNI, 2011; IISD, 2013; Authors.

Although this standard does not affect explicitly the running of corporate informatics, the importance of the standard can be expected to rise in

importance in view of social evolution and its implementation in companies will be required in the future.

1.4 ISO/IEC 38500 – IT Governance

The standard ISO/IEC 38500 was first published under this name in 2008 and was approved in the same year by all the members of the international organisation ISO. It had already been published under a different designation, namely ISO/IEC 29382. The standard is based on the standard AS 8015, which was adopted in Australia.

It is an internationally recognised standard whose objective is to support administration and management of information technologies with formalised methods and processes. The standard gives, like the other above-mentioned standards, guidance on how to achieve set goals and to obtain a certificate for the standard. The standard comprises a framework for its implementation in companies.

ISO/IEC 38500 is sector-independent and the size of companies implementing it is not a limiting factor.

The standard sets out six core principles (Power, 2011):

- **Responsibility** – all employees must know their duties and competences,
- **Strategy** – the IT strategy must comply with the possibilities of IT and with the objectives and strategy of the company as a whole,
- **Acquisition** – investments in IT should be made on the basis of business transactions, that is a business rationale for an investment,
- **Performance** – performance of IT systems must be on such a level that corporate processes are optimally supported,
- **Conformance** – all processes (both in IT and outside IT) must conform with the law,
- **Human Behaviour** – all processes, principles, rules and methods must meet the requirements for human behaviour and the needs of people who are involved in a described process.

These principles are regularly checked against the rules of the PDCA cycle (**Plan, Do, Check, Act**), which are described in detail in (Maryska, 2010).

IT Governance is one of the themes of immediate interest in medium-sized and large companies. Given its topicality it is necessary to take the issue of IT governance into consideration in the model.

3 Frameworks

3.1 CobiT Framework 5

The methodology CobiT Framework 5 (Control Objectives for Information and Related Technology (“CobiT”)) is a description of a set of processes, instructions and objectives with associated metrics of their effectiveness. The methodology is process-oriented. It provides sets of recommendations across processes in different corporate areas. It supplements these with best practices, with the objective of achieving maximum utilisation and efficiency of information technologies leading to attainment of corporate objectives supported by information technologies or their services.

CobiT is based on specialists’ expertise on IT management and is mainly intended for auditors and company managers. A substantial part of CobiT consists of proposed recommendation for controlling and measuring existing processes and internal control mechanisms in a company. Unlike other methodologies and standards it does not give guidance on corporate informatics management or implementation of efficient IT processes.

The history of CobiT is very long and its first publication dates back to 1996. The latest version of CobiT – version 5 – was published in April 2012 as a follow-up to the successful version CobiT 4.1 (ISACA, 2007) and other standards, with a focus on assessment of the efficiency of information technologies (standard Val IT) and risks (standard Risk IT). The evolution of CobiT in time and covered areas is shown in Figure 3.

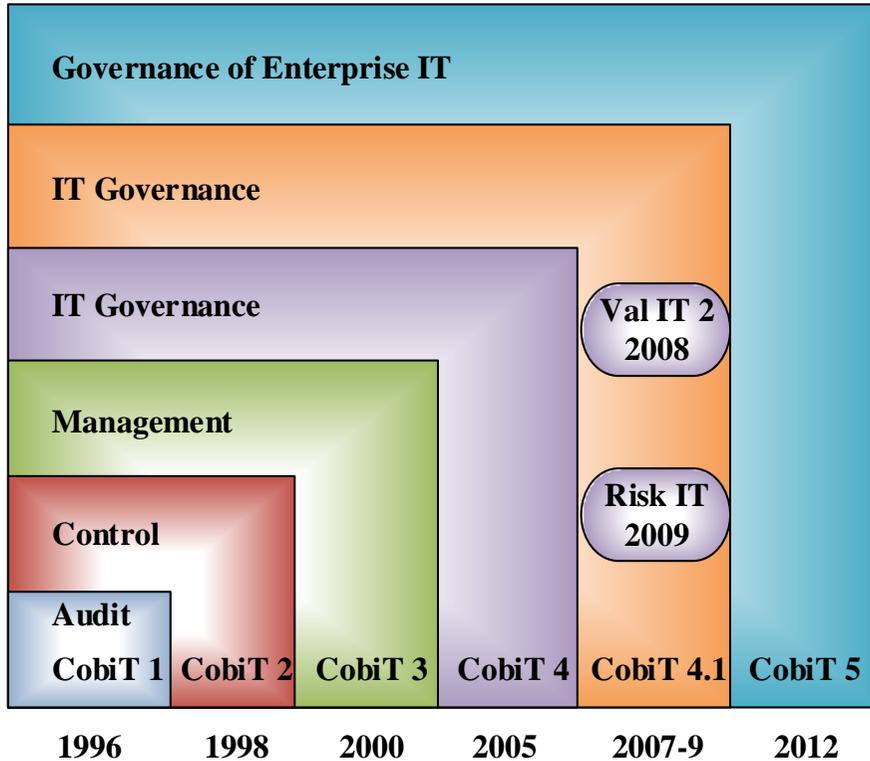


Figure 7 History of the Development of CobiT, Source: Authors; ISACA, 2013.

The methodology CobiT is characterised by central components with defined interrelations. The components support management, control, support for IS/ICT auditing. The central components of CobiT 4.1 are defined in (ISACA, 2007) and those of version CobiT 5 in (ISACA, 2011a; ISACA, 2011b; ISACA, 2013).

The methodology COBIT 5 is based on five principles which must be balanced from the viewpoint of seven perspectives and five management areas (ISACA, 2011a; ISACA, 2013):

- Principles:
 - Stakeholder Value Driven – meeting the needs of stakeholders,
 - Enabler Based Governance Approach – IT management across an organisation,
 - Integrator Framework – the only integrated framework for the management of corporate informatics,
 - Business and Context Focused – support for a holistic approach,
 - Governance and Management Structured,

- Perspectives:
 - Principles, Policies, Frameworks – these define rules important for correct performance of everyday work,
 - Processes – these describe and define activities, so that they yield expected results,
 - Organizational Structures – these describe and define compositions of employee teams,
 - Culture, Ethics, Behaviour – standards of expected behaviour and communication,
 - Information – this indicates sources of information and places where it is needed,
 - Services, Infrastructure, Applications – these describe and define means necessary to obtain information,
 - People, Skills, Competencies – focus on employees, their know-how and competences in view of the objectives a company wants to achieve,
- IT management areas:
 - **Strategic Alignment** – this forges links between business plans and corporate informatics plans. Their linkage is a prerequisite which must be satisfied to achieve added value through implementation and use of IS/ICT;
 - **Value Delivery** – this represents realisation of added value through IS/ICT. It is delivery of effects envisaged in a strategy. The decisive factor monitored in value delivery is optimisation of costs;
 - **Resource Management** – optimisation of investments in IS/ICT, both in technical and human resources. Concerning human resources, an important role is played here by knowledge and its expansion;
 - **Risk Management** – this makes users of CobiT realise that there are risks which responsible representatives of an enterprise must understand and be able to control;
 - **Performance Measurement** – control of implementation of IS/ICT, efficiency of corporate informatics processes.

CobiT version 4.1 differentiated four groups (domains) of corporate informatics processes, which are described in detail in (Maryska, 2010). The methodology of CobiT 5 is structured into 37 processes in 5 domains:

- **domain EDM** (Evaluate, Direct, Monitor) – processes dedicated to configuration of the framework for IT governance and processes dedicated to the achievement of effects, optimisation of risks, resources and stakeholders' management,
- **domain APO** (Align, Plan, Organise) – processes dedicated to planning and purchase management, business relations and suppliers, risk management, IT strategy management, management of corporate architecture, program planning, portfolios and projects, quality control,
- **domain BAI** (Build, Acquire, Implement) – processes encompassing design and implementation of IT solutions. Some processes in this domain are: user requirement administration, design and implementation of IT solutions, program and project management, configuration management,
- **domain DSS** (Deliver, Service, Support) – processes dedicated to deliveries of IT solutions and subsequent support for their operation,
- **domain MEA** (Monitor, Evaluate, Assess) – processes involving monitoring, measuring, and assessment of internal controls.

The relationship between CobiT 5 domains and processes is shown in the following figure.

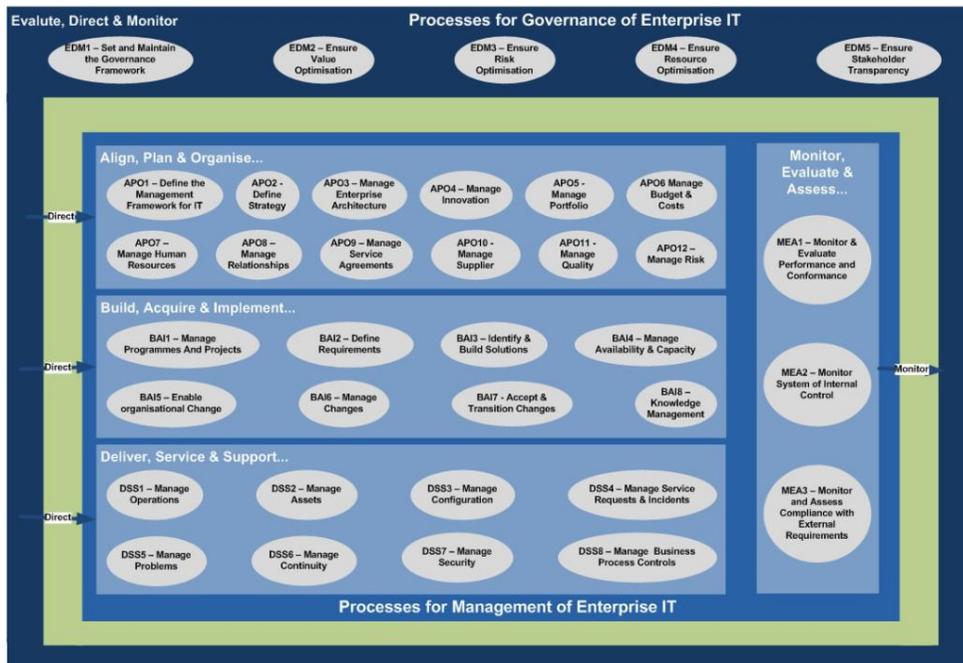


Figure 8 CobiT 5 Domains and Processes, Source: ISACA, 2013.

CobiT can be applied provided in the management of corporate IT processes comprises business requirements for information. Requirements for information can be structured as follows:

- **Efficiency** - requirements for delivery of relevant information in time in a correct, consistent and usable form,
- **Effectiveness** - requirements for processing of information (in the most economic and productive way) by optimal use of sources of corporate informatics,
- **Confidentiality** - requirements for protection of important information against unauthorised use (disclosure),
- **Integrity** - requirements concerning accuracy and completeness of information and its validity in relation to business requirements and expectations,
- **Availability** - requirements related to availability of information for business (now and in the future). Requirements also concerning protection of the necessary resources (data or technological, for example),

- **Compliance** - requirements for maintaining compliance with the laws, regulations, directives and contract terms involving business processes (main corporate processes).
- **Reliability** - requirements related to information benefits for managers' decision-making.

CobiT version 4 (and 4.1) was devised and used as an instrument for auditing corporate informatics management systems. Version CobiT 5 can be characterised as a major evolutionary change based on expansion of the areas covered integrally by CobiT 5. The expansion of the areas is a result of integration of originally separate standards Val IT and Risk IT and a revised perspective of IT management.

An important characteristic of CobiT is harmony with other international standards and methodologies (ISACA, 2011a), such as ISO/IEC 9000, ISO/IEC 38500, ITIL, Prince 2, and CMM, inter alia.

The main benefits of CobiT 5 are stated as (ISACA, 2013):

- inter-linkage between IT and business based on realisation of the needs of business and its orientation and the possibilities of IT,
- understanding of the services and activities of IT on the part of the management – IT is no longer a black box,
- clear definition of IT processes IT and their linkage to corporate processes,
- definition of responsibilities and roles in the context of defined processes,
- the standard is accepted by regulators worldwide,
- a unified vocabulary for all levels of management and company ownership.

This is one of the key standards used today in the management of corporate informatics. The requirement for its inclusion is based on its core principles and the orientations addressed within its framework.

3.2 ITIL - IT Infrastructure Library

ITIL (IT Infrastructure Library) is an integrated list of best practices for IT service management. ITIL is created and administered by the British Office of Government Commerce (OGC).

ITIL has been modified several times since its publication and is currently available in version 3 (ITIL v3), which was first published in 2007 and brought up to date in 2011.

ITIL v3 is published in a series of five core volumes (version 2 contained five volumes), each of which covers an ITSM lifecycle stage from its definition, analysis of business requirements, migration of services to a production environment, its operation and maintenance, to subsequent improvements. Each of ITIL v3 five volumes represents one service lifecycle stage:

- Service Strategy,
- Service Design,
- Service Transition,
- Service Operation,
- Continual Service Improvement.

The individual volumes are described in detail in (Maryska, 2010; ITIL, 2001; ITIL, 2007).

Unlike ITIL v2, ITIL v3 addresses newly or in more detail areas including for example process deployment processes and change management, taking into consideration the human factor, discontinuation of services, supplier management, and an emphasis on seeking balance in various areas of operation.

The following figure shows schematically the core components of the standard ITIL v3 and maps it on such standards as CobiT, ISO/IEC 20000, and others that go beyond the framework of this article.

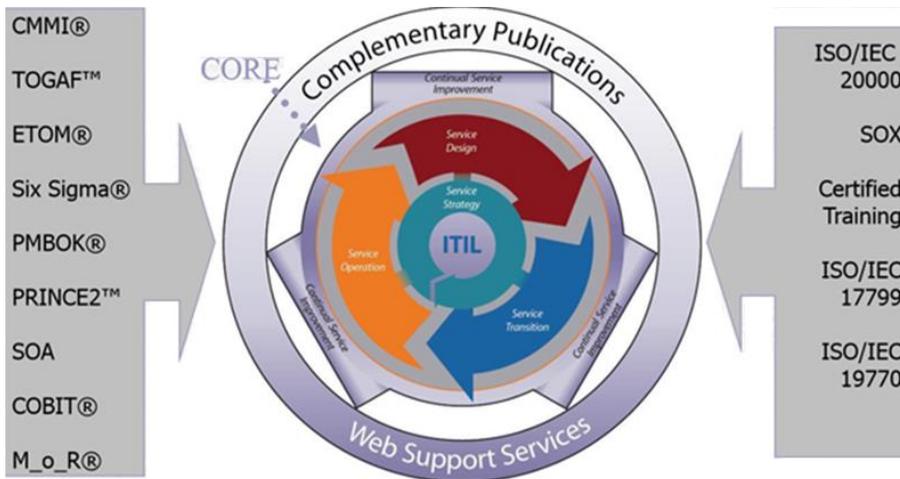


Figure 9 ITIL v3 and other Standards, Source: Nouri Associates, 2008.

A successful implementation of ITIL processes involves effects stemming from processes and methods for improving corporate informatics. Mutual improvement of processes and links between them lead to a continuous improvement of IS/ICT services.

In practice, the main effects of ITIL are, according to (Bastlová, 2008):

- processes whose mutual relationships are established,
- consistent and internationally used terminology,
- cycle of continuous improvement of quality processes, which is one of the core components of ITIL v3,
- effort to limit costs of creation and implementation of new IS/ICT services,
- effort to improve communication flows between IS/ICT workers and IS/ICT customers,
- effort to raise the quality of IS/ICT services, taking into account the costs of quality improvements,
- effort to become more competitive,
- transparent assignation of roles and responsibilities in the provision of IS/ICT services,
- determination of the base metrics of operational performance.

ITIL is suitable for companies striving to achieve conformity between IT and business strategy, dynamic addressing of customer requirements and business.

This standard is based on best practices, which are presented as a set of recommendations. An important element of ITIL enabling its dissemination is the fact that ITIL need not be implemented in its entirety and only parts of it suitable for a firm can be implemented. ITIL can be also implemented in stages. A negative aspect of ITIL is the complexity and usual length of its implementation which averages, according to (Bastlová, 2008) 4-5 years.

During an implementation of ITIL the overall conception of the orientation of the organisation must change from functional to customer orientation. These results in the decision to implement ITIL cannot be left to the management of IT and the decision must be taken on the highest management level.

The main benefits of an implementation of ITIL are:

- reinforcement/growth in importance of the definition of the level of the services provided by IT departments,
- connecting of IT objectives with objectives of the departments supported by IT services,
- optimisation of resources used to provide IT services,
- enhancing cooperation across individual areas of IT,
- providing premium services as key part of corporate culture,
- transformation of corporate informatics from the traditional model offer/demand into a new model, whose essence is customer orientation and creation of added value for customers.

This is another key standard used today to manage corporate informatics. The requirement for its inclusion is based on its core principles and orientations addressed within its framework. One of the core areas of ITIL for the proposed model is the approach to addressing financial questions.

4 Conclusions

The high number of international standards and generally accepted frameworks may lead to resignation to their knowledge and willingness to apply them. It is true that the standards inhibit managers' creativity but, on the other hand, they provide them with a set of tested and usually system-connected tools.

The primary mission of corporate informatics managers and their competences should consist in their ability to identify the purposefulness and

meaningfulness of international standards on the basis of their knowledge. Then, on the basis of their knowledge, combine ready methods and guidelines with solution to real problems in the management of corporate informatics. Let us not seek what somebody has already invented and also tested the suitability of such methods in practice.

From the following summary figure and the preceding text it is evident that the standards overlap in many areas. This assertion applies in particular to the standards ITIL, CobiT and ISO/IEC 26000, which cover all levels and areas of corporate informatics management and can be used, in part, to manage a company as such. The other analysed standards have a more specific focus.

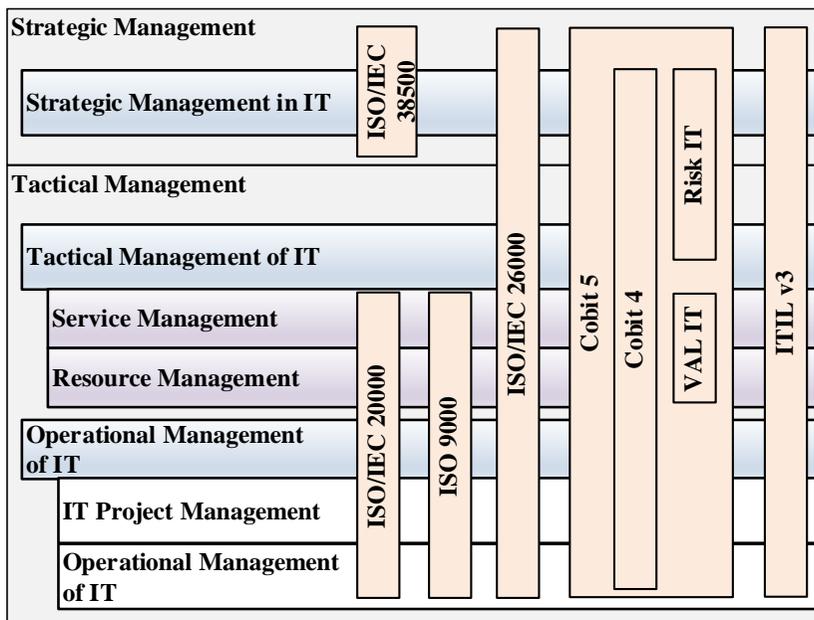


Figure 10 Methodologies and Standards and their Effect on the Management of Corporate Informatics, Source: Authors.

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Testing the Quality of Software in the Form of Services

Jan Ministr¹, Josef Fiala²

Abstract. Currently in frame of the delivery of IT services steadily increasing emphasis on reducing the time of IT services (design, installation etc.) while maintaining or improving the quality of IT services. Testing the quality of IT services is a difficult process for the company in terms of time, expertise of human resources. The article deals with the internal activities of firms in this area, but also external services, which represent a new trend of alternative testing IT services.

Keywords: IT service, quality, test, Total Quality Management, organizational structure

JEL Classification: L86, M15

1 Introduction

The aim of software tester is quick identification of bugs and ensuring their elimination as soon as possible. The relationship between the number of tests performed and the number of errors found shows the Figure 1. If are being tested all the functionality of IT services, the cost of testing are drastically rising and the number of errors reaches the point where further testing are not effective. If the testing process reduced or otherwise modified based on the implementation of an incorrect decision, although there is a reduction in costs, but many errors remain undetected. The goal of an effective testing is a balanced approach when we want to achieve the optimal number of tests while achieving the required quality IT services.

Costs associated with ensuring quality IT services is divided (Patton, 2002) on:

- *Cost of conformance*, which can also be described as an internal failure. These costs fall into stages that precede the transfer of IT services to the customer;

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- *Cost of non-conformance*, which can also be described as an external failure. These costs fall into stages of implementation IT services after delivery to the customer.

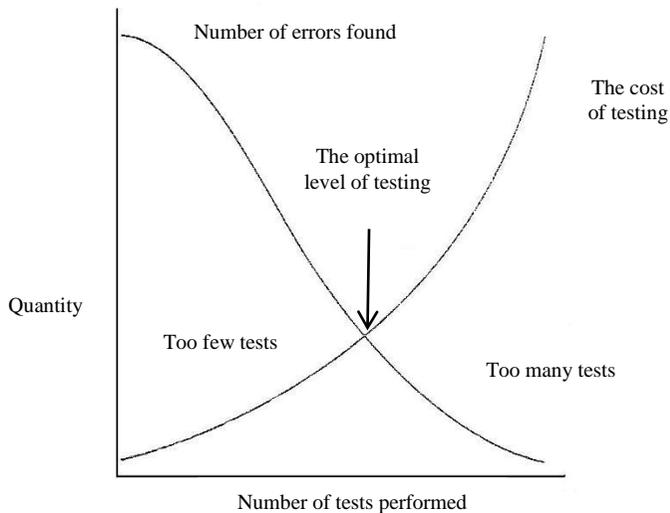


Figure 1 The effective level of testing. Source: own.

Philip Crosby (1996) notes that the costs of compliance, together with the costs of non-compliance, which arise as a result of internal failures are always lower than the costs of disagreement that arose due to external failure. Future costs of quality ensuring are so neglected in favor of short-term objectives of the project to ensure IT services. Firms then have a high cost of quality, although these costs may not be high.

2 Testing the quality of IT services

Testing the quality of IT services (Quality Assurance) is closely associated with the following terms:

- *verification*, which is a process whose goal is to certify that the IT service meets their specification IT services;
- *validation*, which checks whether IT services meet the requirements of the user.

The problem arises when it created the incorrect specification of IT services, which we will discover only when it will be execute the control of realization of user requirements (Wiegiers. 2013).

The next important terms are:

- *Quality*, presents a wide range of functions from the ability to start to execute IT services into the its appearance of the package.
- *Reliability* on the other hand expresses how often IT service crashes, therefore their stability.

If the tester software has an obligation to ensure the quality and reliability of IT services then he must perform both corresponding verification and validation too.

Ensuring quality testing of IT services requires following know-how of specialist of testing:

- *Process* when the tester-specialist must understand the testing methodology, test analysis, Detected tracing, International Software Testing Qualifications Board (ISTQB), Rational Unified Process (RUP) etc.
- *Information technologies*, which represents the orientation in the HW, SW, IT tools, scripting languages etc.
- *Business*, which represents the orientation in the banking, insurance, telecommunications, etc.
- *Clients*, which represents knowledge of specific environment condition of the clients.
- *Teamwork*, which represents the ability to be to controlled and managed.
- *Knowledge of foreign languages*.

The above competencies and skills appropriate tester-specialists evaluate with respect to their working position within the team that the company engaged in quality IT services (Ministr, 2013).

3 Management of tests and organizational Structures

An important attribute that has a significant impact on the cooperation of test-group with the rest of the project team, is the position of the test-group in the overall structure of the company. In practice, there are many different types of organizational structures. The basic structures are described more detailed in next paragraphs.

3.1 Basic Structure

In this organizational structure is the test team is directly subordinate to the head of development. This structure (see. Fig. 2) is often used in small companies (under 10 employees). The disadvantage of this structure is the inevitable focus of interest, when head of developing IT service leads development test team prevents him from doing. The advantage of this structure is the minimum numbers of level of management, which enables effective collaboration between the test team and programmers.

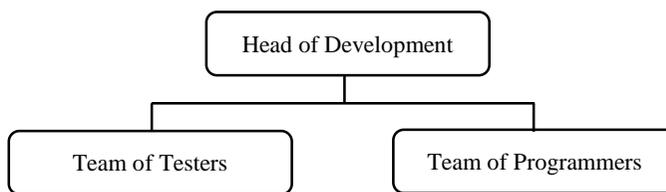


Figure 2 Basic organization structure. Source: own.

3.2 Extended Structure with heads of teams

In this organizational structure (see Fig. 3), testing and development group are subordinated to the head of project. The independence test team directly to head of development plays a major advantage especially when taking critical decisions that relate to software quality. Voice of the test team has the same weight in communicate as the voice of programmers.

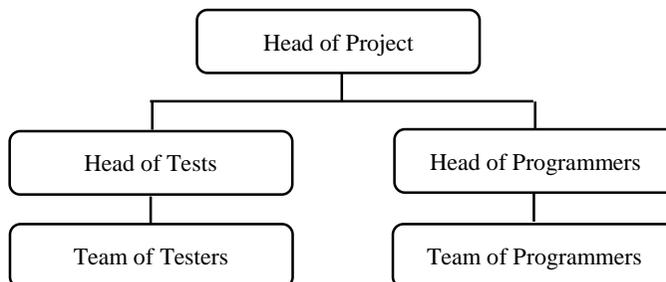


Figure 3 Extended structure with heads of teams. Source: own.

3.3 The structure with team of QA directly subordinate to the Top management

In the development of high-risk projects, it is appropriate that top management heard the voice of quality or voice of the team that ensures QA. This requirement allows the organizational structure, in which the teams responsible for software quality are directly subordinate top management (see Fig. 4). This fact supports independence of QA team on individual projects as individual research teams are on the same level. The level of team competences providing QA within this structure rises because it is carried out not only testing, but also activities in the field of QA. Based on these defined independence, QA group can issue binding standards and principles on base measurement of processes across multiple projects. For information on obtaining quality level are then regularly reported to top management.

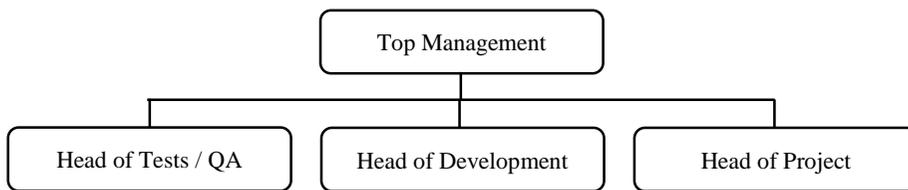


Figure 4 Structure with Team of QA. Source: own.

3.4 The structure with external provider of quality testing

If a company has not the opportunity to build a test team from its own resources, which is able to ensure the necessary quality, while respecting the schedule and budget, then it now the possibility to use outsource way.

A prerequisite for the provision of testing services is the existence of the testing strategy, which is part of the corporate strategy. This identifies the tools for support testing and rules of methodology that defines the overall approach to testing within the service.

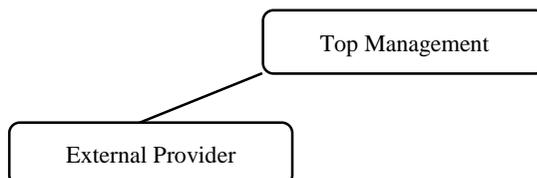


Figure 5 Structure with external provider Quality of testing. Source: own.

Testing as a service is usually delivered the longer term, for most projects which the company leads.

To enable the contracting authority to fulfill his obligations then he must master knowledge of the testing process, information technology, orientation in the business segment of the company and orient in the client process environment. The part of the process of testing as service is quality evaluation of the project, to which the service is provided, but also the evaluation of this service.

The company itself usually evaluate the benefits of service; taking pursuing the achievement of anticipated levels of value added. Regular review of services is also beneficial for suppliers of services. Allows to suppliers in the long term to better meet the demands from the project and improve the efficiency and quality of the service.

Conclusion

It should be noted that these organizational structures represents simplified examples of the many types that exist in practice. Advantages and disadvantages of different structures can vary considerably. In a given company can structure work very well, but for the other team may be the same structure unusable.

Testing the quality of IT services through external services is one of the ways companies can provide the necessary support to achieve high standards of quality in their projects. The main advantage is the reduction of long-term investment in the maintenance and development of large scale internal teams of specialists that are used occasionally. Likewise, external service provision QA is suitable when it is necessary to expand the capacity of internal specialists occasionally.

Acknowledgements

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IT Support for Organizational Creativity Design Challenges

Celina M. Olszak¹

Abstract. The main purpose of this paper is to explore the issue of IT-enabled organizational creativity. Specially, I investigate and discuss what research paradigm and methodology should be used to build organizational creativity support system (OCSS). A comprehensive framework for OCSS and some guidelines for designing such system have been proposed. The study was based mainly on a critical analysis of literature, and reports concerning the creativity models and design science research methodologies for information systems. The results of this research can be used by ICT and business leaders as they plan and develop IT-enabled organizational creativity.

Keywords: organizational creativity, IT, organizational creativity support system, design science research

JEL Classification: D23

1 Motivation

Organizational creativity is crucial to ensure competitive advantage and to survive in the business world (Elsbach and Hargadon, 2006; McLean, 2009; Shin and Zhou, 2007). Organizations face the need to constantly generate new and useful ideas that concern some products, services, processes, managerial practices, as well as competitive strategies. Advances in IT and changing customer demands both drive and require creativity and innovation (Voigt and Bergener, 2013). Organizations that want to be creative have to use new technologies and information systems (IS). To build organizational creativity support system (OCSS), a suitable IT infrastructure, as well as, appropriate design approach are needed. OCSS is about creating and adopting different artifacts in order to generate new and useful ideas that concern some products, processes, and managerial practices.

Although, the studies on IT-enabled creativity have been developing from three decades, they have not referred to the essence of organizational creativity support. They have been mainly focused on creative problem

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solving, creative processes, and group creativity support systems. There is a cognitive gap how to design and build OCSS. In order to cope with this gap, this paper addresses the following research question: what are challenges for designing of OCSS. In order to address the research question, the remainder of this paper is structured as follows: in first section I give an overview of related works on both creativity models, and design science research. Within next section, I present the methodology of my study. Finally, based on the theory of creativity models and design science research, the framework for OCSS was proposed. The theory of creative models helps us to understand and explain the term of “organizational creativity” - as a strategic organization’s capability, meaning the adoption to changing environmental conditions through continuous acquisition of new resources and the creation of new configurations (Sirmon, et al., 2012; Arora and Nandkumar, 2012; Zahra, Sapienza and Davidsson, 2006). In turn, design science research throws more light on designing of OCSS. I conclude my paper with a short discussion of the implications of my research.

2 Related works - Organizational creativity issue

The concept of creativity has been widely discussed over last decades in a variety of disciplines including psychology, sociology, organizational behavior, and IS (Amabile, 1988, Woodman et al., 1993; Cooper, 2000; Styhre and Sundgren, 2005; Khedhoaria, Belbaly, 2011). It is therefore not surprising that the term of “creativity” is very different explained. It is asserted that the outcome of creativity are ideas that are distinguished by novelty and usability (Amabile, 1983; Kao, 1989). Many authors highlight that these ideas are used to achieve some particular aims (Puccio et al., 2011) and they have a significant impact (Arieli, Sagiv, 2011). It is worth mentioning that the studies on the creativity were always strong associated with the issue of innovations. It is considered that each innovation has its roots in creative ideas. Creative ideas start the innovations, and in contrast, the innovations facilitate the creativity.

Last time the term of “organizational creativity” has appeared. In contrast to the term of “creativity” that is rooted in psychology, the term “organizational creativity” is strong associated with strategic management, business strategies, and competitive advantage. According to (Gong, et al., 2012; Klijn and Tomic, 2010; Choi, Madjar and Yun, 2010; Zhou and Ren, 2012) the organizational creativity means the capability to generate new and useful ideas that concern

some products, services, processes, managerial practices, as well as competitive strategies. The organizational creativity is treated as a main vehicle of organizational development (Elsbach and Hargadon, 2006), the basis for staying on the market and innovative success (Shin and Zhou, 2007; Klijn and Tomic, 2010; McLean, 2009). The organizations that support the organizational creativity and adopt the innovative practices, products and services increase their capability to be more competitive (Mumford, Robledo and Hester 2011; Drazin, Glynn and Kazanjian, 1999; Parjanen, 2012). It is stated that organizational creativity is important, not only for long-term survival of the organization and the struggle with unexpected organizational situations (Robinson and Stern, 1997), but also for the whole social-economic development (Florida, 2002).

While other disciplines have paid a particular attention to the creativity subject, it appears that IS discipline has paid relatively little attention to issues related the creativity (Seidel, Muller-Wienbergen, and Becker, 2010). Existing creativity research tracks on IS were based on methods, techniques and tools, requirements and strategies for diffusing them and support systems for individuals and groups (Khedhouria and Belbay, 2011). These research tracks imply that there was an urgent need to use and develop a comprehensive creativity model for IS discipline (Cooper, 2000). Seidel et al. find 4-P model to be the most used general creativity framework. This model is composed of creativity processes, creativity persons, creativity products, and creativity press or environment. In IS, the studies related to the 4-P model, concentrate mainly on creative products and creative processes (Tiwana and McLean, 2005). It is reported that 4-P model alone is not enough embody the role of a comprehensive creativity model. In the literature there are two another creativity models ((Khedhaouria and Belbaly, 2011): the integrationist model of organizational creativity (Woodman, Sawyer, and Griffin, 1993) and the componential model of theory organizational creativity (Amabile, 1988). Componential theory of organizational creativity includes the major conceptual categories, specifying the main components of each category and the predicted relationships between each scale and organizations creativity. In Amabile's original model organizational creativity results from (1) encouragement of creativity including organizational encouragement such as reward and recognition of creativity, supervisory encouragement and work group support, (2) available resources including materials, sufficient budget and time, (3)

management practices refers to allowance of freedom or autonomy, and organizational impediments such as rigid, formal management structures or conservatism (Khedhouria and Belbaly, 2011).

Cooper (2000) has made a significant contribution to the creativity, especially to creativity required for IT-enabled organizational reengineering in order to help managers and researchers understand how to foster such creativity. A creativity model was adopted from organizational theory and used to develop propositions regarding organizational characteristics that can foster IT development creativity in organizations. The author asserts that IT requirements and logical design result from group characteristics, such as the tasks, norms, diversity, and problem solving approach, as well as from characteristics of individuals in the group, such as cognitive factors, motivation, and knowledge. Group and individual characteristics are affected by contextual influence, which result from organizational characteristics such as culture, resources, and rewards.

Process-oriented perspective is very often used to describe the creativity phenomenon. Voigt and Bergener (2013) state that creative processes are understood as interactive interplay of divergence and convergence. They advocate that creativity is a phenomenon occurring in the interplay of person and its socio-cultural context. Creative group processes are collaborative effort of a group to generate and evaluate ideas. A particular subset of group support systems, that support creative group processes, are group creativity support systems (GCSS). They include several types of information systems, e.g. group decision support systems, knowledge management systems, computer-mediated communication, which commonly support the process of idea generation and idea evolution and selection in groups. GCSS combine the properties of individual creativity support with collaboration and coordination support. The authors provided the design principles according to five topics in the CGP including: divergence, convergence, communication, group awareness, and interaction.

Seidel and Rosemann (2008) have introduced the notion of creativity-intensive processes and pockets of creativity as new BPM concept. In this context, they have distinguished and described creative tasks within business processes including: allocating resources, enhancing creativity, managing creativity risks, and enhancing process performance.

Stenmark (2005) argues that the most important factors enhancing organizational creativity include: motivation (quality of work, financial rewards, challenging goals, accountability, job satisfaction), autonomy (influence on work, job control, self-managed teams, absence of external control), work setting (supportive evaluation, collaborative flow, job complexity, cognitive diversity, structured interaction), climate (attitudes towards change, risk talking, management support, supportive environment, management style), and additional aspects (work load, slack, time to experiment, cognitive style, creative style).

Tiwana and McLean (2005) have examined creativity during IS development process. They have argued that development of IS is a creative effort that involves the expertise, insights, and skills of many individuals. The organizations the need to develop systems for novel business applications and new problem domains.

3 Design science research methodologies

In this section I discuss current work on design science methodologies. These methodologies propose various models for IS design that may be foundation for building OCSS.

Hevner et al. (2004) in the paper “Design Science in Information Systems Research” state that “Information systems are implemented within an organizations for the purpose of improving the effectiveness and efficiency of that organization. Capabilities of the information system and characteristics of the organization, its work systems, its people, and its development and implementation methodologies together determine the extent to which that purpose is achieved”. The scholars have considered that the design of IS has dichotomous nature. It may be both a process (set of activities) and a product (artifact) – verb and a noun. It describes the world as acted upon (processes) and the world as sensed (artifacts). The design process is a sequence of expert activities that produces an innovative product (e.g. the design artifact). The evaluation of the artifact then provides feedback information and a better understanding of the problem in order to improve both the quality of the product and the design process. Hevner’s study much attention pays to the issue of environment. The environment is composed of people, organizations, and their existing or planned technologies. They create the goals, tasks, problems,

and opportunities, as well as define business needs that are assessed and evaluated within the context of organizational strategies, structure, culture, and existing processes.

March and Smith (1995) identify two design processes and four design artifacts in IS. The two processes are build and evaluate. The outcome of design science is an artifact, which can be in form of constructs, models, methods, and instantiations (table 1).

Table 1 Artifacts in IS, Source: own

Artifacts in IS	Description
Constructs	Abstracts, concepts, conceptualizations, vocabulary and symbols that provide language in which problems and solutions are defined and communicated
Models	Use constructs to represent a real world situation – the design problem and its solution space
Methods	A set of steps (an algorithm) that define processes and provide guidance on how to solve problems
Instantiations	Prototype, a specific working system or some kind of tool that show that constructs, models or methods can be implemented

Analyzing the essence of design, the scholars (Nunamaker, Chen and Purdin, 1991; Walls, Widmeyer and El Sawy, 1992) emphasized theoretical bases, whereas engineering researches focused more on applied problems. Tekeda (1990) suggested the need for problem enumeration, whereas Rossi and Sein (2003) advocated need identification. Hevner et al. asserted that design science research should important and relevant problems. Ostrowski, Helfert and Xie (2012) proposed process model consisting of six activities: (1) problem identification and motivation, (2) design and development – create artifacts, (3) demonstration and use of the artifact to solve one or more instances of the problem, (4) evaluation – how well the artifact supports a solution to the problem, (5) communication – to researches and other relevant audience such as practicing professionals.

The summary of the main assumptions of design science research methodologies is presented in table 2.

Table 2 Design Science Research Methodologies, Source: (Peffer et al., 2007)

Common design process elements	Problem identification and motivation	Objectives of a solutions design and development	Demonstration	Evaluation	Communication
Archer (1984)	Programming, data collection	Analysis, synthesis, development			Communication
Takeda et al. (1990)	Problem enumeration	Suggestion, development		Confirmatory evaluation	
Eakels and Roozenburg (1991)	Analysis	Requirements Synthesis, tentative design proposals	Simulation, conditional prediction	Evaluation decision, definite design	
Nunamaker Chen and Purdin, (1991)	Construct a conceptual framework	Develop a system architecture, analyze and design the system, build the system	Experiment observe, and evaluate the system		
Walls Widmeyer and El Sawy, (1992)		Design method, meta design		Testable design process/product hypotheses	
Cole et al.(2005) Rossi and Sein (2003)	Identify a need	Build		Evaluate	
Hevner et al. (2004)	Important and relevant problems	Implicit in relevance interactive search process, artifact		Evaluate	Communication

4 Research paradigm and methodology for OCSS

I position my study in the field of design-science research in IS. More specifically, I aim to contribute to the field of OCSS design. This paper contributes to the development of an IS design theory for a system that supports organizational creativity, as well as provides a basic understanding IT-enabled organizational creativity.

OCSS is a special type of information system including hardware, software, people, information resources, and organizational practices in order to generate new ideas for products, services, business practices, and business processes. It presents a next stage in the development of IT-enabled creativity. OCSS should be grounded in strategic management, resource base view, dynamic capabilities theory, integrated ICT tools, as well as design science research methodology. It should create VRIN (valuable, rare, inimitable, non substitutable) resources that are the basis for making the competitive

advantage. The main differences between OCSS and previous creativity support systems are illustrated in table 3.

Table 3 Creativity support systems, Source: own.

Type of creativity support system	Description
Individual creativity support systems	Essence: Idea generation and idea evolution and selection by individuals. Creativity limited to narrow domain. Scope: a single individual. Purpose: increasing the cognitive process, individual inspiration, learning, and reasoning. Used theories: cognitive, behavioral theory, motivation theory. Tools: editors, visualization systems, e-mails, spreadsheets, limited data bases and knowledge bases, scenarios and modelling tools.
Group creativity support systems	Essence: Idea generation and idea evolution and selection in groups. Creativity limited to selected organization's units, departments. Scope: selected groups and teams. Purpose: creating shared idea space, increasing group communication, group consensus. Used theories: creative teams, work group, group IS design. Tools: data marts, GDSS, KM, chat rooms, communicators, synchronic and asynchronic trainings, discussion forums, blogs.
Organizational creativity support systems	Essence: Idea generation and idea evolution and selection by all stakeholders of organization (organization's members, customers, suppliers and competitors). Scope: The whole organization and its environment. Purpose: Taking the competitive advantage, increasing the organization's performance, creating new business models and creative business processes, meet the requirements of changing environment, alignment organizational creativity and strategic management. Used theories: strategic management, dynamic capability theory, RBV, strategic management, business strategy, integrated IS design. Tools: BI, CI, multi-agent systems, search engines, knowledge management, CMS, workflow systems, OLAP, data mining, web mining, opinion mining, DSS, expert systems, BSC, KPM, document management systems, cloud computing, corporate portals, data bases, knowledge bases, data warehouses.

The proposition of framework for OCSS was based on Hevner's methodology (Figure 1). This methodology provides clear and proven guidelines to design process. Seeking the proposal for OCSS framework, it was assumed that such system should meet the following requirements:

- to generate new knowledge and ideas from existing information and knowledge;
- to help to create VRIN resources;
- be a repository of various knowledge, processes and capabilities needed to realization of different activities in organizations;
- a key strategic tool that enables an organization to take the competitive advantage.

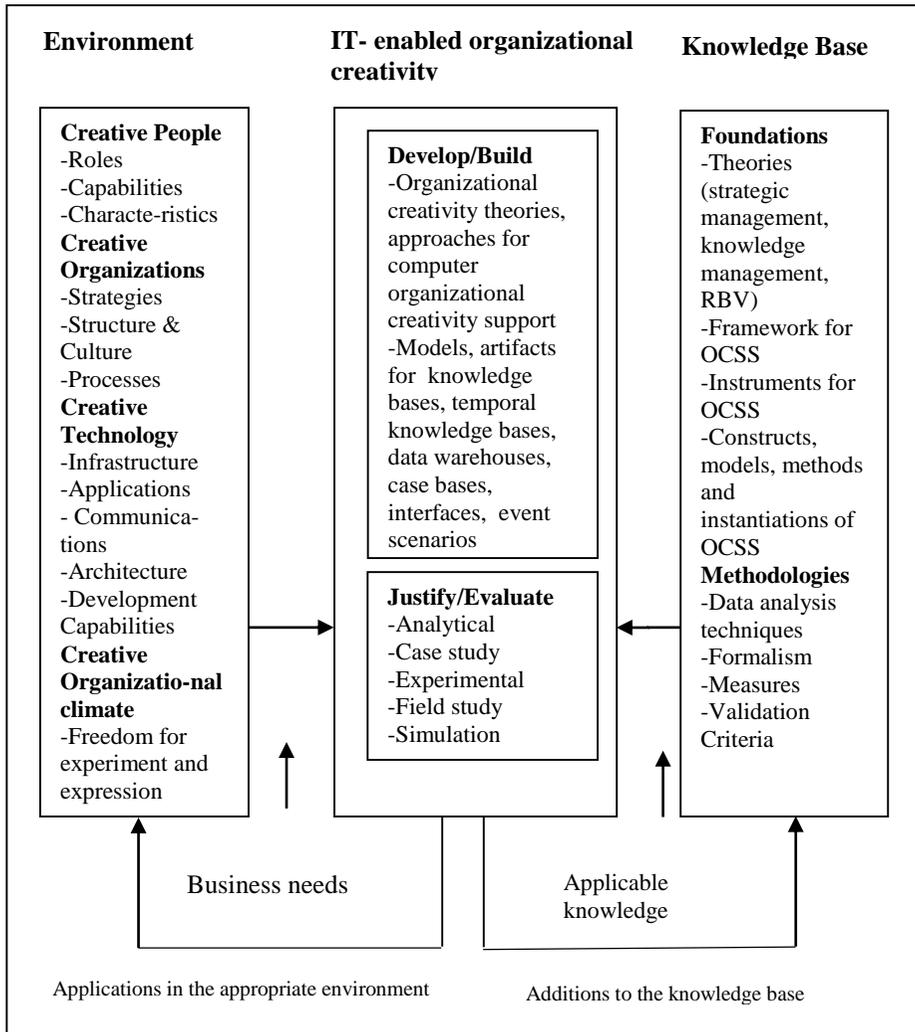


Figure 1 The framework of OCSS; Source: Elaborated on Hevner, et al., 2004.

According to Hevner’s methodology, OCSS should be composed from different innovative purposeful artifacts e.g. data bases, knowledge bases,

interfaces, communication different innovative purposeful artifacts e.g. data bases, knowledge bases, interfaces, communication components, inspiration component, scenarios and modeling space , case studies, shared idea space, and reasoning mechanism that enable organizations to create new ideas, products, services, business processes. Such purposeful artifacts should feed to a specified problem domain: creativity theory, strategic management, and RBV. In the design process of OCSS the evaluation of the artifacts is needed and crucial. The artifacts should meet the requirements of organizations (e.g. strategic goals). It is worth mentioning that artifacts for OCSS must be innovative, solving a known problem in a more effective or efficient manner e.g. new forms of visualization of information, new ways of communication among members of teams, new ways of sharing knowledge. The artifacts must be rigorously defined, formally represented, coherent, and internally consistent, e.g. data bases and knowledge bases should work and communicate together, interfaces should feed to the individual characteristics of creative users. The search for an effective artifacts requires utilizing available means to reach desired ends while satisfying laws in the problem environment e.g. copyrights, patents. Obtained results must be communicated effectively both to a technical audience and to a managerial audience who are responsible for the development of the organizational creativity.

Conclusion

In the information systems domain, the studies on IT-enabled organizational creativity are very fragmentary and rare. This study fills the gap, which is indicated by researches and practice, namely the lack of methodology for OCSS. The paper attempts to answer the following questions: (1) what is the issue of organizational creativity, (2) what is the essence of OCSS and how to design OCSS. So far, based on Hevner's methodology, that is a widely accepted method of planning and designing of scientific studies, a framework for OCSS was proposed.

This paper contributes to the field of OCSS design. On the one hand, it contributes to the development of an IS design theory for a system that supports organizational creativity. On the other hand, it contributes in providing a basic understanding IT-enabled organizational creativity.

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Text Processing Performance in Go Language

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Abstract. Go programming language, introduced by Google represents a new promising platform for distributed enterprise computing. In the first part of the article, reader will become familiar with some basics of Go programming language – syntax, declare of variables, arrays and slices, concurrent programming. As text data processing is vital for information systems, time complexity of string matching algorithms under different conditions in Go language will be evaluated.

Keywords: Go language, string matching, Horspool algorithm, Boyer-Moor algorithm, Knuth-Morris-Pratt algorithm, concurrent programming.

JEL Classification: C61

1 Introduction to Go language

Enterprise computing technologies are shifting towards virtualization and clouds allowing to develop distributed scalable applications. Therefore, there emerge new programming languages with native support for concurrency and thus scalability in large systems. Go programming language (Baugh, 2010) was developed by Google company and it was released in 2009. Go language is being used at Google for many internal purposes, and is freely available for public to be either installed locally or used within the Google App Engine platform. Go is derived from Python and C, but there are differences. Go's syntax is different from C programming language though its nature is the same.

In code below, you can see the basics of Go. The first we start with main function. On the lines 20 and 21 you can see declaration and initialization of variable. Shorter way how to do that is on line 22. If you use ":= " instead of "=", it means that you want to create new variable and its type is automatically determined from the assigned value. Functions in Go can return multiple values (Go Authors, 2014b) as you see on the line 7 in the header of function *multiplication*. Go can return "named" results. In the function header, you

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specify name and type of returned variable and when you call *return key word* in code, actual values of the variables are returned. It can be done in ordinary way as you see in function *returnFive*.

```

1 package main
2
3 import (
4     "fmt"
5 )
6
7 func multiplication(fstNum int, scndNum int) (result int, scndResult bool) {
8     scndResult = true
9     for i := 0; i < scndNum; i++ {
10        result = result + fstNum
11    }
12    return
13 }
14
15 func returnFive() int {
16     return 5
17 }
18
19 func main() {
20     var num, result int
21     num = 3
22     num2 := 5
23     tF := false
24
25     result, tF = multiplication(num, num2)
26     if tF == true {
27         fmt.Println(result)
28     }
29 }

```

Figure 1 Go code example, Source: authors, 2014.

If you are working with Go you have to keep your code clean (Baugh, 2010). You have to use every variable that you declare or error will appear. Go uses UTF-8 encoding instead of ASCII. It means you can use characters of Greek or Chinese alphabet in the name of variables.

Unlike C, arrays in Go are certain values (Baugh, 2010), (Go Authors, 2014a). Length of array is also part of the data type. Array with length of 5 is different data type from the array with length of 10. Slice (Baugh, 2010), (Go Authors, 2014c) is a special data type in Go. *Slice* is a pointer on certain part of array or whole array. *Slice* length is variable, so *slice* is used more often than array which has fixed length.

Go's main advantage is easy writing of concurrent programs. For concurrent programming Go uses entities called *goroutines* (Baugh, 2010). *Goroutine* is similar to thread and they communicate together via *channels* (Baugh, 2010). Channels resemble some kind of shared queues and they are

thread-safe. You can store values in channel with one *goroutine* and pull it out with other *goroutine*. This is easier and more elegant than work with *mutex* that is used in C programming language.

2 Text Representation and Processing in Go

Textual data processing represent an important category of functionality provided by any universal programming language and/or their libraries. As Google services rely heavily on textual data processing, the natural question is, how efficient the Go support for textual data actually is. In (Polák, 2014) we benchmarked selected typical text data operations.

In order to benchmark three typical string matching algorithms, we wrote implementations of the Boyer-Moore (Navarro & Raffinot, 2007), Horspool (Lecroq & Charras, 2004), Knuth-Morris-Pratt (Lecroq & Charras, 2004), (Navarro & Raffinot, 2007) algorithms – in both Go and in Java. Several different implementations were made in Go – the difference is in data type used for handling with strings (string, char array, rune array). Algorithms were also written in multi-thread way and in single-thread way.

Test data were made for each algorithm – best, worst and average case. Each test data are stored in the 100 MB text file. In every case, pattern is at the end of the text file. Implementations were compared by time that they need for finding the first occurrence of pattern in the text.

For all algorithms, the best results were achieved with their Java implementations. As for the Go data types, string was the one performing the best and rune array had the worst performance of them all. Better results were achieved with their single-thread implementations than with multi-thread implementations.

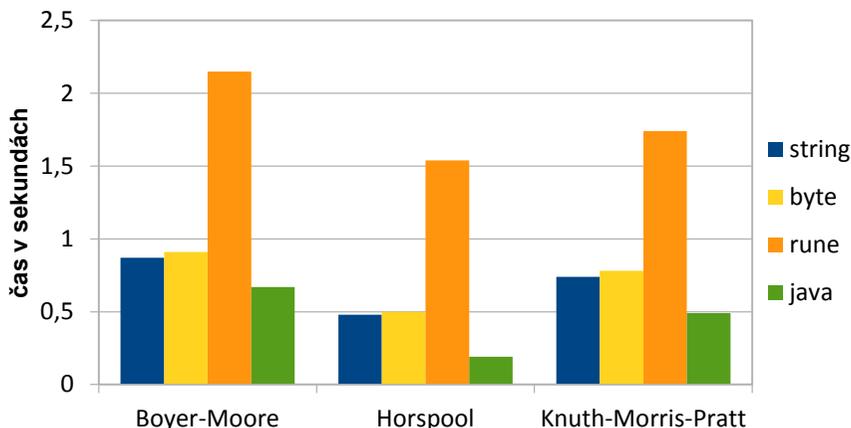


Figure 2 Test results in graph, Source: Práca s reťazcami v jazyku Go (String matching in Go language) (Polák, 2014).

3 Conclusion

In this paper, we introduced Go programming language and shortly mentioned its advantages. However, for a typical class of functionality – textual data processing – the new language did not show any advantage over established Java platform. Particularly, the rune representation of character data did not perform well. The performance difference between single- and multithreaded versions was as expected – the multithreaded version added some overhead which led to a decrease in performance.

To conclude: Go is a promising new language featuring native support for distributed applications. However, there are some typical tasks which might be solved better using legacy technologies such as Java.

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Customer Audit of IT Services

Zora Říhová¹

Abstract. It turns out that the customer, especially in outsourcing IT services larger systems is not able to objectively assess whether the delivering quality of services. The customer controls the contractual outputs and believe the processes leading to them. The customer is usually not able to check and establish possible risk level of individual operations. To confirm the credibility of the services provided and the needs of the financial audit, the customer can request the audit in accordance with ISAE 3402 (International Standards for Assurance Engagements). The paper describes the experiences from the a customer audit and its findings, including recommendations for IT companies and customers.

Keywords: Audit, providing of IT services, standard ISAE 3402, standards ISO

JEL Classification: L86, M15, M42

1 Introduction

External services in the field of business informatics (IT) are a common part of corporate governance. External supplier (the provider) of administration of business informatics either in the form of partial or complete outsourcing related to the trend of increasing the efficiency of core business processes and the availability of quality IT services. Providing of IT services, is based on a contractual agreement to provide the SLA (Service Level Agreement). Contracts generally assume / require that the supplier of IT services is certified according to standard ISO 90001, ISO 20000-1 and ISO 27001. It turns out that the customer especially in outsourcing of larger systems is not objectively able to assess whether services are provided in good quality. Submitter controls the output of a contractual agreement and believe the processes leading to them. The sponsor is usually not able to check and determine the eventual level of risk.

Gradually, there will be fact that as the audits of accounting standards that are used correctly, will be IT more often audited, if standards are used

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correctly to specific dates and specific orders. The reason is that the final data is necessary to audit not only for the work of functional specialists (eg. Accountants) and people who work with the data (eg. Administrators), but also in terms of automated information systems (eg. Accounting data are processed only accounting but their processing is automated of information systems). The reason is to verify the correctness, truthfulness, credibility and legitimacy of the processing.

In case the customer needs to examine the services and their implementation, may request the audit in accordance with ISAE 3402 (International Standards for Assurance Engagements), which is respected by financial auditors of customer. Standard ISAE 3402 is in force since 2011, and follows the SAS 70 standard. ISAE 3402 certificate is issued with a validity of the financial year in which related the controlled data.

It will be demonstrated the most important aspects and problems that emerged during the audit for IT service providers who have ordered and paid by the customer.

2 Audit

„Audit is generally objective verification of status, phenomenon, purpose, or effect becoming a desirable phenomenon, ie. models, norms, standards, etc. Audit is inspected by an expert - auditor, the result is a comprehensive view as the audit opinion. Audit is one of the management tools Svatá (2012)

We can also give another definition that captures the essence: *"Control is a summary of all policies, procedures, practices and organizational structures that are created in order to provide objective assurance that business objectives will be achieved and that undesired events will be eliminated in advance or at least early detected and corrected* (INSTITUTE, IT Governance, 2007).

For additional information with audit issues may also be obtained for example. In (SANDERSON, 2012), (ELDER, 2010).

IT service providers commonly known standards such as ISO standards of quality, safety or performance of IT services. ISO Certificates are valid for 3 years (each year has to be done supervisory audit) and most IT companies are leaving it up to those standards certified. ISO standards essentially proclaim

that all business processes must be documented, managed and continuously improved. The most common certification regarding the standards ISO 9001 ISO 2000-1, ISO 27000, ISO 10006, ISO14000, ISO18000. Mostly provider for this certification prepares an internal audit and then follows an audit conducted by an external auditor who shall grant / not grant certificate declaring the conformity with quality standards (<http://www.cqs.cz/Normy/CSN-ISO-IEC-20000-12012-Management-sluzeb-pro-informacni-technologie.html>).

Praxis but forced audit procedures that are reviewed services even companies that have ISO certificates. Normally the control of the services performed on the basis of regular reporting of contract (SLA). However, there are situations where a customer needs to have certainty about the course of providing services, and not just reports at specified intervals. In this case, it is appropriate to use audit in accordance with standard ISAE 3402.

3 Standard ISAE 3402

Standard ISAE 3402 is an international standard for ensuring global standards for reporting and control of service organizations, made by auditor, whose aim is issued for the purpose of user entities and their auditors' report on the controls of a service organization providing services to user entities when those controls may be relevant for the internal control system of user entities' financial reporting. (http://isae3402.com/ISAE3402_overview.html). Effectively used by June 15, 2011. Extends the standard SAS 70 (the Statement on Auditing Standards No. 70), which defines the standards for auditors, which must apply in internal controls at service organizations. SAS 70 was developed by the American Institute of Certified Public Accountants (AICPA) as a simplification of criteria auditing standards originally defined in 1988 is also standard ISAE in compliance with the requirements of the Sarbanes Oxley Act (SOX).

The ISAE 3402 audit report are classified as either type I or type II. In the type I service auditor evaluates the efforts of organizations in the audit period to prevent accounting irregularities, errors and distortions. The auditor also assesses the probability that these efforts will produce the desired future results. A type II contains the same information as in type I, moreover auditor attempts to determine the effectiveness of controls agreed by their design

/ implementation. Messages of type II generally include data on customer selected the six-month period. The reports are part of a financial audit of the customer.

This audit is carried out mostly multinational companies that have prepared templates and frameworks that then systematically reviewed. The contents are examined in the same area as standards ISO 2000-1 and 27000, namely:

- Change management, implementation and approval solution
- Logical and physical security
- Configuration management
- Incident and Problem Management
- Data Management
- Risk Management
- User Management

4 Planning and procedure of audit

Summarized experience based on my own working in the field of certification and audit projects with IT service providers in the position of Project Manager and Process@Risk Manager. Audit according to ISAE 3402 preceded the experience of auditing ISO 2000-1 and 27001. These audits were more specific and that the matrix took place among a group of states (Dvorak-Rihova, 2011), (Rihova 2011) and aimed to consolidate procedures and compliance with ISO in the group of five states.

The audit plan creates an organization based on planned events (eg. change of seat the organization, mergers, major organizational changes, restructuring etc..). On this basis, begin a responsible person in the organization prepare audit. Phase of the audit, which must be audited organizations by an external auditor to provide assistance are:

- Conclusion of the contract on audit
- Pre-planning
- Creating audit plan
- Implementation of Audit
- Conclusion and issue audit reports
- Monitoring the implementation of the conclusions of the audit report.

Below is an example of the audit according to ISAE 3402, which required the customer as proof of the correctness of the operations. It is not enough merely the fulfillment of contractual SLA, but must also review the various work processes and personnel data passes through the system.

Audit included all countries (18 in total) that provide IT services for the same customer, whose results affect the financial audit of the customer (SAP projects, SAP server, data center). The objective of the audit was to pass without disagreements and incorporate all the recommendations emanating from the audit.

The audit was conducted by Ernst @ Yang (EY) - and for the Czech Republic was intended Munich branch EY, who invited a Czech-speaking consultants. This will ensure that auditors can study existing documents delivered in Czech.

The audit was planned in terms of scope, time and personnel requirements. Customer provided to the audit the SAPserver that is located in a data center customers and examined the activities in the predetermined half year.

Consulting company EY submitted one month in advance of the audit plans, in which the first specified the areas in which the audit will cover. Preparing for the audit was minimal because of the submitted templates was not clear what specific documents or data will be examined.

Duration of audit was originally set to 5 days. In fact, the audit was conducted two months in which for the auditors had to be continually present methodology, contracts and real listings of data on which to judge the accuracy of the provided services.

The thoroughness of the audit was based on proving:

- what methodology / contract / higher corporate standards / are used
- that all relevant staff are familiar with the methodology or contract.
- whether the declared data practices are really used, and concrete activities are documented and checked (on selected a six-month period).

The auditors investigated the status using interviews, studying documents and solicited specific listings for the processing. The audit was conducted correctly, very thoroughly and absolutely consistently.

The areas of audit were therefore defined in advance. Here are the main areas that were investigated:

- 1) Reporting - whether in contract requirements, if they are regular, where it stores that are properly signed, whether any complaint from the customer and how they are handled.
- 2) Management of availability and continuity of the area is highly tied to risk analysis. It had to demonstrate testing of emergency plans at least once a year and it was necessary to demonstrate the relevance of individual measures in accordance with the contract
- 3) Risk Analysis - Risk sharing in small (does not endanger the productive operation of SAP), medium (could endanger the productive operation of SAP), large (threaten productive operation) and the current methodology for risk analysis, the auditor examined with the greatest care not only in theory, if is and as defined in the agreement and in the methodologies providers, but also from the practical compliance (extracts from the diaries of operating - if any amendment is given degree of risk and what measures are taken to eliminate the risks - eg. eyes controls, the administrator of one shift checks activity second shift). Preparedness for risk management at individual cases took a lot of time (examined in almost all areas, especially by changes and testing). Mandatory monitoring is an important part of risk management.
- 4) Management capacity - examines the existence of the planning process, including the capacity of the responsible person. There must be a capacity plan, including procedures and techniques for condition monitoring capacities.
- 5) Security of information and the associated physical and technological security are examined according to established security policies - for example system backup to tape, storage of tapes, marking of tapes, tapebook on storage, eligibility to the server, cardbook, monitor the entrances to the server room each day, administrator passwords.

- 6) Incident Management - examined was the helpdesk functionality, if all incidents are recorded, including the solutions, time for the solution and related communication with the customer.
- 7) Problemmanagement - the auditors examined the documented procedure for escalating the incident records of troubleshooting, time for solution, etc.
- 8) Configuration Management - here it was necessary to prove age, technical for the individual components used. Here audited by auditors completeness databases, identification of configuration items and their records in the database, a tool in which the lead.
- 9) Changemanagement - an area which required a detailed care of auditors, when entering changes, authorizing changes, solution design and approval of authorized persons, control tests, related documentation. Even changes of a technical nature must have been approved by the customer - if it is not explicitly in the contract. Thus also the administration (eg. enlargement of memory)..
- 10) Release management - the documentation of preparation and release of new versions, acceptance testing, acceptance protocols. Everything has been studied to form and content of selected examples.
- 11) Customer satisfaction survey was part of the terms of the regularity of surveys and monitoring, evaluation and settlement of possible negative trends.

5 Evaluation

The findings of the auditors were four levels. The findings, which could eliminate immediately (eg. traced the relevant minutes of meetings, change some inaccuracies in the formulation of internal standards, finding all the cards to enter the server room and complies with book entries) and may not be placed in the final auditorsreport.

Furthermore, the findings of category small (low), which is already in the final report stated, but their severity was not for limiting the audit result (drawing attention to a particular situation, for example missing signature in the minutes of the meeting, which in turn added, inconclusive evidence of

knowledge of certain standards of staff service server, management books of backup tapes.).

Findings of secondary importance (medium) from the standpoint of the customer could cause problems and auditors were formulated as recommendations (eg. implement rigorous monitoring and supporting of four eyes when performing any operations, conclusive test plans, create test plans, methodology, the documentation of the transition from the test in the production environment, risk assessment of the operating log in implementing certain changes and a threat to the productive operation, objections to use excel as a database CMDB (the author can not ensure the relevance of the changes).

The most serious findings of the "high" category are serious findings that may affect the productive operation of the system and the quality of the results. For example a missing document, the customer in writing identify changes which agrees in advance (preauthorized changes) and is not necessary to ask the customer for approval (eg. technological change - extension memory, deleting old files, backup). This category would include major findings of such findings. Unless the provider has failed to show recovery from backup tapes (at least once a year, non-compliance statement inputs to the server with a cardbook of entry, policy of change the passwords etc.

The removal of the findings of all levels took customer (special reports are reported corrective measures), the auditors recommended the removal of the findings of levels medium and high. It was established a deadline and the auditors these measures thoroughly checked.

In case of any failure of corrective actions by the provider has not received, so a certificate ISAE 3402 and its processing and the providing of IT services should not be regarded as true. This would not have obtained customer financial statement audit with "without reservations" with all the other consequences.

The audit was conducted in all countries where customers had their services (18) and it was necessary to remove all categories and findings in detail these remedies document.

6 Recommendation

In IT companies is necessary to build a system of quality control is necessary to know not only IT professionals ISO standards, but also internal documents. It is necessary to monitor that shows deficiencies in the systems themselves or their additional adjustments may err providers not only in personal security, but also in technology (inconsistent administration, unchecked and insufficiently tested treatment program, but also handling the program, unacknowledged or unauthorized changes in the program, the deployment of new HW) and it could be that the system would have to provide correct and true data.

Recommendations for IT service providers can be summarized in the following points:

- Having an enterprise-wide IT policy and emergency plans
- Implement a systematic checks documented procedures;
- Select and train staff;
- Establish and follow safety rules.

7 Conclusion

Customer audit is one of the ways to check the service vendor with an impact on financial services and thoroughly map the working and safety procedures. Certificate ISAE 3402 is eligible document for financial authorities and financial audit client, as evidence of the credibility and reliability of the outsourced IT services. Audit of this type is very strict audit, which the customer pays and who very carefully examines and evaluates the submitted documents and data.

This audit will force providers to realize the important details that are often perceived as self-evident and formal. Audit reveals weaknesses and risks, which the provider often not even aware of yet because everything works and contract services to provide. Applies the need for continuous monitoring and improvement of processes and thereby increasing efficiency, controlling state verification setup and optimization of the business.

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Transaction Model for Value Oriented Business Process Modeling

Jaroslav Ševčík¹, Jaroslav Žáček², František Huňka³

Abstract. The paper proposes a new transaction model for value oriented business process modeling based on the Resources Events Agents (REA) enterprise ontology. The transaction model is formalized by the Petri Net theory. First part of the paper introduces common business processes and analyses general transactional model approaches in business processes. Second part defines the transactional model with respect to the REA enterprise ontology and defines the transaction model states. The model itself is defined and visualized by the Petri Net modeling tool. Third part shows practical example of the proposed transaction model. Last part of the paper concludes results and discusses a practical usability of the proposed transaction model.

Keywords: transaction model, value oriented business process modeling, petri nets, REA ontology.

JEL Classification: L14, L23, M11, 021

1 Introduction

The most significant business goal of any enterprise has been the maximum utilization of facilities available to achieve desired objectives of productivity and profitability. Most of the companies use a business process to describe and control their productivity. Most of analysis is done through specialized software created according to specific requirements of the company. However, the transaction model is not a direct part of the business process and therefore the business processes are not able to control the process comprehensively.

1.1 REA enterprise ontology

Resources, Events and Agents (REA) enterprise ontology (Geerts, 2000) is a concept for creating enterprise infrastructure designs based on resource ownership and its exchange. REA model concepts are divided into two groups: operational level and policy level. Operational level forms the core of the

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model and describes the specific facts that can be observed. The operational level includes basic concepts: Economic Resource, 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 (Hruby, 2006).

To monitor the values in the model of the business processes we have to use a transactional model. However, REA enterprise ontology does not contain the transactional capability (Hunka, 2014). This fact is very limiting for practical usage. We can define the ontological frame, but we cannot watch and follow the steps of the ongoing business transactions.

2 Transactional model

This part defines the transactional model with respect to the REA enterprise ontology and defines the transaction model states. Transaction model is based on Design and Engineering Methodology for Organizations - DEMO (Dietz, 2008, Pombinho 2014, Dietz 2004 and Dietz 1999). Transactional model presents a view of the individual states of the transaction. There are basic form states: request, promise, production, demonstration and acceptance. Designed transaction model is a basic description of the transaction. It does not describe a refund or other contingencies. There are two roles - an initiator and an executor. Figure 1 shows the transaction model.

The first state of the beginning transaction is **Request**. This state represents the point where the initiator formulates his requirements. Example of a request could be the interest to buy a product (for example a pizza).

When the request is formulated, it is forwarded to the executor. The executor decides about the acceptance or rejection. It is represented by a pair of states. If the executor has determined that he is not able to fulfill the requirements, then transaction will move into state called **Rejection**. The transaction is unsuccessful and ends after this transaction state.

If the executor determines that he is able to fulfill the requirements then transaction moves to state **Promise** and the executor promises to fulfill the request.

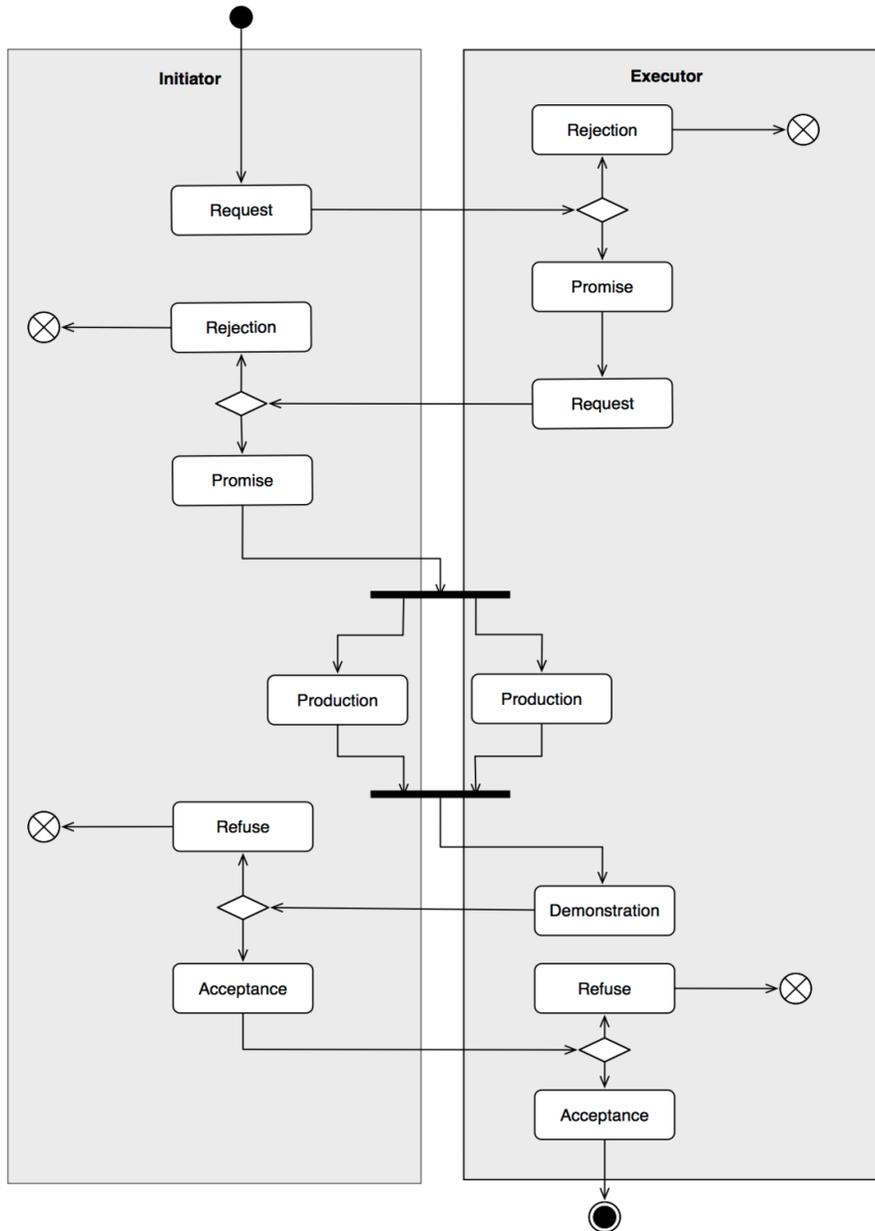


Figure 1 Transactional model. Source: own.

There is another state, which is a **Request** of the executor. At this stage of the transaction the executor formulates conditions under which he will fulfill his promise. An example may be the price of the pizza and delivery conditions. This is a situation where the executor specifies characteristics of the resource - what he wants to get in return for his resource. Once the requirements are specified, they are forwarded to the initiator for approval. The approval process is represented by two possible states. According to the decision of the initiator may follow state **Rejection**. This happens when the initiator does not agree with the terms of the executor. In this case, the transaction ends unsuccessfully. However, if the initiator accepts the executor's conditions the state is changed to **Promise** on the side of the initiator. For example a promise to pay specified price for the pizza.

Once the requirements of both parties are committed, the transaction can proceed to the next phase. There are two parallel states called **Production**, which are on the initiator side and on executor side. The executor is preparing resources to fulfill his promise. An example may be the pizza production process. And the initiator is preparing resources for fulfill his promise. An example is the preparation of financial amount to pay for the pizza.

Once the production phase on both sides is completed, the transaction gets into the next state. This state is the **Demonstration** of executor's resource. The executor presents the created resource to the initiator. An example is the demonstration of the pizza to the customer. This is followed by the initiator's decision, if the executor has fulfilled the promise of the initiator or not. If the initiator rejects, transaction is going to state called **Refuse** and the transaction is terminated as unsuccessful. If the initiator agrees the transaction goes into state **Acceptance**. An example could be that the customer decides the pizza is exactly what he like. This is followed by a decision of executor that he initiator has fulfilled his promise. An example may be that the customer payed the required amount. If the money transfer is successful the transaction continues to the **Acceptance** state and ends as a successfully finished. Otherwise the next step is Refuse and the transaction is unsuccessful.

2.1 Design of the formalism for the transaction model

REA ontology provides a good basic frame (Hruby, 2006) to build an enterprise system without the transaction model. To integrate the transaction model into REA ontology we need to formalize the DEMO

transaction model described in the previous chapter. We can formalize the model by using a Petri net theory. Petri net provides a simple and powerful theoretical tool for studying the problem of concurrency. They are supported by a large number of available tools. Petri net allows modeling and analyzing a large spectrum of management problems.

An important part of the transaction model is the process of exchange. The exchange process consists of at least one incremental event and at least one decrement event. These events change the value of the resources through the transfer of rights to another economic agent. Transactional model determines when the exchange process can be executed. The process of the exchange is modeled using Petri nets and it is shown in Figure 2. There are two kinds of tokens. The first type of token is coordination. It contains information about the exchange may be performed because all conditions of the transaction have been fulfilled. The second type of tokens represents a resource.

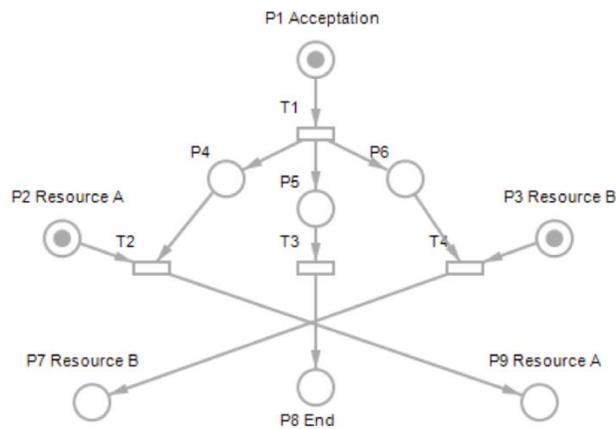


Figure 2 Process of exchange

There is a place P1 Acceptation with a token that represents the fulfillment of the conditions. And also there are two places P2 Resource A and P3 Resource B, which represents the location of resources before exchange process. Places P7 Resource B and P9 Resource A represents the location after exchange for resource. Once coordination token arrives at P1, it goes through the transition T1 to auxiliary places P4, P5, P6. In the next step the token goes into the transition T2 and T4, which issues a command to transfer the resource A from the place P2 to the place P7 and at the same time the resource B from the place P3 to P7. Coordination token ends in place P8 and marks the end of the transaction.

The process of exchange is not the only one in the company. Another important process is a process that creates a new product or service or adds value into an existing product or service. This process is called the conversion process. The conversion process consists of several decrement events and several increment events. In every decrement event is consumed or used some resource. Based on this, there is a production of resources or services which is identified by incremental events.

As you can see in the Petri net example of the conversion process, there are three inputs and three outputs. The token in the middle enter into the model as a controlling token and fires up the token on the left and right side - two resources. After firing the resource tokens the initiators are consumed by the arcs T2 and T3. We cannot model this situation by ordinary P/T Petri net because the situation is not deterministic. We cannot decide if the output token is the resource type or the controlling type. Therefore we have to use a different formalism to model the conversion and exchange process which is fundamental of the REA ontology. To meet the modeling conditions we have to use a modification called Object-valued Petri net (Zacek 2014).

3 Practical example

This part shows a practical example of the proposed transaction model. An example is a small shop with pizza. It was created by formalism of Object-value Petri net (Zacek, 2014) that models the transactional model. This model shows how to process each step of the transaction token in the form of coordination and transfer of tokens that represent resources.

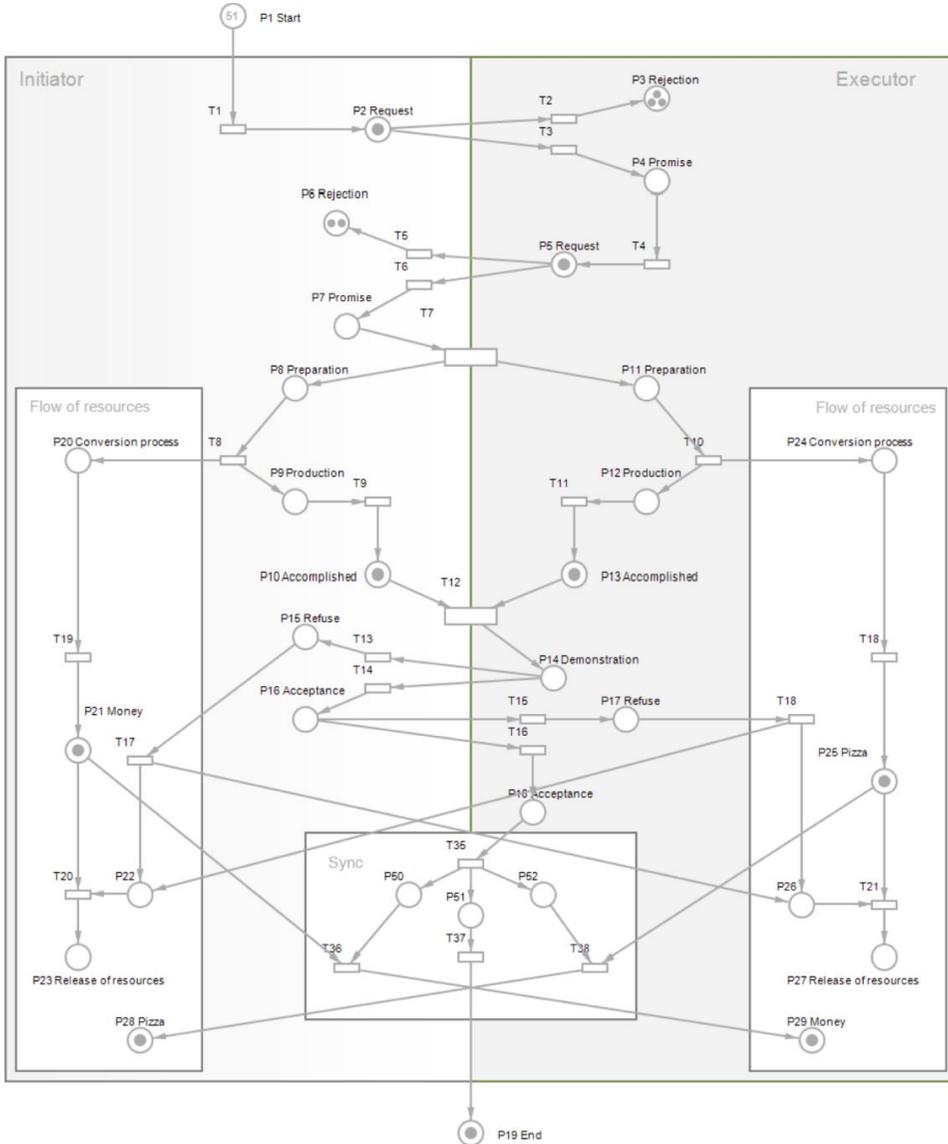


Figure 3 Petri net model

The resulting Petri net is formed by places $P = \{P1, P2, \dots, P29\}$, and transitions $T = \{T1, T2, \dots, T21\}$. Figure 3 show this model. The initial state of the transaction model is in place P1 Start. First, each party to the transaction set requirements and are approved by the other party. This is done sequentially as the place P2 to the P7. Since the transition T7 to T12 part of the transaction proceeds in parallel way. Sections called Flow of resources creates necessary resources for the conversion process. Model presented on figure 3 does not describes only the coordination activities but also shows the flow of

resources. Arc marked as T12 triggers a negotiation process leads to the gradual approval of sources. If there is a rejection of resources, the resources are released. If both sides approves the initiator and executor enters the exchange process and exchange produced resources. In this case the trisection ends successfully.

4 Conclusion

This paper proposes a new transaction model for value oriented business process modeling based on the Resources Events Agents (REA) enterprise ontology with utilizing and Object-valued Petri Net theory. 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.

Acknowledgements

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Realization of the Integrated Management (strategic, process, human resources management) System Implementation Project

Marek Smrček¹, Alexandr Toloch²

Abstract: The project was focused on the implementation of the new method of management and execution of organization activities into a service-process organization, providing its clients with swift and high-quality services based on systemic approach, measurement and continuous improvement of provided services. The goal was therefore to create efficient process-service organization, based on clearly defined services and processes. The process, as the service provider, is controlled by rules (process model and documentation) and can be measured and therefore also controlled and improved. However, controlling just the processes is not enough. It is necessary to create a comprehensive control system, based especially on clearly defined strategic goals. It is therefore necessary to control the performance on the strategy level and to ensure monitoring of its implementation through suitably defined and measurable goals, which will enable us to operate correctly (to define parameters) on the level of processes and activities control, through which we ensure availability and quality of the required products/services of the organization.

Keywords: process model, process control, KPIs, process output measurement, product catalogue, corporate process management.

JEL Classification: M11,M15

1 Corporate process management

Modeling tools integrated in ATTIS.BPM allowed to create well-arranged process map of OIKT ČZU and to display additional attributes in it, describing individual processes/activities (inputs, outputs, matrices etc.) as needed.

It allows dynamic viewing of all levels of process modeling (processes, sub-processes and activities), changing entered data, modification of individual attributes, entering comments etc. A first step in creation of a comprehensive process model of OIKT ČZU was the definition of processes on individual levels of the process tree. We started with

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a definition of the top level of the process tree and continued with nesting of more detailed process levels (Fišer, 2014).

In the OIKT ČZU, we used the standard division of processes to main, supportive and control. For the purpose of mapping of IKT project control center processes, we defined new types of objects in the code list for projects controlled by the center (active, suspended and finished) and object type case for activities, for which description as a process is not applicable or does not make sense.

Kliknout pro vložení nového řádku		
akt. - KO zakončovací	255; 128; 255	<input type="checkbox"/>
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akt. - schvalovací	255; 0; 0	<input type="checkbox"/>
akt. - zahajovací	144; 238; 144	<input type="checkbox"/>
case	173; 216; 230	<input type="checkbox"/>
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Figure 1 BPM process steps types (including newly defined for project and case). Source: own

Entering projects into the process map (PM) within the processes of the project control center (IKT) allowed us to create clearly arranged relationships between projects, project teams and to monitor allocation of personnel to processes and projects, see description bellow, in chapter OIKT ČZU organization structure (Ministr et al., 2009).



Figure 2 Projects of IKT project control center in PM. Source: own

The advantage of process modeling by the above described method is the creation of an interactive model, which illustrates OIKT ČZU hierarchic process arrangement in a tree structure and also contains clear process maps, illustrating the progress of processes to the level of individual activities. The arrangement of the process map ensures understanding and unambiguity of

understanding of the progress and continuity of processes for a wide spectrum of the department's employees.

The process maps can show, along with basic objects, from which the process is modeled, also other attributes for individual objects: inputs, outputs, matrices, relationships from/to, organizational support etc.

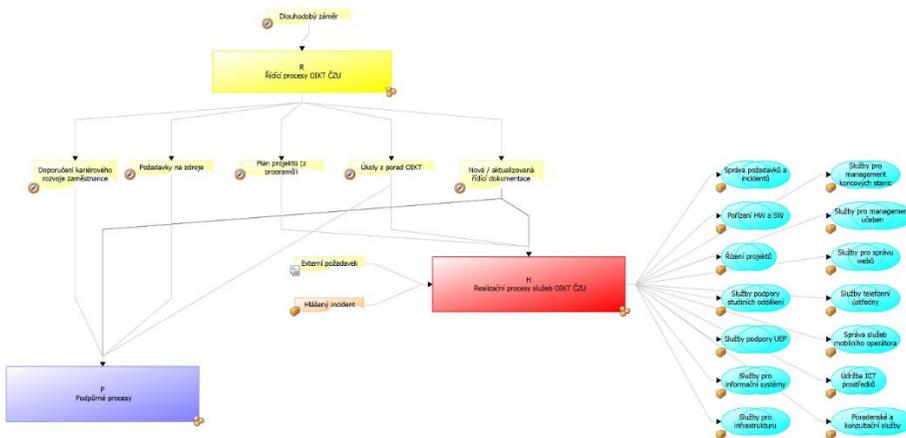


Figure 3 Process map with illustrated inputs and outputs. Source: own

Each process or process step contains attributes for a more detailed description. These attributes are divided into 4 basic folders (main attributes, sources, relationships and other) and each folder contains more detailed division, see figure below.

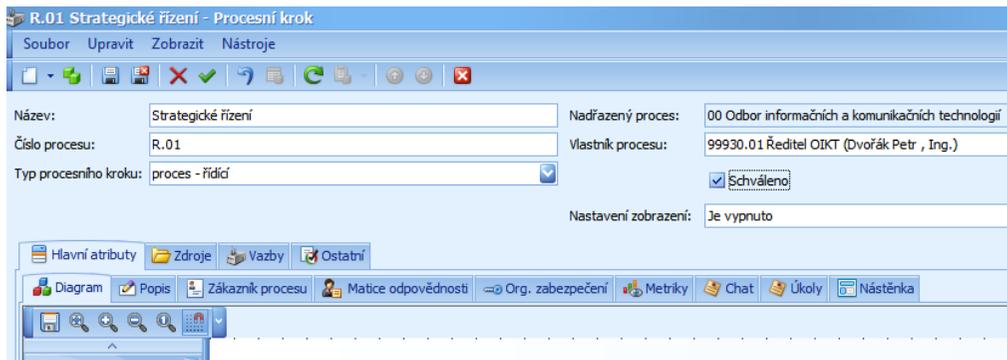


Figure 4 Process/process step detail. Source: own.

2 OIKT ČZU Organizational structure

We created an interactive model of OIKT ČZU organizational structure (organigram) in the ATTIS.org module and we defined working positions,

Realization of the Integrated Management (strategic, process, human resources management) System Implementation Project

workplaces and persons. ATTIS allows completing the classical organigram of a company by process teams, which are widely used within OIKT ČZU for the implementation of projects, as one of department products. Process teams were established for key projects and individual members of process teams were allocated with time resources for executed activities within the processes and projects. The prepared organizational structure model, including the process teams, allowed us to monitor the loading of individual employees, to prevent overloading of resources and better planning of these resources, to monitor the substitutability of the resources, etc.

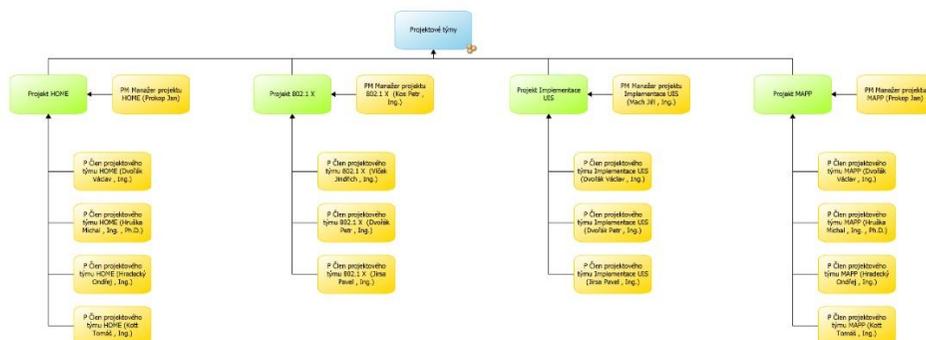


Figure 5 Project teams as part of OIKT ČZU organizational structure model.
Source: own.

The linking of the process model with the objects of organizational structure creates a comprehensive image of process-organizational arrangement of the department. The relationships between the code lists of the organizational structure (ORG) and individual process steps – BPM module code list are defined through process roles, which are assigned to working positions.

The overviews in the process model allow monitoring of relationships between processes, relationships between processes and its customers, displaying of the responsibility matrix for individual processes, comprehensive viewing of process inputs and outputs.

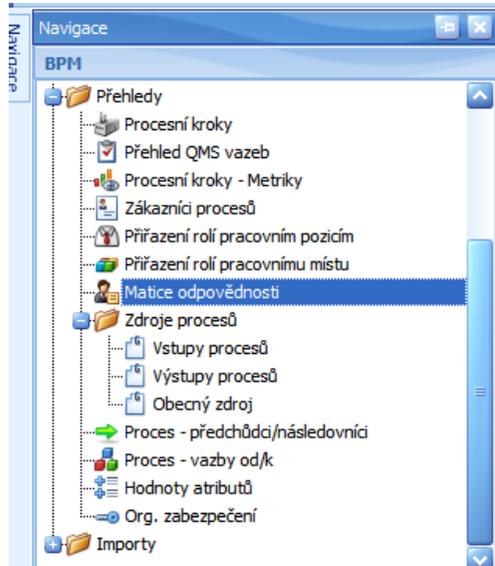


Figure 6 Basic overviews of a process model. Source: own

The overview tables allow quick and easy summary analysis of selected attributes for a detailed overview of the selected context and preset relationships of the process model. The work with records in the overview table is simplified by functions supporting a selection of columns for displaying, grouping according to selected fields, data filtering etc.

Procesní krok	Typ odpovědnosti	Typ procesního kroku	Nadřazený proces
Kliknout pro vložení nového řádku			
Role: Vedoucí střediska infrastruktury (Počet=50)			
H.04.06.06 Návrh, úpravy a aktualizace měření v systému SyDesk	Vykonává	case	H.04.06 Údržba
H.04.06.05 aktualizace HW a SW dle plánu údržby	Vykonává	case	H.04.06 Údržba
H.04.06.04 Tvorba plánu údržby a jeho aktualizace	Vykonává	case	H.04.06 Údržba
H.04.06.03 Evidence HW s informacemi o jeho pravidelné obnově	Vykonává	case	H.04.06 Údržba
H.04.06.02 Návrh harmonogramu a kapacity servisních oken	Vykonává	case	H.04.06 Údržba
H.04.06.01 Administrativní a technologické postupy údržby pro jednotlivé technologické celky	Vykonává	case	H.04.06 Údržba
H.04.04.19 Zamítnutí nebo odložení požadavku	Vykonává	akt. - KO zakončovací	H.04.04 Server
H.04.04.06 Konzultace a schvalování návrhu řešení s vedoucím SI	Vykonává	akt. - schvalovací	H.04.04 Server
H.04.03.19 Zamítnutí nebo odložení požadavku	Vykonává	akt. - KO zakončovací	H.04.03 AV

Figure 7 Overview of process steps for the "Infrastructure department manager" role

The overviews for inputs/outputs and other attributes of the process/process step can be obtained in a similar way.

3 Sources - OIKT ČZU service catalogue

One of the key outputs of the integrated management system implementation is a catalogue of products (suitably arranged list, itemization or inventory of different entities with the same meaning, nature, character, purpose). The items of the service catalogue are connected as outputs of individual implementation (main) processes to clearly show which processes support the particular service, which resources are needed for it etc.

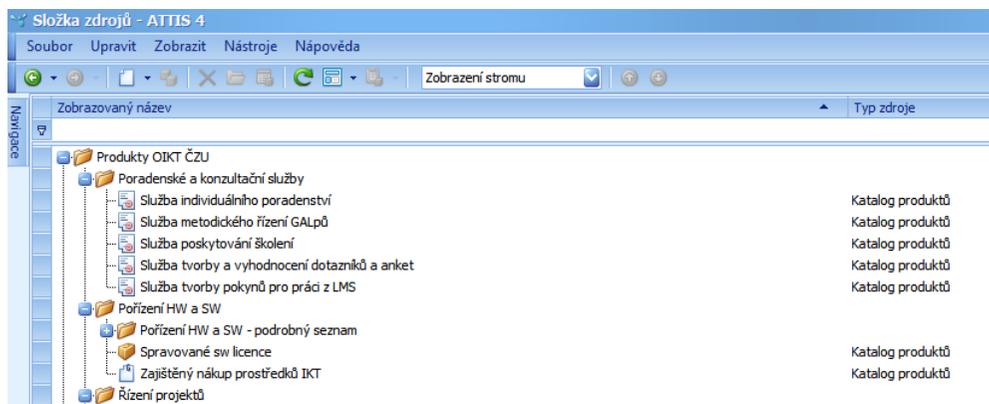


Figure 8 Part of OIKT ČZU product catalogue in source code lists.
Source: own

4 Parameters of SLA

The heads of OIKT ČZU centres prepared parameters of SLA for each item of the service catalogue and inserted them into a formatable description in ATTIS source code list. Therefore it wasn't necessary to create any redundant documentation, the service catalogue administration was simplified and a clear relationship was created between a provided service and an implementation process, which supports it. This relationship allows simple identification of the owner of the implementation process and from a process step attribute - organizational support even for individual employees, which participate on the support of the service at hand.

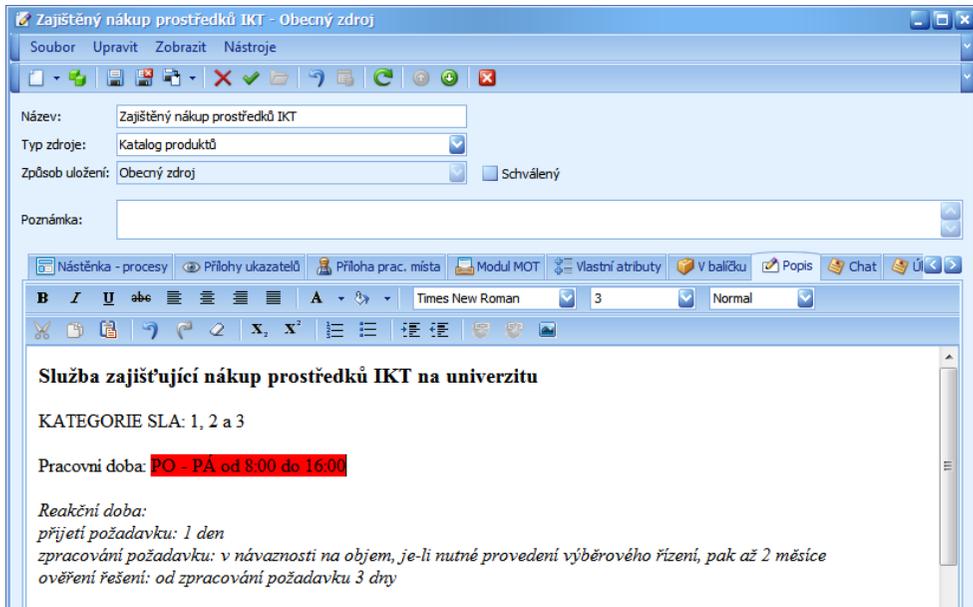


Figure 9 Parameters of SLA in source description (service catalogue item).
Source: own.

5 User defined sets

The most frequently used sets were created using the set designer (standard ATTIS component), such as a service catalogue, employee agenda, competences etc. allowing to generate a selected set in a chosen format, e.g. PDF, by a single "click" so that the update of key documents of the department is as simple as possible. It is possible to generate up-to-date documents after each change of the process model, organizational structure, sources or MBO model.

6 OIKT ČZU performance measurement

The measurement of company's performance is conceptually based on the Management by Objectives approach, but it maintains its versatility and therefore it fulfills the requirements for creation of any system of measurable key performance indicators (KPIs) for anybody – a company, institution, project, individual user

The advantage are the elements of visual management, where the so-called traffic-light system shows indicator and goal values by colour and indicates the development trends of the measured values using color arrows.

Each defined indicator or strategic goal was assigned in the MBO module to a particular employee of OIKT ČZU, together with a responsibility for its completion. The responsible employee should also take part in creation of the indicator interior and its metrics. The visualization of relationships between the indicators allows, in case of need, to identify probable causes of negative development, providing the department management with a useful tool for more accurate and timely reaction (Ministr, 2013b). The breakdown of indicators was conducted down to the level of individual employees of the department. Each of the selected indicators and strategic goals of the department was defined by a detailed description (general verbal and also structured in individual items) and necessary metrics.

Any amount of metrics can be used within on indicator, but in such case it was necessary to specify, how the system should proceed during colouring the indicators in the map by a traffic-light system. It is possible to specify one default metric, according to which the system colours the indicator in the map, or to color the indicator according to the worst or best metric respectively. Auxiliary metrics were defined in certain indicators (summary) for recalculation, which are preset as default and which, in result, will colour the selected indicator.

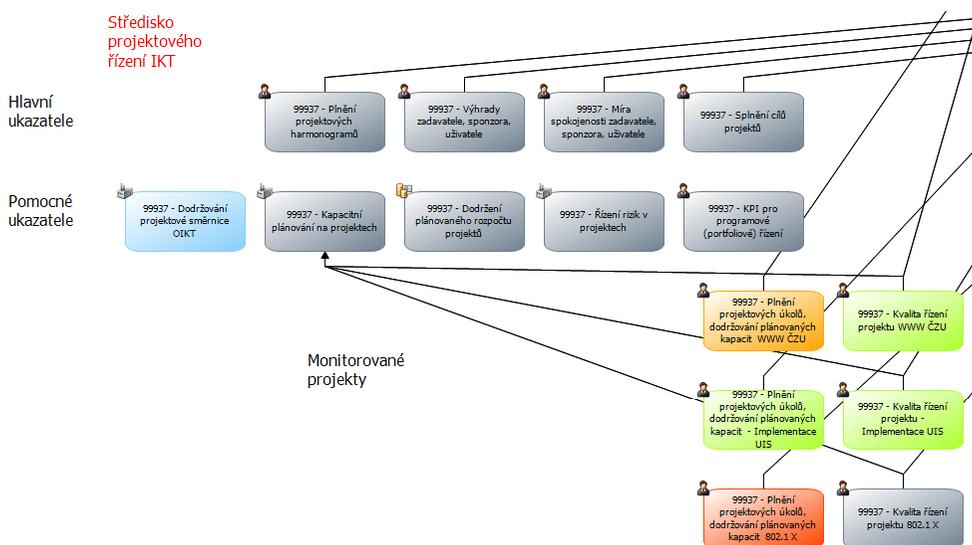


Figure 10 Indicator of the MBO model of OIKT ČZU. Source: own

7 Reporting

Reporting and assessment of values by the "traffic-light" method was introduced in the ATTIS.MBO module after definition and validation. Reporting is generated automatically according to preset time schedules.

Reported values are entered into the system by one of 3 methods:

If the system has a defined formula for calculation, the system reports and assesses the value automatically. During the next stage of the project, an interface for data transfer from other information systems (attendance, helpdesk) will be programmed in the system; the value will be transferred and reported automatically as well. For metrics with preset manual value entry, the system prepares manual entry of values after generation of reporting, the reporting person will receive a notification e-mail (see description below) with a notice, the reporting person will log into the system and manually complete the reported value, which the system will assess and colour with an appropriate colour.

Non-reported reportings in the reporting view are coloured black. It is possible to continuously check how many values are missing in the system. It is also possible to use the reporting lock-out function, which prevents regressive manipulation with values. The system was also preset to request verbal comments upon entering of critical values. Based on experience, these comments are a very good indicator for management and a controlled communication tool for efficiency. If two subsequent values are entered into the system, the system indicates the development trend of these values using arrows in the table and in the diagram. This secondary element allows easy visual orientation in situations, in which e.g. the indicator is in red values, but shows a growing trend.

8 E-mail notification

After the launch of automatic report generation services the e-mail notifications were preset. These notifications are automatically generated in ATTIS and sent to reporting persons after each generation of reporting according to a time schedule (weekly, monthly, quarterly, annual). If the reporting person does not enter a value into the report within 4 days, another notification is generated, inviting the reporting person to report the particular

metric. If, even after this notification, the reporting person does not enter the metric value, after 7 days an e-mail notification is generated and sent with information about the missing reporting to a responsible person (“supervisor” in the MBO model).

9 Fat / thin client

Not all OIKT ČZU users need to model processes, modify organizational structure, edit MBO model etc., therefore it is not necessary for them to access the system through a "fat" client. Fat client is installed for supervisors of the department and other selected employees, whose work agenda requires a full access and for whom it would be uncomfortable to work in a thin client; for other employees of the department, an access through a thin client launched in a web browser is sufficient for reporting, model viewing, chat use, notice board etc. (Ministr, 2013a).

10 Employee's personal page

Each OIKT ČZU employee was created a personal (personalized) page, which after login simplifies orientation and provides direct path to relevant information. Personal page of the logged-in user filters through his/her user account workplaces, processes, documentation, indicators, metrics etc. (Plamínek & Fišer, 2005) which are connected in particular ATTIS models with his/her person.

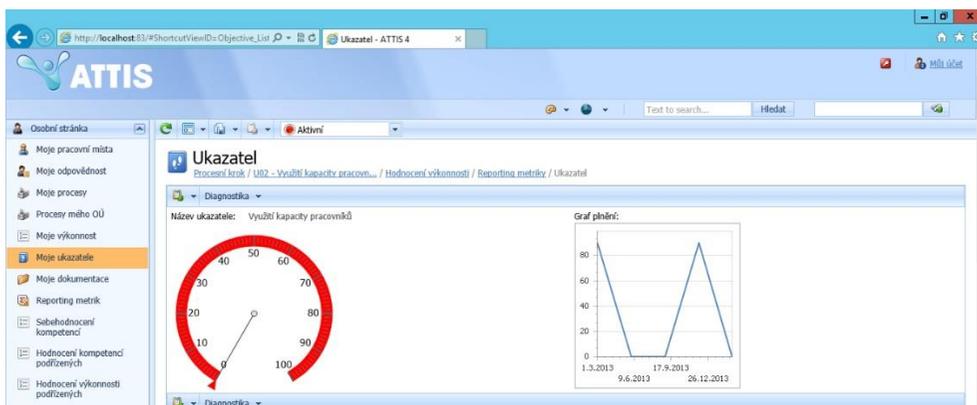


Figure 11 Employee's personal page. Source: own.

11 Conclusion

The planned implementation stages of the OIKT ČZU integrated management system were successfully finished and a regular metrics reporting was launched. Our company provides regular OIKT ČZU support as a part of the service contract; we help the department employees with routine activities within code list management, model and object update and other activities that would represent an unnecessary time burden for OIKT ČZU supervisors.

After approximately one year of full operation of the integrated management system, its benefits will be assessed and the OIKT ČZU management will decide whether other ATTIS functions will be implemented – such as interconnection of competence and output assessment of employees with the reward system.

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The Survey and Measuring Usage of Information Technology Services

Jaromír Veber¹

Abstract. Questionnaire surveys are quite often used in the research field of IT. Thanks to questionnaire survey it is possible to get enough data that can confirm or refute the research hypotheses and it allows to build statistically based arguments. The article is focused on how to create an IT questionnaire survey. Particular attention is paid to options for measuring the intensity of usage information technology services within the organization in the survey construction. The article suggests several practically based possibilities and these are confronted with the general recommendations for survey creation. The results are recommendations for solving this specific problem in practice.

Keywords: questionnaire, intensity, IT, measuring, normalized survey.

JEL Classification: C83

1 Introduction

Considering division into historical periods our time can be described as information age possibly plastic age. In our time the information is considered to be a significant competitive advantage and are now a key factor for success in all fields of human activity (Tvrdíková, 2008). In every moment a huge amount of data is recorded from which it is possible (in different ways) to obtain relevant information.

Different questionnaires are tools for focused data collection, most of them are directly aimed at obtaining specific information (and thus relevant information), or at least information in certain field. Although the field of IT is engaged in processing and storing information, thus in order to improve practice in this filed, it is often necessary to obtain also information about the field itself. The questionnaire is a great tool that allows scientists to obtain enough data. Such data can then be evaluated by statistical methods and results of evaluation may offer up some conclusions (or even essential knowledge).

The use of a questionnaire and appropriate statistical methods does not necessarily mean that our hypotheses are proved / disproved and our claims

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are correct. To achieve this claim it is necessary, in addition to collecting a sufficient sample of respondents also lay such questions in the right way, so that the answers to these questions reflect exactly what we want to know. Art of thinking about what answers our question invokes; whether it is misleading answer, or whether the answers will provide exactly data we need for our statistical methods, is rather complicated problematic that can't be completely covered by this article and I'd recommend reading additional literature during questionnaire construction. However this article should help scientists who wants to create questionnaire in the field of IT.

In this article the author focuses mainly on what issues / questions to ask in order to measure *how much / how intensive various organizations use information technology services*. There are described currently used procedures and many other thinkable alternatives. Among them are emphasized the most suitable ones and the suitability / unworthiness of available options is also argued.

2 General questionnaire construction

During the research for this article, the author failed to find specific recommendations for creating an IT questionnaire, and therefore it can be assumed that the problem is currently solved ad-hoc using general questionnaire recommendations. Therefore let's mention now the general recommendations for creating surveys.

The problem of making the survey falls within the fields of philosophy, linguistics and statistics. This issue is addressed in many papers, let's mention (Dyer et al., 1976; Martin, 2006; Särndal et al., 2003). The question construction considerations introduced in work of Paul Grice (Grice, 1991) led to interesting implications for the interview process:

- 1) Asking a question communicates that a respondent should be able to answer it.
- 2) Respondents interpret questions to make them relevant to the perceived intent.
- 3) Respondents interpret questions in ways that are relevant to their own situations.
- 4) Respondents answer the question they think an interviewer intended to ask.

- 5) Respondents do not report what they believe an interviewer already knows.
- 6) Respondents avoid providing redundant information.
- 7) If response categories are provided, at least one is true.

“These implications help us understand a number of well-established questionnaire phenomena. Consistent with item 1, many people will answer survey questions about unfamiliar objects using the question wording and context to construct a plausible meaning. As implied by items 2 and 3, interpretations of questions vary greatly among respondents. Consistent with item 4, post-interview studies show that respondents do not believe the interviewer “really” wants to know everything that might be reported, even when a question asks for complete reports. Consistent with items 5 and 6, respondents reinterpret questions to avoid redundancy. As implied by item 7, respondents are unlikely to volunteer a response that is not offered in a closed question.” (Martin, 2006, p. 2).

Now let’s mention glossary related to questionnaires and interviews:

<i>closed question</i>	A survey question that offers response categories.
<i>open question</i>	A survey question that does not offer response categories.

3 Questions for IT related questionnaire

As mentioned above the questionnaire for the field of IT is often constructed ad-hoc using general recommendations; however what are the recommendations for structure of questionnaire survey?

“Survey results from a questionnaire may be vulnerable to the structure of the questionnaire, in particular, the order of the questions. It is commonly suggested that questionnaires should start with simple, nonthreatening closed questions, and that questions on particular topics should be grouped.” (Dunn et al., 2003)

There is no general structure for questionnaire and it may vary depending on what information the responses should provide however it is a good and common start to collect some kind of demographic characteristic –information about the respondent. The questions should avoid collecting any personal information unless it is necessary for research (respondents are reluctant to

provide them and might also refuse to fill questionnaire at all) (Taylor and Bogdan, 1984). If the survey is focused on organizations, we want to collect information about the organization the respondent comes from.

Even in this case there may be a problem with some of the questions that the questionnaire respondent mustn't communicate because of organizational information policies, but in other cases the employee will often be willing to answer such questions, because it relates directly to the work he does and such queries are a fairly good start for a survey.

Considering the demographic part of a survey the author in his dissertation (Veber, 2013) encountered a problem: it was required to gather information: "How much / intensively does the organization use its own IT?". It's simple information that might be also useful for other questionnaire surveys; however it is not that simple to collect it using a questionnaire survey.

4 The problem of measuring usage of information technology services

In order to get such an information there are also many ways to find out this information but some options are better than the others and some have their own issues that may not be obvious at first glance.

First and most simple and often used solution is to ask respondent simply to *number of employees and the sector of organization activity*. Although this is a good starting point and it might provide us information to create a picture about an organization and its probable situation in IT it is not accurate for measuring intensity of IT usage. Because not all employees use IT services and also every organization may use IT services in different way.

Next step to improvement considering issues of previous option is to measure (ask for) *number of employees who use IT services*. The cloud services are nowadays quite often charged according to the number of users who use them, so this indicator is likely to be able to indicate the degree of utilization of IT services. However there are three other hitches. The first one is that the service used by 5 employees intensively every day, (for example evidence of stock inventories) burdens IT resources as much as other service used a little by 500 employees (for example attendance records). The second issue is the interpretation of question as mentioned in chapter 2 findings 2) and 3) because

the definition of an employee who uses IT services, is not generally known, and each respondent may interpret it differently. Even though if respondent would somehow interpret the question well there's third issue because he might not be able to supply data for it especially in large corporations, it may be very difficult to find out the answer (number) because it is not usually monitored. For these reasons, this indicator is also not suitable for providing kind of information we want.

Once we shift our attention from measuring (asking) for number of employees we might turn out attention closely to IT. In this domain it might seem suitable to measure (ask for) the *number of different IT services that the organization uses*. But again this indicator unfortunately also faces several similar critical issues. We have to face the fact that the actual number of services is not the same as the intensity of IT services; different services also need different amount of IT resources. For example attendance records service does not need same resources CRM data mining service. And also the problem of question interpretation is problematic because every respondent may understand IT service in different way. Also one service may aggregate more different components that may be operated as separate services elsewhere. And the last problem is again the question whether the respondent will be able to tell us exact or at least approximate number. Those are the reasons to search for other more accurate indicator.

Accurate measurement of the volume of IT services, the organization uses, would theoretically be possible if we'd follow the *computing power used by IT services*. If we'd for example obtain an information that IT services in organization consumed average 200 MIPS / week - it would be fairly accurate information about the extent of IT services usage in company. And despite the fact that this indicator would be affected by the way the organization use IT services and quality of applications, such information would probably be best possible indicator. However, we should not be asking the questions that the respondent is unable to answer, and given that author is not aware that the organization would monitor this indicator, or were able to measure it in a simple way, we had to consider this indicator as inappropriate.

In subsequent considerations, we should stick to performance measurement in combination with indicators that respondent can easily find out. As the best turns out to be *the number of servers that the organization*

uses. This is a number that can be relatively easily determined, or is often observed at the level of IT. Number of servers also indicates necessary amount of computing power - more accurately the amount of power required during peak hours. Consider the issues the previous (rejected) options. The first one accuracy of number – there is still an issue because different servers do not have the same computing power and it may vary considerably. The second one is not an issue at all because if we ask for number of servers everybody will know what we are asking for (well virtualization may complicate it; but let's analyze that later). And the last problem may be whether respondent is able to tell us the number. This is not problem at all because number of servers should be monitored on IT level and IT department of an organization should be able to supply this number. This is the last considerable measurement we find out to indicate the usage of information technology services and it does not suffer so many (so fatal) complications the previous did so let's look closely at how it could be used in practice.

4.1 Evaluating number of servers and virtualization

Nowadays it is very popular to run in addition virtualization software on physical servers in order to provide virtual servers. Server virtualization is becoming very popular. The author processed the survey (Veber, 2013), which focused on a variety of large organizations from various industries and sectors, it was found that in the Czech Republic benefited from server virtualization by 2013 for almost 60% of organizations. There was also identified relatively strong correlation between the number of operating servers and virtualization deployment (larger number of servers means higher probability of virtualization deployment). And it's expected that in the near future the number of organizations deploying virtualization will grow.

However how does phenomenon of virtualization affect the explanatory power of server counting? Using virtualization a single server can run a larger number of virtual servers, and server performance may be subdivided between individual virtual servers. This allows to run larger number of virtual servers on the more powerful physical server and on a less powerful physical server smaller number of virtual servers. However, this may not always be the case, because if one virtual server requires more power, the performance may be assigned to it at the expense of starting smaller number of other virtual servers. Despite this confounding factor, the number of virtual servers reflects the

volume of services better than the number of physical servers - precisely because of opportunity to allocate all available power to individual virtual servers. Thus, if the organization uses virtualization, it is more accurate to inquire about the number of virtual servers. Of course, this number should be monitored on IT level and the IT department of an organization should be able to fetch this number fairly quickly.

So how should we properly ask to obtain information about the number of servers? The question might be: "How many (virtual) servers does your organization operate"? The question, however, apparently is not entirely correct, because it asks for two things at the same time and it may not be clearly understood especially if respondent don't know what the virtualization is. And there is other consideration to think about: "Can we compare the number of virtual servers and number of physical servers (in case when virtualization is not deployed)?" Author found out that we can't compare it simply by value, there are two opposite phenomena during virtualization transition. First – the number of physical servers is dropping mostly 4-20 to 1 as mentioned in (Golden, 2013, p. 36) but number of total (virtual) servers is rather growing because we may run more virtual servers to isolate different services as mentioned in (Herrod, 2006). So the result of transition to virtualization is in most cases lower number of physical servers, but rather higher number of virtual servers. Therefore it is better to add one more question: "*Does organization use virtualization?*" So we get additional closed question – classes for response should be three: "Yes"; "No"; "*I don't know*". The third one should cover respondents who don't know what the virtualization is. During survey evaluation we may simply discard all who did not know what the virtualization is. The original question on the number of servers could be: "*How many servers does your organization use? (In the case of virtualized servers do not count on a physical, but virtual servers)*". Again we are directly asking on simple number. It is better to let this be open question – even though we might need later to classify responses it's be better get classes through clustering statistical methods. Those two questions are ideal for general use since they are easy to answer for respondent and also provide useful information about IT services utilization.

5 Discussion

The number of server is quite meaningful number; however its explicitness can be further improved – for example using other additional questions like: “What is number of cores your servers have?”; “What is age of your servers?” The other indicators could also be improved using additional context or using combination of indicators. For example number of employees using services, number of servers and sector of activity but all these additional queries require additional research to find-out dependencies for interpretation so it’s not completely trivial.

6 Conclusion

The article discussed and suggested recommendations of how to measure the intensity of IT services used in organization in questionnaire surveys. Various methods were discussed their strengths weaknesses were highlighted; at the same time one of the methods recommended for general use. However each survey may require different level of precision while measuring the intensity of the use of IT services, and although various techniques have been proposed, the right option depends on the needs of research.

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MOBILE TECHNOLOGY FOR BUSINESS

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Architecture of Enterprise Applications for Cloud

Jaroslav Šmarda¹

Abstract. The modern concept of cloud solution today indicates a wide range of internet technologies. The quality of cloud-based solutions is decisively influenced by the solution of the highest (application) layer of the cloud.

The basic requirement for the architecture of cloud applications is that one installation of software must serve all customers in the cloud. Suppliers can then provide regular new versions of applications that are immediately available to all customers.

Such applications must allow configuration for individual customers unlike customization, which is associated with the generation of multiple clones of applications. Model-driven agile development is usually used for cloud applications. As an example of the software architecture of cloud applications I introduce our Vema V4 Cloud solution. We have more than 500 customers of V4 Cloud applications.

Keywords: software architecture, cloud solution, configuration, customization, metadata-driven application, model-driven agile development.

JEL Classification: C88

1 The basic attributes of cloud solutions of enterprise applications

In many cases the development of cloud solutions is restricted by a low amount of enterprise applications suitable for clouds.

The term „cloud“ includes several layers of hardware and software solutions. In this article we focus on the application layer of cloud, which is called SaaS (Software as a Service).

This introduction focuses on the six main attributes of cloud solutions according to Naomi Bloom (2013) who is dealing with the attributes of SaaS. Bloom calls this solution Blooming SaaS.

The first and the most important attribute is that **software architecture of enterprise applications is type 1:N**. This architecture is also called multi-tenancy. 1:N means that there is only one installation of the software necessary

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and all the customers of the cloud can use it. This results in a substantial increase of effectivity.

Architecture of 1:N needs the enterprise applications to be designed to have the same code for all the customers.

With our solution Vema V4 Cloud one version of the application (e.g. application for salary processing) has the same code for processing in the Czech Republic or Slovakia and also for all the resorts such as education, health etc.

The second attribute is that **the application performance is provided as a service through the internet according to the contract with the provider.**

The contract is very important and is usually for several years. According to Vema V4 Cloud (2014) it is the same case with V4 Cloud, where the contract guarantees the availability of the service and security of the processing to the customer.

The third attribute is that **the software and the data are at the provider and processed by the provider.**

In case of V4 Cloud software and data are located in a professionally administrated data centre. The centre is secured from fire and other types of damage. The data also has a backup outside of the data centre.

The fourth attribute of the cloud solution of that **the provider regularly offers new versions of enterprise applications, which are immediately available to all the customers.**

This is similar to the regular internet solution, when new versions of sites appear without notification and the users usually do not even notice it. Do you know what is the current version of Facebook and what was it like a month ago? These new versions are a necessity due to the increasing number of users and the fact that there is one version for everyone. The provider of 1:N applications is fully in charge of the distribution process and the single installation, so he can promptly react for example to legislative change and then make a new updated version available for all the users.

In case of our solution V4 Cloud we usually supply four big **versions** a year to our customers and at basically any time in just a few hours we are able to create a new, small version of the application we call an **update**.

The fifth attribute is **YES to configuration, NO to customization**. Customization means individual change for one or only a few customers. This customised version of the application cannot be operated in the 1:N regime, but only in the 1:1. The way how to satisfy the individual needs of customers is through extensive configuration.

In the case of V4 Cloud there is a huge amount of attention paid to system and application configurations.

The sixth attribute is the **development of model-driven applications for cloud solutions**. The next part will be focused on the fifth and the sixth attribute in detail.

2 Metadata-driven Applications

The requirements for 1:N applications are much higher than the ones for 1:1 applications. The most important ones are:

- the algorithms have to be universal enough to handle processing of all the customers
- the application has to provide a new version regularly and often
- the application has to be configurable in a way that individual changes can be made for each customer
- From the requirements it is evident that 1:N application must be “smarter” than most applications.

Metadata are any data about other data. In this case it is data processed by applications, e.g. in our payroll application the data are the personal numbers, names and salaries of the employees. Metadata can then be the data on structures, range of characters, or currency of the salary.

According to Naomi Bloom (2013), **modern applications are metadata-driven**. In comparison with earlier applications, which mostly contained code, modern applications contain a strong layer of metadata and less programming.

In modern applications the most of functionality is abstracted to metadata. Interpretation of metadata is one of the main algorithms. The application then goes through the metadata and does the processing.

The configuration of metadata-driven application means enabling the user to change a certain part of metadata by using a configuration programme.

3 The Model-driven Development of Applications

Metadata are a key part of modern 1:N applications.

Modern applications suitable for 1:N regime contain many functions that are the same for applications from practically any domain field. Applications from different domain fields process different data, but a big part of the functionality abstracted to metadata is the same, as well as the system attributes and functions.

Vema applications that fulfil the requirements for 1:N regime are used here as an example.

In all Vema applications the access to data is provided with the use of a universal **data processor**, which we call data editor. The applications of course contain a strong layer of metadata. The data processor interprets the metadata when obtaining and updating data records.

3.1 Application Generator

The common attributes of applications and functionality abstracted to metadata create a solution; first a model of the application is created and then the application (the main structure of it) is generated by a common application generator. The main part of the generated application is of course metadata.

According to Šmarda (2010) our application solution is exactly the same. One of our applications is the **application generator**, which also has the same attributes as the other applications.

The generator is used for the definition of the **model of the application**. The model of the generator is naturally also defined.

The term “model of the application” represents a few tables where the basic parameters and the data model of the application (metadata) are defined.

The main function of the generator is generating the applications. The generated application consists of metadata, data processor functions report generator and other system functions. When using the data processor above the configurations data, the application can automatically use the configuration editor and also the tool for the definition of the access to the other parts of the application according to the user role (a safety model). Functions that are specific for the domain field (e.g. counting of the salaries in the payroll application) are written in C++ or Python and are connected to the generated application. Also these functions have access to the metadata of the application. In future it seems more perspective to use Python instead of C++.

4 Conclusion

Enterprise applications operated in a cloud, i.e. in the 1:N regime when one installation is used by all the customers in the cloud, need to fulfil new types of requirements.

Modern applications that fulfil these requirements are using a strong layer of metadata and we call them **metadata-driven applications**.

The way to develop modern applications operated in a cloud is **model-driven development of applications**.

This is the development used by Vema. The success of our approach can be demonstrated by more than 530 customers in the Czech Republic and Slovakia that use Vema V4 Cloud.

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Development of the Business Information Systems - ITS Reflection in Education at Universities

Milena Tvrđíková¹

Abstract. The pace of change in our society is increasing in all fields of human activity. Changes require knowledge, flexibility and fast access to information. These trends place greater demands on teaching in universities. Information and communication technologies (ICT) providing modern infrastructure play a key role in these changes. ICT support most of the changes and facilitate the compliance with the requirements placed on individuals. Simultaneously, ICT also provide tools to increase efficiency, innovation and competitiveness in virtually all sectors of the economy.

The basis for the effective use of ICT is understanding of the information needs and understanding of key processes in a given activities. To increase the competitive potential and improve the quality of corporate governance are offered innovative comprehensive Enterprise Resource Planning (ERP). ERP systems are undergoing noticeable change that affects both the users and suppliers of such systems. This paper discusses the selection of the type and manner of implementation of ERP for provide teaching on economic faculties at universities.

Keywords: Integrated Information Systems, Enterprise Resource Planning - ERP, Business Intelligence, Cloud Computing, Education.

JEL Classification: I25, O33, L26

1 Characteristics of Integrated Enterprise Information System

Today, the acronym ERP (Enterprise Resource Planning) is used to denote comprehensive information systems (IS) of organizations that integrate and automate a large number of processes related to the relevant company activities (activities related to the production, finance, accounting, supply chain, CRM, HRM, etc.).

Before, ERP used to denote the unification of the various company applications and platforms into a homogeneous solution. In connection with

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the rapid development of ICT and the increase in the amount of available information, this solution is no longer sufficient. User demands for quality, scope and content of information have increased.

This led to a further improvement of integrated systems and their inclusion in ERP:

- Business Intelligence (BI)
- Customer Relationship Management (CRM),
- Corporate Performance Management (CPM),
- Supply Chain Management (SCM),
- Enterprise Content Management (ECM),
- Electronic Data Interchange (EDI),
- E-business applications.

As a result, this gives rise to an issue that is still current. What is better ? "All in one" or "Best of Breed"? Although "Best of Breed" systems can be easily modified, mutual integration between the various systems is often complicated.

2 Trends in ERP

In the context of ERP, the major trends are as follows, as stated in (Mikoláš, Peterková and Tvrđíková, 2011):

- Connection to social networks – expanding social and professional interaction. Social networks have become not only a source of entertainment, but a popular source of information and ERP components. Especially those that help to look for work or associate members of a particular ethnic group or professional or amateur artists (LinkedIn, Naymz, etc.).
- Fabric computing – (a new generation architecture for enterprise servers) a trend in existing server technologies. The combination of powerful server capabilities and advanced networking features.
- The move to Cloud computing and service development in ICT.
- The ERP trends also include automation – linking suppliers with customers using greater automation, e.g. automated ERP portals or connection to Electronic Data Interchange (EDI) – exchange of structured messages between computers and computer applications. Data are structured according to pre-agreed standards agreed upon at the level of national or international standardization communities and then

electronically transferred automatically without human intervention in the form of messages. The EDI is the most widely used data format for electronic business transactions in the world.

- Connecting the company IT to a search engine – Enterprise search.
- Connection to a functioning e-government.
- Another major trend is mobility – companies are sufficiently equipped with mobile ICTs and want to use them in business processes.
- Pressure on quality of the ERP user interface. Users are no longer willing to put up with working in ERP as a necessary evil, require intuitive and user-friendly work with applications.

3 Business Intelligence Tools

The term Business Intelligence (BI) means a system of tools, project solutions and organizational measures which enable knowledge management of organizations. These tools are increasingly applied in companies and institutions worldwide. Stackowiak, Rayman and Greenwald (2007) describe BI as "having the right access to the right data or information required for appropriate decision at the right time".

BI tools represent the effective interconnection of data potential of the company operating transaction system with the analytical needs of the individual management components:

- they can access an information database by means of a specific access, and can also generate reports,
- they provide on-line analytical means,
- they make available a broad field of internal and external data,
- they are simple to use,
- they are used directly by managers without assistance,
- they present also information in graphical form.

BI systems transfer large volumes of raw data into logical structures that represent the control and decision-making processes in the company.

The multidimensional nature of BI tools is a distinguishing feature that allows you to quickly and easily create new views of data, put them into a new context, search patterns (trend characteristics), indicate key indicator deviations from planned values, work with history and anticipate future development as say Davenport, Harris and Morison (2010). BI applications are

primarily based on the use of the so-called multidimensional data storage. It is based on a multidimensional table (data cube) allowing fast and flexible changes of dimensions, i.e. changes in the user's view of the modelled economic reality.

The view of the economy of any organization is multidimensional. The tasks of this nature are typical tasks in enterprises, government, banking, audit offices, etc. The advantage of BI applications in solving these tasks is their ability to work very flexibly in a super-spatial matrix with a significantly larger number of cells.

As you can see on figure 1, the effect of BI tools as an integrating factor of enterprise IS is very significant.

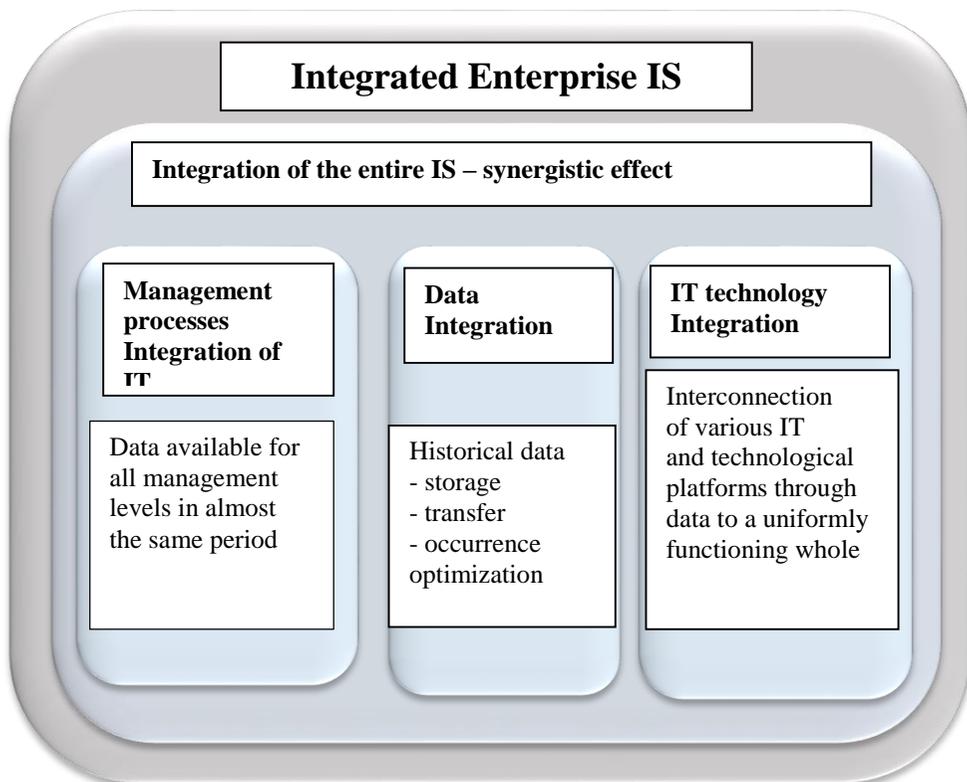


Figure 1 Integrated enterprise, IS Source: Tvrđíková (2008)

The result is as stated in Tvrđíková (2008):

- Integration of control processes – data are available for all levels of management within almost the same time limit.

- Data integration – data warehouse creation and data mining.
- Information technology integration – they interconnect (at least by linking various data) various information technologies and technological platforms used in the company, they drive the interconnection of the company's IS into a functioning unified whole.
- Total system integration – BI applications are among strategic applications within the company. They transmit data between all levels of management in the company and thus represent an important factor for integration of the whole IS of the company. In their development and implementation, awareness of the various parts of the company's IS is gained which leads to ultimate integration into a synergic ally functioning whole – Integrated enterprise IS.
- The data quality can be defined in different ways, in this case, assign an arbitrary simple definition – quality data are those that correspond to the reality, they are complete and consistent. If you want to work with the best data, we have to ensure their five essential characteristics. Completeness – the need to identify and treat the data that are missing or unusable (for various reasons). Compliance – all data should match the requested format, Consistency – data may not contain values that represent conflicting information. Uniqueness – if there are duplicate entries, they must be removed (not necessary for data warehouses). Integrity – all data should include all the defined relationships to other data.
- Data quality is currently mostly suppliers of information technology designed as a set of two processes-data quality analysis (data profiling) and correction and repair data (data cleansing). These processes are repeated on a regular basis and are reflected in the data warehouse environment.
- The BI data infrastructure consists of Data Warehouse, Data Marts, Operational Data Store and Data Staging Areas. Data quality is one of the basic requirements for Data Warehouse and Operational Data Store.
- As well as quality data, metadata also form an essential part of any modern information system. The main advantage of the existence of metadata is easy understanding of the principles, functionality and content of IS. The importance of metadata as the main tool for establishing the content and status of IS has significantly increased in recent years. The basic reason for the existence of metadata is that

they give context and sense to otherwise inaccurately described cluster of information. Metadata in a company can be divided into two basic groups. Technical metadata is information about the settings of individual IS and relevant technical processes (e.g. how to acquisition and frequency of the data in the databases of the data warehouse, etc.). Material metadata – information on relevant content solutions, thus adding context and the importance of individual values (and not only in terms of content, the importance of this expression-as is understood in the organization, but also in the form of a calculated-how it is possible to arrive at the value of this expression).

4 Cloud computing

NIST (National Institute of Standards and Technology) defines CC as „a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources” (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. The second part of the definition describes actual added value: „CC Model consists of five basic characteristics, three models, and four implementation models”. Model shows table 1.

Table 1 Cloud Computing Model CC 5-4-3 (NIST), corrected by Macquarie.

Source 1: http://www.t-systems.cz/produkty-a-reseni/cloud-computing/604902_1/blobBinary/pdf3-ps.pdf

Services requested	5 CHARACTERIZATIONS		
High-speed access	Public Cloud	4 IMPLEMENTATION MODELS	
Source sharing	Private Cloud	Infrastructure as a Service IaaS	3 SERVICE MODELS
High flexibility	Hybrid Cloud	Platform as a Service PaaS	
Measured services	Community Cloud	Software as a Service SaaS	

At present, terms were created for different CC services types that can be found in offers and literature as "CC distribution models".

CC as all the technologies has advantages and risks. For customers, CC significant benefit is transfer of risk and responsibility to a service provider. As you can see on Fig. 2, service provider is responsible for implementation, audit, monitoring, required capacity planning, maintenance, support and availability control. Flexibility and solution scalability are next important benefits.

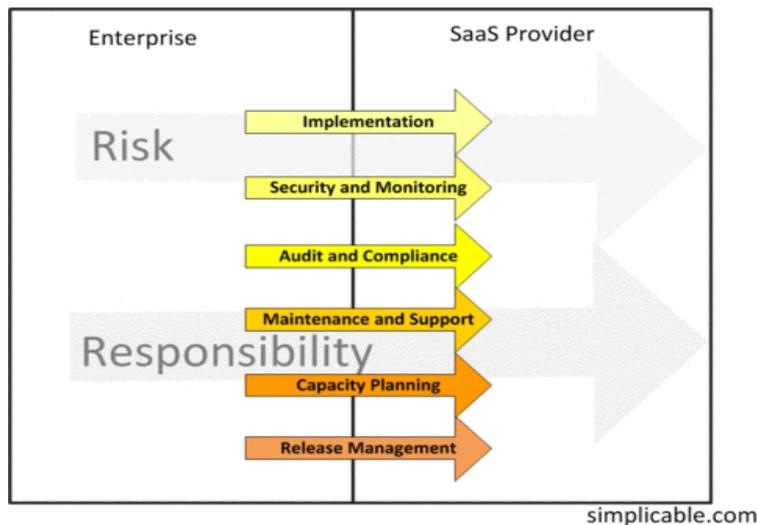


Figure 2 Transfer of risk and responsibility to a service provider
Source : <http://simplicable.com/new/cloud-computing>

Limiting factors for CC are possible risks of not keeping stable IT transfer on internet and increased costs of big data volumes transfer (price of volumes data transfers can be more expensive than local SW purchase). Next limiting factor is the apprehension of sensitive data security and data as such.

CC usage narrowly interconnects ICT costs and the possibility to familiarize and use professional and up-to-date computing systems. For customers, CC represents a new option and promises a better possible selection.

4.1 Cloud Computing as the Possibility of up-to-date ICT at Universities

Cloud Computing Advantages and Difficulties Use in Education

The education possibility of flexible number of students. A defined number of users do not limit capacity for that is flexible. Not only students can

work with ICT who have specialization in IT. This flexibility has a great meaning for universities and colleges because different student groups and different taught subjects in various semesters are not a problem anymore.

Access to applications from any place that offers internet connection. Students are not dependent on ICT access in education process only (specific computer rooms frequently), they from any place where access to internet is possible (student hostels, home, internet cafés, and the like).

Teamwork support – students can be divided into groups and they can share data, information and work results in these groups. They can cooperate on a task as a team, even in the case they are dispersed geographically (for example during study sojourn in a foreign country).

Supervision of student access to study. Pedagogue has the possibility to follow activity of individual students during work on a given task. Provider does monitoring services continuously (paid are actual used services). Pedagogue can see records.

Ability to respond to requirements of students and pedagogues. Suggestions, error reporting, the questions of students (pedagogues) are stored. In majority of cases, provider immediate comes with the advice how to solve a problem or there is a message - what was cause of error, when the error will be removed.

Help. The beginner user has high-quality help (mostly in English). A video with sound is provided very often. Students without deeper ICT knowledge are not excluded.

CC brings other advantages for universities: Non-stop upgrade of SW by service provider. Application implementation speed; removal of implementation barrier is a great advantage for universities. Transfer of administration and maintenance to service provider and transfer of the risks connected with this.

Difficulties

Undisciplined students not removing their data and reports. Students often complicate CC service administration by overloading available capacities (the unsuccessful results of their activities). Internet quality connection is requirement. Problems can arise with a long response time when many students want to have access to same application in the same instant of time.

Questions connected with security of sensitive data. However, this problem is not a fundamental, because students use simulated data or freely accessible data mostly.

4.2 Transition of IT companies to Cloud Computing

Transition to CC should be done gradually. Choose tempo transition so that you maintain a consistent IT environment.

Table 2 Transition of IT to Cloud Computing, Source: own

Transition of IT to CC		
Feasibility study – content (to be drawn up by company or an independent consultant)	Selection of CC supplier (selection criteria)	CC from user's perspective
Analysis of current situation	Service transparency	Types of users
Target solution concept	Reliability of suppliers	User expectations
Economic assessment of the current and target state of IT operations	The availability of all components of the service	Mobilization of internal company resources
The list of positive changes for end users	Flexibility and integration possibilities	
Risk management plan		
The schedule of works for a transition to CC – migration project proposal (we recommend migrating in successive steps)		Thorough training and motivating users

Recommended steps of the transformation process:

- **Feasibility study** (see Table 2). The study should not be limited to economic issues. The transition must bring positive changes for end users and this must be emphasized. The study can also be ordered from an independent consultancy.
- **Provider selection.** One or more suppliers can be chosen; however, while negotiating the terms and conditions, it is necessary to allow the possibility to change the supplier of individual services. Before the final decision on the supplier, collect all the necessary information.
- **Information about the service transparency.** The customer has the right to know the HW the service runs on, what applications and databases are used and what the plans for the future expansion of services are. An important factor is the physical location of services

- CC stores the data and applications in a specific data center. It is therefore important to know where the services are operated, especially with regard to compliance with legislative conditions.
- **Reliability of the supplier.** Reliability of the supplier. Important factors in determining the supplier's reliability are the time the provider has been in business, the number of employees, references by existing customers and whether it guarantees availability and high quality SLA. References by other customers are helpful in this respect. The provider should allow the customer to perform regular audits of the services provided.
- **Availability of all components of the service.** The value of the availability of services from the provider should not fall below a threshold of 98%. It means, seven days downtime on the infrastructure due to maintenance and unexpected problems are considered. Otherwise, everything runs continuously. Accessibility is a very important thing, especially if the user requires continuous access for customers and partners.
- **Other recommendations** - User access solution, user access administration, identity management are important. Create cloud strategy, the aim is not only reduce costs. Should you pay great attention to the conditions expressed in an agreement for service providing - Service Level Agreement (SLA).

5 Conclusion

The paper focuses on changing requirements on integrated information systems and their influence on the university training of such systems. The choice between implementation of “All-in-one” and “Best-of-Breed” is discussed with respect to the progress in ERP development and user’s requirements.

Based on the personal author’s experience (more than 10 years of BI teaching), BI systems were chosen from the modules extending ERP. Implementation of BI into the information system enabling management according to knowledge is frequent demand of corporations. The courses of BI are taught in CC environment because it is supposed that CC solutions proportion is increasing at expense of on - premise systems. Moreover, CC

solutions also increase the quality of local solutions and make the exploitation in either the national or the international measure.

Pros and cons of CC in education are discussed in Section 4, as well as the recommendations for the implementation usable in teaching.

ERP systems that are robust, data-safe and open for extensions are necessary tools in corporations. The task of educational institution is to learn students in this field and to give them practical skills with ERP.

Acknowledgements

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INFORMATION SOCIETY AND EDUCATION

Project EARN as a platform for linking Research, Innovation, Services and Education in the field of automation

Roman Danel¹, Michal Řepka², Robert Amann³

Abstract. In the EARN project (European Automation Resource Network, supported by the EU LifeLong Learning Programme) we want to find a way to improve cooperation between Higher Educational Institutions (HEI) and industry across Europe. The project is focused on the innovation chain (from HEI to industry) and dissemination of information about the services offered. A further goal is to involve students in research and transfer their thoughts and ideas into practical implementations. The approaches of HEI and companies are different – companies expect fast solution of their problems and projects while universities are focused on long-term and complex research activity. Project EARN wants to create a link between these two worlds by building a platform for sharing universities' resources (such as equipment, services, laboratories...). This platform offers the possibility to optimize the links between research, education and application practice. Due to the professional background of the participants of the project - JAMK University of Applied Sciences (Finland), Vorarlberg University of Applied Sciences (Austria), University of Applied Sciences Esslingen (Germany) and VŠB - Technical University of Ostrava (The Czech Republic) - the pilot project is focused on the area of automation. In the future, we expect to connect other participants and extended focus into other areas.

Keywords: EARN, resource network, innovation chain, services, R&D&I

JEL Classification: I25, O32

1 Introduction

In 2011 the EARN international project (“European Automation Resource Network”) was launched. EARN collects and evaluates the best practices to integrate education, R&D&I and university services in the field of automation.

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It provides a new path for students to integrate learning and participation in university R&D&I activities. The innovative developments in the project will become adaptable and can be transferred to other higher education institutions and further on to enterprises. The initiator of the project is the JAMK University of Applied Sciences (Finland, Jyväskylä) and the other project partners include the Vorarlberg University of Applied Sciences (Austria), University of Applied Sciences Esslingen (Germany) and Technical University of Ostrava (VŠB – TU Ostrava). Our paper sets out the reasons why the project was initiated and the objectives we want to achieve.

The main objective of the EARN project is to improve the method of transferring ideas and conceptions from university environments to practical application in industry.

2 Reasons for initiating the project

At present there is a strong need for the smooth integration of education, research, development, innovation and services in an efficient way to support enterprises and the community. Today the participating HEI (Higher Educational Institutes) organizations have activities in education, Research-Development-Innovation (R&D&I) and services but the operations are segmented with only a few links and the full potential of teachers, students and staff is not taken into use in all these operations.

From the students' point of view, curricula have not allowed the selection and earning of credits by working in R&D&I and services. From the teachers' point of view there are no clear resourcing models to allow personnel to divide their time between teaching and R&D&I work. The present situation has decreased student and teacher involvement in R&D&I activities although in all the partner universities participation exists.

If a commercial entity – company – is interested in collaborating with a university and formulates specific requirements, the problem may lie in the fact that universities often lack a comprehensive understanding of the available services, equipment and apparatus. Processes of how to proceed in such cases, who to turn to, are often not established and elaborated. Therefore, the university's potential may remain unexploited for the simple reason of a missing suitable contact person (Řepka, 2014).

The field of automation is wide and companies require a large variety of information in order to succeed. It is impossible for one university alone to be an expert in the whole field of automation.

Therefore, the initial presumptions of the EARN project can be summarized as follows:

- Improve integration between enterprises and universities
- Involvement of students, teachers and university personnel into these links
- Enterprises' needs to solve problems – how can they reach universities and use their potential?
- Universities have equipment, laboratory, knowledge,... how can they offer them and forge links to industry?
- How is the innovation path linked?
- Lack of competence to serve R&D&I to enterprises (Danel, 2012).

3 Main project objectives

Now we would like to detail the main project objectives:

- Improving the role of institutes in innovation chains
- Building of a network environment for resource sharing between partners (Laboratories, Equipment, Offered courses or training, Know-how, Consulting and Learning Materials)
- Integrating learning in R&D&I projects to be a part of the curriculum
- Ensuring that students and staff participate in service activities

The main objectives of the project are to study, find and evaluate the best practices of integration of education, R&D&I and services so that students learn skills which match the requirements of the enterprises and spur entrepreneurship and also university teachers and staff participation in R&D&I and services is sufficiently resourced and motivated.

The partial project objectives are:

- Supporting lifelong learning in automation in the participating regions
- Integrating education and R&D&I from the student's and staff's point of view: evaluating the best practices and developing the curricula and staff resourcing to activate working in teaching and R&D&I + services

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- Encouraging the entrepreneurial thinking of students
- Creation of the HEI network supporting better the community and enterprises by utilizing the whole competence and laboratory potential of the participating universities
- Strengthening the co-operation between higher educational institutes and enterprises
- Improving the competitiveness of small and medium-sized enterprises.

The idea of the EARN project is to find a way how to share the best practices in the integration of HEI R&D&I with education and how to develop the processes together. The triangle of education, research and innovation is the basis of the EARN pyramid developed by JAMK (fig. 1). The created HEI network works in the same way as company networks offering comprehensive services to end users.

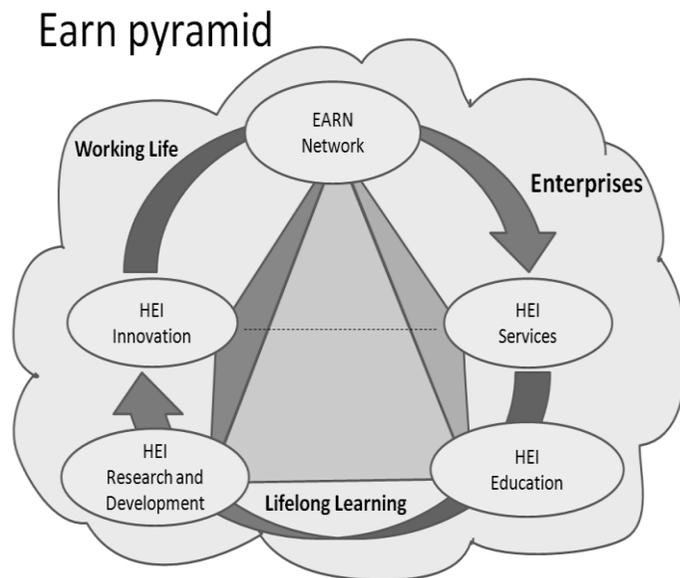


Figure 1 The idea of the EARN project – EARN pyramid developed at JAMK

We are also working on improving the innovation chain between universities and industry. It is important to know the difference between innovation and invention. Innovation exploits new ideas leading to the creation of a new product, process or service. Invention is useful only for the inventor. Invention transforms into innovation if the invention improves some product, process or service.

4 Work Packages

Each partner implements numerous tasks from various areas in the project, while having one area (Work Package) as its main focus, being responsible for the outputs defined for such an area.

Table 1 EARN project Work Packages

WP	Description	Responsible Partner
1	Management	JAMK
2	resource network environment and platform	VŠB – TU Ostrava
3	R&D Integration into teaching and learning	Hochschule Esslingen
4	Services	FH VORARLBERG
5	Innovation chains	JAMK
6	Quality assurance	All partners

5 Platform for sharing resources

One of the objectives of the EARN project is to create a platform which shall enable project partners to store, systemize and share information and knowledge about automation, automatic control and control systems. The platform is designed to also be beneficial for parties interested in potential cooperation from the industry. The EARN project information system shall offer companies various services which the universities participating in the EARN project can provide and implement. By service, we mean a whole spectrum of activities – from expert consultations, research activities, specialized training, seminars, to the utilization of specific equipment or laboratories. The information system shall also contain information about completed projects focused on cooperation with industrial companies as a source of inspiration of how such cooperation could work. The objective is to find a way of interconnecting the world of university-based research, characterized rather by long-term and conceptual projects, with the corporate sphere, where companies are looking primarily for quick solutions to current problems. Interconnection of these two philosophies is not always easy and in many European countries this interconnection of university-based research

with the industry is seen as insufficient. Another area on which the EARN project focuses is the involvement of students in the research and innovation network (from idea to implementation). The created platform should also contribute substantially in the future in this direction. The method of applying the ideas of students in research or actual applications is not often successfully resolved.

The information system created under the EARN project comprises the following parts:

- Web portal with information about the project and best practices for transferring innovations from universities to industry
- Database of services (primarily automation focused) offered by participating universities; parties interested in utilizing services can use the system to search and contact responsible persons or can enter requests for services
- Sharing of information resources and educational materials from the sphere of automation utilizing the LMS system for accessing these resources; initially a platform of resources shall be created covering the following areas:
 - Process Automation and Control (JAMK)
 - Robotics and Machining Automation (Hochschule Esslingen)
 - Mechatronics (FVH)
 - Modelling and Interactive Media (VŠB – Technical University of Ostrava)

6 Promotion of European-Wide Cooperation between Businesses and Universities of Applied Sciences in the Area of Production and Automation Engineering

Universities of applied sciences offering engineering degrees often provide a range of services for businesses; the businesses with which they cooperate are usually situated in the same geographical area as the university.

Within the framework of the EU project EARN, these local services:

- 6) are now being offered beyond regional borders throughout the whole of the European Union
- 7) the range of services is being considerably extended through the integration of services provided by other partners.

This is all made possible through an international service network of universities of applied sciences in the form of a central databank.

The services advertised through this project are limited to laboratory services (e.g. measurements, prototype development, laser cutting), training, networking (e.g. conferences) and consulting. They do not include lectures, theses, student projects, the generation of research results or other standard university work (fig. 2).

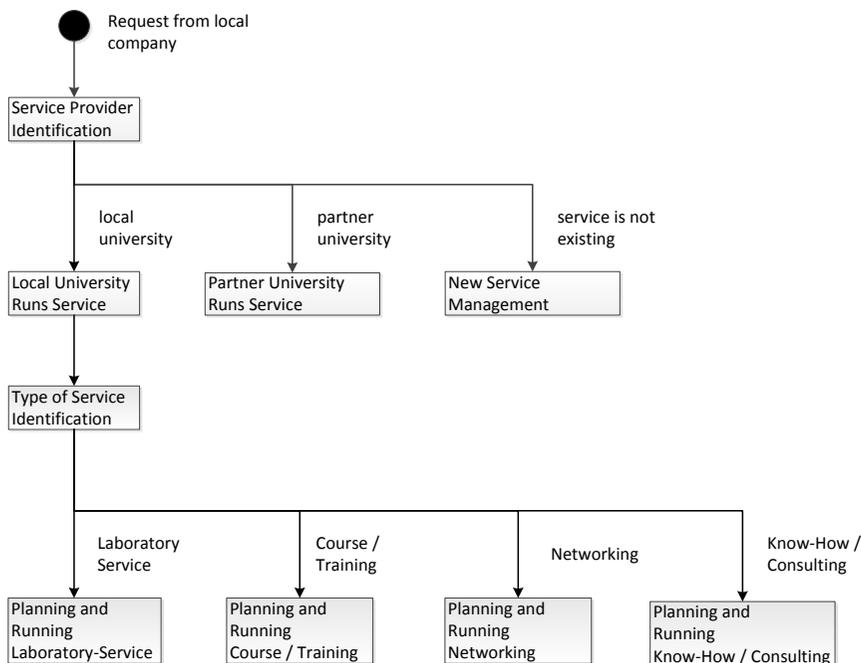


Figure 2 Process map (Planning and Running Services)

The basis for the databank is a form for describing the services. This was developed in cooperation with project partners and businesses in Austria, Finland, Germany and the Czech Republic. Using existing services as examples, each project partner tested the form; the results of these tests were considered in the form's final version.

Important elements for the description of services are: contact persons, place, description of services, customer involvement, costs, timeframe, infrastructure used and references. Further information is also required depending on the type of services. Additionally, there are questions about best practices, possibilities for involving students and internationalization needs (the provision of services through an international partner).

The service databank includes information about the range of services on offer, including a detailed description of the equipment and machines used as well as short reports about current and past orders.

The service information will be translated into the language of each participating country in order to facilitate international networking. Every service activity – including that of international partners – can also be managed by local partners. That is the reason why the names of regional contacts are also provided.

The implementation of the databank using the form developed is now complete. At present, current services are being entered into the databank and other universities of applied sciences are being invited to participate in the implementation and expansion of the European resource network for production and automation engineering.

7 Conclusion

The EARN project was launched in November 2011 at the kick-off meeting of partners in Jyväskylä. The close cooperation of partners is coordinated at regular monthly consultations via videoconference and at an annual partners workshop. The project is planned over a three-year period with a planned conclusion in October 2014.

Besides the objectives outlined in this paper we would like to achieve the goal of making the outputs from this project usable even after its conclusion, particularly based on the following activities:

- Attract companies to use EARN international networks
- Build and increase a database of the partners' resources (equipment, laboratories, courses, consulting, know-how...)
- Build an information portal for public audience allowing enterprises or other universities to use offered resources

- Reach other universities that would be interested in participating
- Involve students in research activities and provided services

EARN is not the first project attempting to register university resources and efficiently transfer innovations to industry. The purpose of this project is primarily its internationalization, collecting expertise from many countries, enhancing the utilization of resources and potential of universities on an international scale. To make this idea a success, it is essential, besides managing all processes, to provide for the necessary awareness of all involved parties (universities, companies, students, etc.) of all the available possibilities.

The network of shared R&D&I services can increase the capability of universities to improve the innovation chain, to integrate learning and students into service activities and their better understanding of industrial competitiveness.

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EARN
European
Automation
Resource
Network



Education and Culture DG

Lifelong Learning Programme

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The Expert and Analytical System of Decisions Support for the National Bank of Ukraine

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Abstract. The governing bodies of National Bank of Ukraine should make informed decisions in highly dynamic and with large level of uncertainty of the external and internal environment of the country and its economic and political situation. These decisions should take into consideration all the risks and are characterized by very high economic, social, political cost. Proposed to the leadership of the National Bank Ukraine create an integrated hierarchical System of Situational Expert and Analytical Centers that work by a single regulation interaction, using modern tools of mathematical modeling and newest information technologies to support timely decisions that are an adequate to level of complexity, dynamic, nonlinearity the situation development in the conditions of many criteria, many factors and many restrictions, in particular time for decision.)

Keywords: The National Bank of Ukraine, system of support of making decision, outpacing response, situational expertly-analytical center, hierarchical architecture, geographically distributed structure, monitoring, intellectual situational analysis, risk-oriented approach.

JEL Classification: M12, M15,

1 Introduction

The process of informed decision making by the governing bodies of the National Bank of Ukraine is in conditions of political and economic instability in the country. This process has many criteria, factors and a large number of constraints This requires innovative approaches, makes us look for the best means of accumulation of intellectual and organizational capacity

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to study the problem of rapid and intensive preparation of decisions based on objective information.

Aggravating the problem that the state has no a single information space, different levels of socio-economic development of regions, local leaders are not prepared to act in extreme situations.

Considering the social importance of the banking system, which is one of the main sources investment of financial resources in the economy, and the dependence between of its parameters of development and rates of economic growth (Bondar, 2011) we can confidently say that the efficiency of banking system has significant impact on the country economic development, and the effects of banking risks are very tangible, because they are the cause of many financial losses of members related to each other chain of monetary and credit obligations. Therefore at implementation of Bank Sector Reform Strategy to 2020 an extremely important for the National Bank of Ukraine, as a special organ of state administration, is to improve the quality and efficiency of management activities.

In this case, to represent the complete picture of the problem situation, its assessment should be comprehensive, and in the control loop should be included mechanisms of evaluation analysis of changes in social and economic situation in the country and its regions for choosing ways to adapt to them. For this need be applied methods of intellectual situational analysis and expert systems based on the new information technologies.

2 System of the Expert and Analytical Situational Centers

The governing bodies of the National Bank of Ukraine and its management at different levels and in different regions require expert analytical support of decisions which are timely and adequate to the current situation. System of the expert and analytical situational centers of the outpacing response (SEASC), which working by a single interaction rules, is capable of resolving this problem. This provides increasing the speed of access to relevant information, development of domestic technology and the accumulation of experience and knowledge to resolve the problems, coordination is achieved

Talking is about territorial-distributed system SEASC, purpose of which is promoting the development and realization of effective policy of the National Bank of Ukraine, aimed at ensuring stability of the Ukraine monetary unit, based on the priority of achieving and supporting of stability of prices in the country, promoting the stability of the banking system and observance stable rates of economic growth, attracting in decision-making national intellectual and scientific potential and using best international practices.

Considering approach adopted in (Letunovsky, 2013), (Aleshin, 2011), (Ilyin et al., 2011) recognize that the system of situational expert and analytical centers of national Bank of Ukraine is a person-machine system settled of related analytical centers, which consists of comprehensive group of problem-oriented expert analysts, staff of technical support and providing of information security and also Informational and software and hardware implementing information technologies with monitoring of external and internal environment, its situational analysis in order to predict and production of application of algorithms of related control influences governing bodies of the National Bank of Ukraine for the prevention problem situations and minimizing deviations from the set goals, ensure the reliability and survivability of the banking system as during the current activity, and in conditions of the emergence and development of the crisis in the state banking system regions.

Main features that differentiate SEASC from other systems of decision-making support are following:

- Provision of analytic and prognostic information in real time for acceptance by managing organs or OPR of timely decisions in difficult situations with a high dynamics of changes in their area of responsibility;
- forming on the basis of processing analysis, synthesis and evaluation of large amounts of primary operational small amount of informational integral parameters (aggregated data) to adequately characterize the current situation;
- Identify tendencies of development of situation to assess the reliability of prognosis;
- Collective work and decision-making by the members of the Board, Board of Directors, the Chairman of the National Bank of Ukraine,

organization of their interaction with the leaders of the lower levels, displaying on the collective and personal visualization tools;

- Supporting the choice of rational management decisions, based on the analysis and evaluation of few variants on the basis of incorporation and accumulation of data about typical problems or crisis situations and their corresponding of typical management decisions.

In view of the above, the system expert and analytical situational centers of the National Bank of Ukraine - a system of interconnected set of analytical centers that consists of: a comprehensive group problem-oriented expert and analysts, technical support staff and providing of information security, informational, communicational and software and hardware tools that using the latest information technology implements processes for monitoring the external and internal environment, its situational analysis for the purpose of forecasting and the development of interconnected algorithms of use the control actions of governing bodies of the National Bank of Ukraine to prevent problem situations and minimize the deviations from the set goals, providing of reliability and survivability of the banking system as in the current activity, and in terms of appearance and development of crisis situations in the state, banking system, regions.

For geographically distributed systems SEASC for the National Bank of Ukraine proposed a three-tier architecture (Fig. 1), that meets the strategically, tactical and operational levels of management horizon of prediction, respectively, long-and medium-term, short-term and operative.

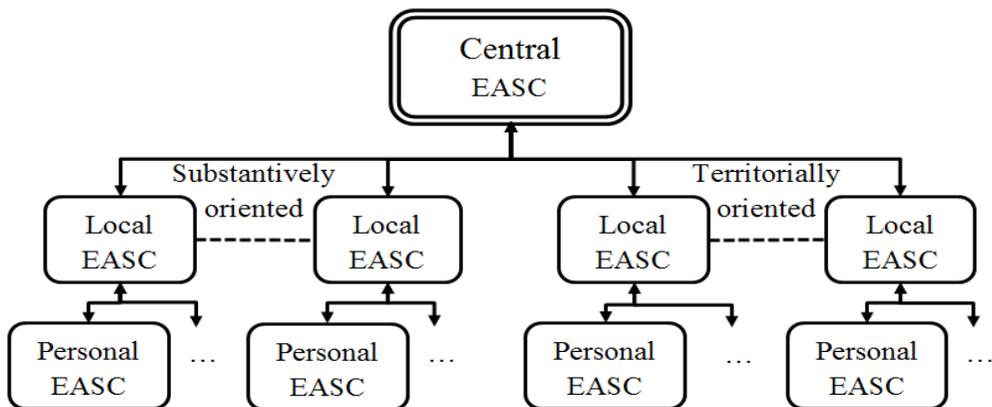


Figure 1 System Architecture Expert and Analytical Situational Centers for National Bank of Ukraine, Source: own

The system SEASC includes:

- Central SEASC carries spatiotemporal analysis in real time of aggregate at the appropriate directions by substantively- or territorially-oriented Local SEASC and strategic forecasting and on this basis to support decision-making for Council, Management Board, Head of the National Bank of Ukraine, for solving complicated large-scale problems;
- Local substantively- or area-based SEASC of structural units and territorial departments and educational institutions in the defined areas, that in a complex compliance with the essential and other functions of the National Bank of Ukraine, solve the problem of transformation of operational information to the situational model and analysis and short-term forecasting and enabling the Central SEASC handle the results of their work to real time;
- Personal portable SEASC for decision-makers (DM) face the challenge of express assessment of the situation, operative access to managed objects to ensure that individual's mode "always informed of developments" regardless of the time and place of their stay.

In compliance with the tasks Central EASC must contain the following required components:

- complex expert analysis environment with methods and means of providing convergence of different expert opinions; information provision (information model of controlled objects and the environment, models of situations and threats, etc.);
- Information and Linguistic Support (information retrieval languages, the classifiers, rubricators, dictionaries, regulatory and reference documents, etc.);
- means of monitoring of controlled objects and external environment and keeping and purposeful distribution of accumulated information;
- software and information analytical support, including GIS tools for spatial and temporal analysis of data;
- complex of telecommunication and industrial tools, including tools of 3D visualization and documenting of information; tools of controlling and functioning System EASC.

To the construction of System SEASC contribute: availability and development of corporate information and telecommunication

of infrastructure Of the National Bank of Ukraine, that ensures use of SEASC trusted software and developed means of information protection; network development of protected video conferencing; integration of corporate informational resources and systems.

This allows at the projecting and building System EASC to concentrate main attention on the following: forming of complex groups problem-oriented of analysts experts; preparation of technical personnel; building condition monitoring subsystem of controlled objects and external environment integration of data from different own and external sources, and forming actual and reliable information resources; development and implementation of information-analytical systems based on the use of geographic information systems spatiotemporal analysis and instrumental and modeling and forecasting tools; creation of a single information and communication area governing organs and DM based on the information and technology integration SEASC with use of technologies portal decisions which will provide high speed of access to the required of distributed information its reflection, consolidation and analysis of databases and remote access to participate experts in the preparation of management decisions.

In compliance with accepted architectural System EASC complex expert analysis environment should also have a hierarchical structure and consist of problem-oriented expert group in accordance with main and other legally defined functions Of the National Bank of Ukraine (Pohorilko and Fedorenko, 2006), (Law of Ukraine, 2014a), (Law of Ukraine, 2014b). Such regular groups of upper level internal experts can be:

- Council members of NBU, NBU members of Management Boards, Audit Committee; Advisory Group Head of the NBU;
- Alternates Chairman of the National Bank and department Directors (with the appropriate directions);
- Expert-analytical group of scientific research center and scientists of higher education institutions Of the National Bank of Ukraine.

Temporary groups of external experts can be formed of specialists from scientific establishments of National Academy of Sciences and Ministry of Education and Science of Ukraine.

To the structure of problem-oriented groups Local EASC can be included employees of the relevant methodological and analytical divisions

Of the Departments, other structural units and specialized scientists of higher educational institutions Of the National Bank of Ukraine.

Composition of information and software Local EASC determined by features of the responsibility zones (of subject and territorial) organs and decision-makers. For example, LEASC Audit Department should provide automation of continuous monitoring, intelligent analysis and audit processes complex GRC (Governance, Risk management, Compliance) at the National Bank of Ukraine.

3 Information Resources and Expert and Analytical Technologies

Information resources that are monitored and analyzed, are divided (Fig. 2) to internal (from their own subjective and objective means of monitoring and control) and external, which can be open (by departmental) and limited access (of interagency, international and other with limited access). To obtain the necessary information from the past (information intelligence) requires cooperation with the relevant authorities.

Internal information resources are, in the main database (DB) of Program-technical complexes, which can be divided into three groups: database transactions with external counterparty's database of internal operations, subsystem DB automation of support processes.

Works also analytical system "Reporting" which provides data visualization, which stored in the repository of the National Bank of Ukraine. In the process of monitoring and previous analysis:

- formed repository of situational data – formed service documentation and reporting on the results of monitoring – is carried out structuring and formalization of heterogeneous data significant events in accordance with the selected information model of subject area;
- identifies and subsequent monitoring of important or controlled events and situations as well as initial assessment of the current status and issue appropriate messages.

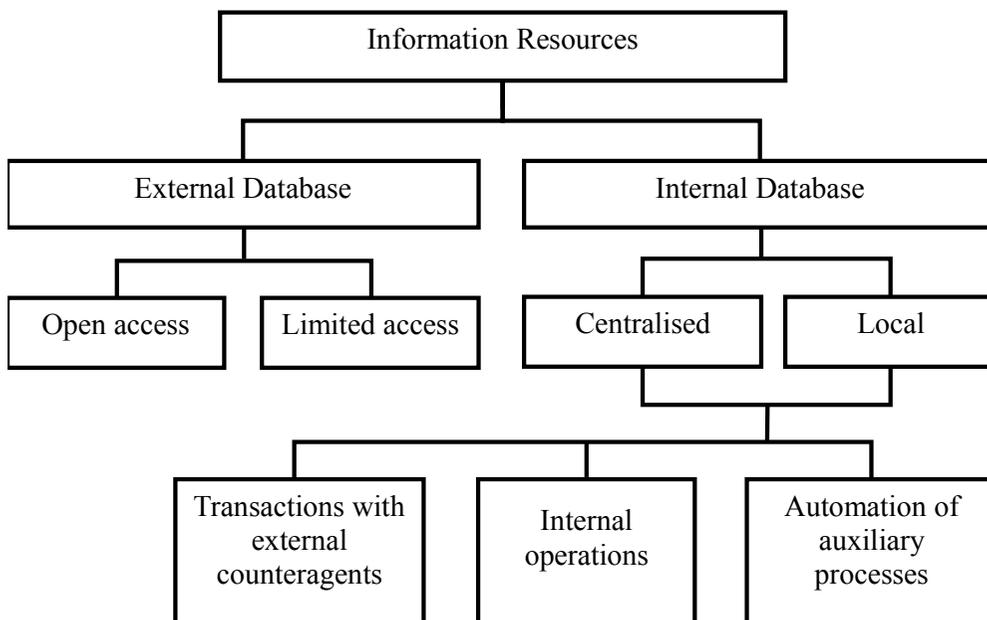


Figure 2 The structure of information resources which are subject to analysis.
Source: own.

Expert and analytical technologies used in the content SEASC are located on the junction of problem solving describe social reality, the state of dynamic socio-political and economic processes and intelligent methods for structured, weakly structured and unstructured information.

These technologies should provide:

- identify important situations, their ranking in order of importance, types and types;
- the formation of the current list of analytical tasks according to the situation and requirements consisting of ATS;
- to develop possible solutions (using standard solutions worked out) using the control actions to achieve target states controlled objects;
- easy access to all ATS as accumulated data set, and to aggregate indicators of the current situation and a retrospective of the problem situation based on information technology portals;
- formation of adequate methods of visual representation of solutions to the problem of operational planning for individuals that decision;

- prediction of the situation based on the prevailing of situational models and models of threats, including and considering the use made of solutions to meet the challenges of strategic planning;
- evaluation and approval of results of long-term planning;
- statement on the control and monitoring of certain decisions and integrated indexes situation.

4 Conclusions.

Is proposed integrated hierarchical system SOSEAC combines methodical, software and instrumental and technical facilities of information and analytical support making the effective administrative decisions under conditions of uncertainty by the governing bodies and DM Of the National Bank of Ukraine.

Expert and analytical technologies which are used in SEASC are at the junction of solution tasks description of social reality, condition of dynamic socio-political, economic processes and intellectual structured methods of analysis, poorly structured and unstructured information.

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Model and Algorithms for Control of Auditor's Remote Access to the Corporate System of Bank

Serge Ivanyshyn¹

Abstract. Complex automation of banking activity is the main trend in the development of information technology banking. Automation of internal audits requires remote access to the corporate banking network. This is due to the requirements of the mysteries of the audit, the complexity of the software and developed a two-tier system of banking institutions. The problem of remote connectivity to information resources of banks in terms of security is similar to the problem BYOD. There are proposed an algorithm of the automated control of remote access. The algorithm is based on the separation of the work area in the virtual space of the bank's server. Agent of program of auditor has all the powers of access to databases. Necessary calculations are carried out in virtual space within the perimeter of the corporate network. The results of the audit are transmitted over a secure channel on the laptop of the auditor. Workspace safely cleared the shredder at the end of the session. There are proposed a model of remote access control based on the Role-Based model Access Control for the algorithm.

Keywords: integrated automation of the bank, internal audit, BYOD, Role-Based model Access Control.

JEL Classification: C13, D81, G32

1 Introduction

Modern approach to the audit requires complex automation of all stages of the audit. The use of specialized audit software helps reduce the cost of the audit, improves the quality and efficiency of the audit. Nowadays there are dozens of software solutions of complex automation of auditing. The following programs are among the leaders in popularity. The program "IT Audit: Auditor 4.3" is integrated with 1C: Enterprise 7.7, 8.2. It provides auto-complete data of audit working papers with 1C: Enterprise. The program has the ability to create their own methods of audit term to 450 audit procedures (Система IT Audit, 2014a). The program «AuditModern» provides conceptually new approach to internal audit of various organizations, including banks. The program is autonomous and independent of the information systems of organization, restricts access of

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stakeholders to the results of audits, database audit evidence and findings, and provides control over the activities of internal auditors in the central and remote offices (Система IT Audit, 2014b). The program «AuditXP» allows you to plan and carry out audits in complex control quality assurance, change audit method (Гольдберг-Софт, 2014).

The program of applications integrated automation of audit are provided by support of developer, of connection to the latest regulations and are of high cost - about \$ 5,000. Placement of programs of this type on auditor's laptop is the key to reliability and confidentiality of data and results of the audit. The auditor uses in his own practice specialized programs. Auditors require coordination questions mobility audits and information security business and corporate security software.

An important issue that arises in the course of complex automation audits are security auditor remote connect a laptop to the LAN of the organization to be audited. This imposes new requirements on safety management for the bank and for the mobile computer auditor and it known for our time as the problem of BYOD (Bring Your Own Device). Thus, convenience, high quality and reliability of remote audit department of the bank as well as any other organization require revision model of computer network security.

2 Comprehensive Security Strategy BYOD

The requirements of modern business processes in the bank significantly accelerate the pace of information management cycle in which bank's corporate networks and personal devices (laptops, tablets) participate. There is a number of interrelated issues. How to effectively monitor the use of resources and corporate data bank by auditor? How to ensure that auditors do not use personal devices for data storage in cloud repositories? How best to ensure the security of personal devices? How to effectively implement and maintain software solutions in terms of interaction with different operating systems and technology?

For a complete solution to the problems have been proposed system BYOD class Mobile Device Management (MDM). These systems have several disadvantages, do not provide a safe introduction of personal devices in business practice and practice remote audit. For example, MDM systems allow you to remotely manage mobile personal device if the device appears on the

network. But these systems do not take into account the possibilities of insider threats. The most effective solution to data security is access to information assets through bank branch terminal session to Windows-virtual environments which are protected DLP (Data Leak Prevention) (Астахов, 2014).

The auditor has access to the data only after authorization of account in the domain Active Directory. Access is provided through a secure VPN tunnel after rigorous mutual authentication of the user and the device simultaneously are made. It is important to note that unlike conventional BYOD devices for device of auditor there must should provide the ability to process of bank's corporate data or organization's one that are on the server.

Thus it should be to ensure that corporate data will not be distributed beyond the controlled device. Data on the server cannot be changed by the auditor. You should also ensure that the date of the audit report management data cannot be changed by bank employees. Bank is responsible for backing up data. Monitoring data in the auditor's work should not filter the contents of files and data, which is configured DLP system for casual users of BYOD. The results of the audit should not remain on the server of the bank.

It is proposed all applications (in this case the program auditor), which work with corporate data, to run inside a virtual Windows session on a server of bank for all these requirements are provided after the rigorous mutual authentication of auditor and its device are made. The results of the program's calculation are transmitted to a computer auditor. After the session, all the results of the auditor's specialized program in a virtual environment are destroyed securely. In fact, in virtual server environment of the bank there should be organized workspace of auditor, where the agent of the program is runs with the laptop or tablet of auditor.

The agent has the right to read data located on a server bank, which he uses to further processing. The results of processing are transmitted to the device auditor through secure channel. DLP system that works within the perimeter of the corporate network bank is configured so that the data from the server does not have the right to leave the perimeter. But the results of the special program auditor represent entirely different data and DLP system does not prevent the transmission of data on the corporate network perimeter. A shredder runs in the workspace auditor virtual environment after the session.

The proposed strategy requires the agent in auditor's program that can be installed in a virtual environment and transmit the necessary information for further processing to a computer of auditor. There shredder is need. With server-side bank is important to apply the security model of the computer environment that allows you to perform secure changes in the level of confidentiality.

3 Model of Auditor's Remote Access Control

There are the basic concepts of the object and the subject of access to information in the theory of model of the computer system's security. Depending on the method by which access is provided, there are consider five basic types of security models of computer systems: Discretionary Access Control, Mandatory Access Control, Information Flow Security model, Role-Based model Access Control, Subject-Oriented Sandbox model (Зегжда and Ивашко, 2000).

For automated banking systems benefits are provided Role-Based model Access Control (ISO 27000, 2014). Nowadays, under Role-Based model Access Control there are developing actively a variety of options depending on the specific problems of safe access (Kuhn and Coyne, 2010), (Coyne and Weil , 2013), (Щеглов К. А. and Щеглов А. Ю., 2014). BYOD phenomenon needs its own development model of Role-Based model Access Control.

It is known that all security information described access of subjects to objects. In the case of the auditor's remote access to bank information objects will be called the following areas of space. Firstly, it's information area ($area(inf)$), which is required for all audit information - databases 1C: Enterprise and databases of other specialized banking software. Secondly, it is the working area ($area(work)$), virtual server bank area, where the agent program auditor operates.

The subject will be called an agent of specialized program of auditor which processes the data of object. Problem management consists of providing access rights as Role-auditor, depending on the object. There is need to extend the basic Role-Based model Access Control to solve this problem.

The user U_{aud} is added to the set of users U , the role R_{aud} is added to the set of roles R , the right P_{aud} is added to the set of rights P and the session S_{aud} is added to the set of sessions S .

The right P_{aud} is a function of the object to which role R_{aud} requesting access:

$$P_{aud}: P_{aud} \rightarrow P(area): P(area(inf)) = \{read\}; \quad (1)$$

$$P(area(work)) = \{read, write, create, delete, open, close, execute\} \quad (2)$$

Function $PA: R \rightarrow 2^P$ determines for each role a set of access rights.

Function $UA: U \rightarrow 2^R$ determines for each user a set of roles to which he may be authorized. Sets of roles and sets of access rights for U_{aud} and for all other still divided into disjoint for object $area(work)$:

$$R = R_1 \cup \dots \cup R_{aud} \cup \dots \cup R_n, \quad R_i \cap R_{aud} = \emptyset \quad \text{for } i \neq aud; \quad (3)$$

$$|UA(U_{aud}) \cap R_i| = 0 \quad R_i \neq R_{aud}; \quad (4)$$

$$P = P_1 \cup \dots \cup P_{aud} \cup \dots \cup P_n, \quad P_i \cap P_{aud} = \emptyset \quad \text{for } i \neq aud; \quad (5)$$

$$|PA(R_{aud}) \cap P_i| = 0 \quad P_i \neq P_{aud}. \quad (6)$$

For the object $area(inf)$ the role and user's access right of user U_{aud} may overlap with roles and access rights of other users, depending on the security policy of a particular banking institution:

$$R = R_1 \cup \dots \cup R_{aud} \cup \dots \cup R_n, \quad R_i \cap R_{aud} = \{A\} \quad \text{for } i \neq aud; \quad (7)$$

$$|UA(U_{aud}) \cap R_i| \leq 1 \quad R_i \neq R_{aud}; \quad (8)$$

$$P = P_1 \cup \dots \cup P_{aud} \cup \dots \cup P_n, \quad P_i \cap P_{aud} = \{B\} \quad \text{for } i \neq aud; \quad (9)$$

$$|PA(R_{aud}) \cap P_i| \leq 1 \quad P_i \neq P_{aud}; \quad (10)$$

A and B are non-empty set.

Conditions on dynamic mutual exclusion roles are similar to the Role-Based model Access Control.

For the role of the auditor there should be limited to a maximum number of users that can be logged on it, similar to the access right of auditor there should be limited to a maximum number of roles:

$$|UA^{-1}(R_{aud})| = 1, \quad (11)$$

$$|PA^{-1}(p)| = 1. \quad (12)$$

Number of concurrent sessions $roles(r)$, which can be simultaneously logged in to the role of the auditor is limited:

$$|roles^{-1}(R_{aud})|=1. \quad (13)$$

Also, for each role there is ensure that it could be an authorized user, it must be define the roles to which the user must be authorized also. For the role of the auditor such set is an empty set for the object *area(work)*, and non-empty set for the field *area(Inf)*. In the last case non-empty set is determined by the security policy of a particular bank. Similar requirements are imposed for access rights.

4 Conclusions.

The complexity of software, security and business continuity as well as secrecy of audit require of remote audit from laptop of auditor. Automation of internal audits requires remote access to the corporate banking network. This is due to the requirements of the mysteries of the audit, the complexity of the software and developed a two-tier system of banking institutions. The problem of remote connectivity to information resources of banks in terms of security is similar to the problem BYOD.

There are proposed an algorithm of the automated control of remote access. The algorithm is based on the separation of the work area in the virtual space of the bank's server. Agent of program of auditor has all the powers of access to databases. Necessary calculations are carried out in virtual space within the perimeter of the corporate network. The results of the audit are transmitted over a secure channel on the laptop of the auditor. Workspace safely cleared the shredder at the end of the session. There are proposed a model of remote access control based on the Role-Based model Access Control for the algorithm. This requires changes to the Role-Based model Access Control. The character of the changes is determined by different access right of auditor for the individual workspace server of bank and depends on the security policy of a particular bank.

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Teaching Possibilities of Dimensional Modeling in Microsoft Excel

Vítězslav Novák¹, Petr Rozehnal²

Abstract. Practicing of dimensional modeling to solve business intelligence applications is most often performed on the selected relational DBMS, which can be a problem for students of economics at the Faculty of Economics, because a deeper knowledge of the DBMS is assumed. The basic software tool of economists is still Microsoft Excel. This article should demonstrate that Microsoft Excel can also be meaningfully used for dimensional modeling to solve business intelligence applications.

Keywords: business intelligence, dimensional modeling, Microsoft Excel.

JEL Classification: A23

1 Introduction

To explain the principles of business intelligence to students of economics can often be a problem, especially when their knowledge of the usable application software ends with Microsoft Excel and when they are completely unaware of the principles of relational databases and the use of any relational database management system. Nevertheless, this knowledge may be sufficient, because Excel offers the functions, which are possible to use for explaining of principles of solution of business intelligence applications.

2 The architecture of solutions of business intelligence applications

Business intelligence (BI) is according to Laberge (2012) an overarching term that refers to the knowledge, processes, technologies and applications that make management decisions easier on the basis of business data processing, e.g. sale, production, finance and many other data sources.

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The architecture of solutions of BI applications according to Pour, Maryška and Novotný (2012) is not fixed, the specific arrangement of the components of BI can greatly vary depending on the situation and the needs of the given company. However, a simplified architecture of BI solutions can be described with the figure below:

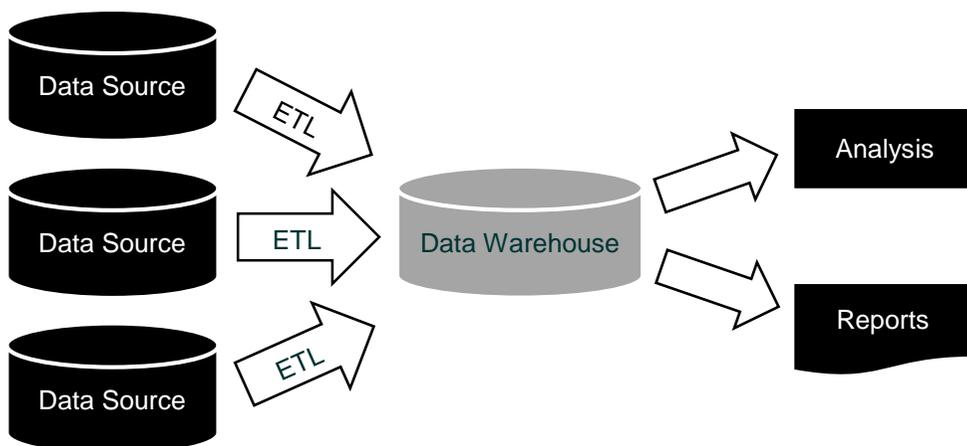


Figure 1 The simplified architecture of BI solutions, Source: own.

Transactional databases that are used by different enterprise ERP, CRM and other systems are a typical data source for BI tools. These data are extracted using ETL tools (Extract), transformed to the desired form (Transform) and then loaded (Load) to specific data structures of data warehouse. Consequently, these data can be analyzed and the analysis results can then be provided in the form of reports for decision-making of company managements.

Regarding the use of Excel in this architecture, Excel workbooks can certainly be one of the data sources, tools such as Excel import or export data, removing duplicates etc. can be used as an ETL tool, in the same way Excel can be successfully used as a tool both for data analysis and the creation of output reports probably with using of pivot tables and charts. However, what may seem problematic is using Excel as a data warehouse, in particular for the following reasons:

- a seeming impossibility of creating relationships between the dimension tables and the fact table,
- the size of the tables is limited by the number of rows in worksheets of the workbook.

Unfortunately the number of rows in a worksheet in the workbook cannot be increased, but Excel has made great progress, when between 2003 and 2007 versions, the number of lines increased from the original 65,536 rows to 1,048,576 rows and it may already be a sufficient number of rows for solving of BI applications for teaching purposes (but maybe also smaller companies). The impossibility of creating relationships between tables is only illusive; see chapter 3.3 Creating views over the dimension tables and fact tables.

3 Excel in dimensional modeling teaching

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.

These individual steps will be explained in detail in the following chapters with adaptation to Microsoft Excel.

3.1 The design of dimension tables and fact tables

Each dimension and fact table consists of a list of Excel. 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).

In the step design of dimension tables and fact tables it is therefore necessary to define a header for these tables and preferably put each one on a separate sheet. It is not necessary to name sheets, but for the sake of clarity, it is highly recommended.

3.2 Filling of dimension tables and fact tables with data

The next step is filling the dimension tables and the fact table with data. This may be a problem in the case of BI teaching because larger amounts of real data may not be available. Fortunately, Excel disposes of many features that allow you to generate artificial data. It is mainly the function `RANDOM()`, which is not so suitable, because it only generates random numbers greater than or equal to 0 and less than 1. A more appropriate function is therefore `RANDBETWEEN(bottom; top)`, which returns a random number between specified lower and upper limits. All functions are available in Excel *Formulas* tab.

To generate random strings (e.g. random names of companies where the company name is formed with the word "Company" and a random number) it is also possible to use these functions with concatenation in the formula with the given string using the `&` operator, e.g. `= "Company" & RANDBETWEEN(1; 10)`. It is also not a problem to generate random dates, because Excel contains e.g. `DATE(year; month; day)` function, which creates a date from three integers. And for the date to be random, it is possible to replace the parameters of `DATE` function with the `RANDBETWEEN` function mentioned above, e.g. a formula creating random date occurring at any date in 2014 might look like this: `= DATE (2014; RANDBETWEEN (1; 12); RANDBETWEEN (1; 31))`. Excel adjusts any fail date to an allowable value.

It is no longer a problem to copy the resulting formula into multiple rows, because for the purpose of filling a large number of cells Excel has a *Fill* function available on the *Home* tab (*Home* → *Fill*).

There also very often occur a series of values in the dimension tables. Even here Excel has the needed feature on the *Home* tab. In the *Fill* menu *Series* function occurs (*Home* → *Fill* → *Series*), which lets you create both numerical series and date series.

As also Howson (2008) says, when using the Star schema, several levels of hierarchy in one dimension table are often used (e.g. goods has a name and category), which has the consequence that the identifiers and descriptive data of higher levels of the hierarchy are repeated in particular records. To generate such tables is not very easy with the standard features of Excel mentioned above, because they are not able to generate series with recurring data, and therefore it is suitable for this purpose to create a custom function. These

include mainly a feature that allows generating their own series with any text as a part of the value with the possibility of repeating values with the specified step. This generator could look e.g. like this (see the figure below):

The image shows a dialog box titled "Generate series" with a red close button in the top right corner. Inside the dialog, there are six input fields stacked vertically, each with a label to its left: "Start value", "Stop value", "Step", "Repeat value", "Prefix", and "Suffix". The "Repeat value" field has a ". time" label to its right. To the right of the input fields are two buttons: "Generate" (top) and "Close" (bottom).

Figure 2 The proposal of the generator of own series, Source: own.

Such a generator of own series should accommodate both start and stop values with the step of the series, but optionally it should be also possible to specify the number of repeating of each value, and for the needs of generation of random strings also the option to specify a prefix or a suffix string to a series of numbers.

In the fact tables it is necessary to repeat some series several times (e.g. with every country identifier to repeat all good's identifiers). Here Excel also does not dispose of any needed function for an easy repetition of series (copying a block of cells several times), so it is necessary to create this feature. This feature might look like the following figure:

The image shows a dialog box titled "Copy block" with a red close button in the top right corner. Inside the dialog, there is one input field with the label "Copy selected range" to its left and ". times" to its right. To the right of the input field are two buttons: "Copy" (top) and "Close" (bottom).

Figure 3 The proposal of a feature for copying a selected block of cells, Source: own.

In this tool for copying selected blocks of cells the only required parameter is how many times it is necessary to copy a block of cells.

A good property of Excel is that for every action it recalculates all formulas. If, however, functions for generating random values are used in fact and dimension tables, then Excel recalculates these functions constantly, but this results in constant changes of data in the tables. So that this does not happen it is necessary to freeze the tables, i.e. to replace formulas to their values. This is possible with copying the table and then inserting it in the same place, but only as values with using *Paste Special* feature on the *Home* tab (*Home* → *Paste* → *Paste Special* → select *Values*).

3.3 Creating of views over dimension tables and fact tables

Joining tables based on primary and foreign keys is the domain of relational database management systems. Excel, however, disposes of a similar feature and it is Microsoft Query application available in *Data* tab hidden in the *From other sources* menu as *From Microsoft Query application* (*Data* → *From other sources* → *From Microsoft Query application*). This feature allows you to create views over several tables joined with relationships from any data source.

In order to be able to work with tables in Excel in the Microsoft Query application, ranges of cells of tables must be named. For defining the names of ranges of cells it is best to use the *Name Manager* feature on the *Formulas* tab (*Formulas* → *Name Manager*).

3.4 Performing of analyses and reports over created views

Applications of analyses over generated views, or creating reports are traditionally strong features of Microsoft Excel. For this purpose it is possible to use many of the features of Excel, primarily pivot tables or pivot charts available on the *Insert* tab (*Insert* → *Pivot Table* → *Pivot Table* or *Insert* → *Pivot Table* → *Pivot chart*), but there are also useful simpler functions as *Subtotals* available on the *Data* tab (*Data* → *Subtotals*) and many others.

4 The proposal of an add-in of Microsoft Excel for solving Business Intelligence applications

As it was described in the previous paragraphs, Excel disposes of many features usable in dimensional modeling in solutions of BI applications. These features, however, are scattered on many tabs of ribbon of Excel. In order to support solving the above-mentioned applications more effectively it would

certainly be preferable to create a special tab called e.g. *Business Intelligence*, which would contain all the required functionality including their own newly created functions such as generator of own series or function allowing to copy blocks of cells. It would also be clearer to divide these features on the *Business Intelligence* tab into several groups that could copy particular steps of dimensional modeling in solutions of BI applications mentioned above. This *Business Intelligence* tab might look like e.g. the following figure:

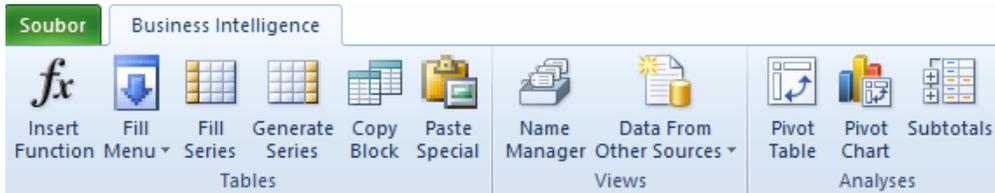


Figure 4 The proposal for a new Business Intelligence tab, Source: own.

To distribute the *Business Intelligence* tab together with modules of Visual Basic for Application which are required for using the newly created functions it is most appropriate to create a so-called add-in of Microsoft Excel, which is then very easy to add in Microsoft Excel with using the *Add-Ins* feature on *Developer* tab (*Developer* → *Add-Ins*). The *Developer* tab in Excel by default is not visible; it must be enabled in the *Options* on the *File* tab in the *Customize Ribbon* section (*File* → *Options* → *Customize Ribbon*).

5 Conclusion

In the previous chapters the possibilities of using Microsoft Excel in dimensional modeling in solutions of BI applications were described. Excel offers many features usable for this purpose. To work efficiently it is suitable, though, to create several additional features, e.g. an advanced generator of own series or a feature that allows multiple copying of the selected block of cells. So that these new features, but even standard Excel features were easily available, it is advisable to create your own new tab in the Excel ribbon and to distribute it together with created features in the form of an add-in of Excel.

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Protecting Biometric Template in Authentication Protocols of Computer Networks of Bank

Elena Nyemkova¹, Volodymyr Chaplyha²

Abstract. This article is devoted to the requirements on a hash function that provides closure of biometric data in information networks by access the customer's account. The hash function is described as a table of numbers, the sequence of mixing is determined by the sequence of biometric data. The protocol of mutual authentication of a client and the server of payment system is given. The number of client's safe applications to ATM is estimated.

Keywords: biometric template, mutual authentication protocol, transaction, unauthorized debiting, client, account, hash function.

JEL Classification: L86, M15

1. Introduction

Biometric authentication in a computer network is one of the promising areas of information security. Biometric authentication is more secure than passwords and identity documents. It is also the only way to recognize fraud. Currently, biometric systems are not completely reliable in terms of recognition errors, as well as in terms of preservation and transmission of biometric templates online. These difficulties are a barrier to the widespread use of biometric systems in the real world.

Specialists consider two types of attacks in the context of biometric authentication (Fatangare and Honwadkar, 2011; Standard ISO/IEC 24745, 2011). They are forgery attack and data leakage from the database templates. Forgery attack can occur because currently there is no unambiguous method of matching fixed biometric data to their respective owners. Verification of physiological characteristics or observation of random factors are proposed as a possible solution to this problem. Data leakage from the database templates, and its equivalent – unauthorized interception of data pattern in the network

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(mobile banking, internet banking) are situations when the information about the template of a legitimate user come to scam's notice.

The following requirements for the security of biometric template are considered. Firstly, physical fakes of biometric features cannot be restored from template data. Secondly, template protection scheme does not affect the result of biometric authentication systems. Thirdly, you can create a variety of templates from one biometrics to replace one of them in case of compromise. Nowadays biometric template protection is carried out through the transformation of biometric features and with the help of biometric cryptosystems. In the latter case protected template contains both a biometric template and the cryptographic key.

This work is devoted to the development of cryptographic biometric template protection method. It is suggested to use the findings in biometric ATMs. It is also possible to use them for authentication in mobile banking. The peculiarity of the suggested protection is the possibility of making a in a secured sketch of authentication information of ATM or mobile device through which customer's bank account is accessed.

Card accounts security is associated with three types of fraudulent transactions defined by ways of access and methods of operations. Ways of access include transactions via cash machines (ATM), payments via terminals in shops (POS) and mobile access to the account via internet banking (CNP). Although in these three listed methods a client deals with a single object – his/her own account, and gets access to his/her account via the same authentication method – entering PIN and presenting card information, levels of fraudulent transactions both in absolute and relative terms for ATM, POS and CNP are significantly different. According to the European Central Bank (European Central Bank, 2013a; European Central Bank, 2013b) the level of fraudulent ATM transactions accounts for approximately one-sixth of the total number. Methods for identification and authentication of clients, provided they use ATM from year to year, remained virtually the same and the changes concerned the quality of plastic cards - the transition from magnetic stripe to chip. However, this was not a significant obstacle to fraudsters. Various innovations are constantly being tracked and more advanced ways of unauthorized debiting of card accounts are being created.

2. Requirements on Hash Function During Client's Biometric Authentication

To date, the following trends determine the progress of protection against fraudulent transactions with card accounts: firstly, the transition to biometric authentication of a client and, secondly, a number of requirements (Яндекс.Директ, 2013) on authentication protocols. Biometric authentication provides a higher level of protection for client's account and therefore client's greater responsibility for what happens to his account. The latter allows to take the responsibility for unauthorized withdrawals from customer's account off banks and reduces banks' losses. That means that biometric authentication benefit both clients and banks. In the ATM sphere the switch to biometrics has already taken place: in Poland and Japan, the transition to biometric ATMs has begun (vascular pattern on client's palm is used). Private Bank has introduced voice authentication for smartphone owners using online banking (БАНКИРЪ, 2014).

There are a number of new requirements on authentication protocols during transactions. One of the main requirements is mutual authentication of a client and the side giving permission to access the card account. The second requirement is mandatory authentication of the device by means of which access is provided. The third one is mandatory encryption of information transferred over the network.

The volume of biometric data is significantly larger than the data for PIN and plastic card number and make up about 70 KB. Therefore, the hash function, that is used to close information when it is transmitted via network, has to process fairly large amount of information efficiently. Thus, taking into account the class of information system security, a hash function must satisfy the following requirements:

- to work effectively with fairly large amount of information (not less than 70 KB);
- to provide identification and authentication of a client;
- to provide identification and authentication of the ATM via which the transaction takes place;
- to provide mutual authentication of a customer and a processing center.

The process of identifying a client requires that PIN should be entered. With the advent of biometric ATMs the requirement to remember the sequence

of PIN digits can be eliminated. For example, some biometric data positions can be assigned to determine the PIN. Thus, customers have to present their biometrics to ATM, from which data for identification is extracted, the rest of the biometric data is used for authentication. Due to the large volume of biometric data the definition of not one but several PINs for different banks can be provided. The role of plastic card then is reduced to the determination of the bank in which the customer's account is served. If the card is lost, the customer and the bank don't lose anything.

3. Construction of Hash Function and the Estimation of its Parameters

As a rule, the hash function performs the conversion of semantic information using the session key. To work with biometrics it is proposed to use the sequence of client's biometric data as a session key, and to add the information about ATM, the date of transaction and the sequence of random numbers, known to both ATM and processing center (to enhance security). Semantic information is contained in a special table in which the process of mixing rows and columns is performed.

The original table is a square matrix of numbers that are not repeated. They may be the addresses of matrix cells. The first step is to prepare the table for initialization as a client hash function. To do this cell contents is reliably mixed using cyclic shifts of rows and columns. Four random numbers are generated. The first number determines what will shift: a row or a column. The second number specifies the number of a row or a column. The third number specifies the position at which the shift will start. The fourth number determines the shift direction: left or right for a row and up or down for a column. Applying this operation repeatedly, we obtain reliably mixed matrix. As a quality control of mixing the function of correlation between the original matrix and mixed one is side. Fig. 1 shows the correlation function between two matrices depending on the number of cycles of mixing. Matrix of size 16 by 16 is taken as initial, the number of matrix elements is 256.

The number of cycles of mixing depends on the size of matrix, the larger the matrix, the greater the number of required cycles. From Figure 1 we can see that for sufficient level of mixing it is necessary to perform not less than 256 cycles, which coincides with the number of matrix elements.

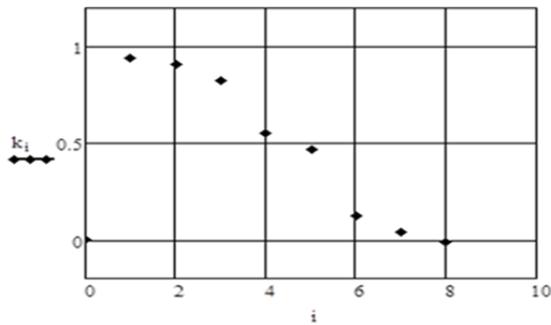


Figure 1 Correlation function between the original matrix and mixed. The number of mixing is 2 raised to the power of “i”. Source: own.

The next operation was performed to test the quality mixed matrix. Sums of the numbers of all columns (similar rows) of the matrix were calculated. Sixteen sums were considered. Results for sums in columns before mixing are shown in Figure 2. Results for sums in columns after mixing are shown in Figure 3. The left side of Figure 2 shows a uniform increase in the values of sums V with increasing of the column number i . The average value of sums is equal 2040. The right side of Figure 2 shows a histogram of the distribution’s density of sums. Vector midpoints of intervals int put off along the abscissa. Frequency of occurrence into the interval of values of sums h plotted along the ordinate axis. The analogous quantities are shown in Figure 3.

As seen from comparison of Figure 2 and Figure 3, the nature of the change of sums changed significantly. It became chaotic. As seen from comparison of Figure 2 and Figure 3, the nature of the change of sums changed significantly. He became chaotic. Period, in which sums fall into, broadened considerably. The shape of the histogram distribution density has the form of a random distribution.

The second step of preparation is the introduction of user’s information. The user enters his/ her identifying information: it can be passphrase, just a set of words, drawing sufficient number of lines, and finally – user’s fingerprint. The entered information is transformed into a sequence of numbers that determine further mixing of matrix. Then hash function (matrix) is considered to be initialized and together with client’s biometric data (reference data) is stored in bank’s database.

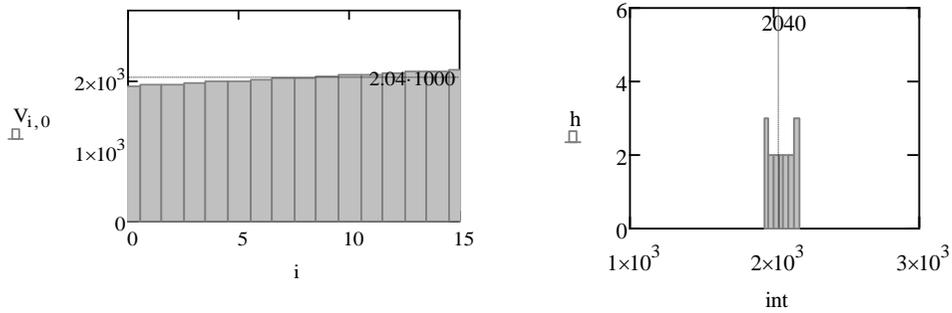


Figure 2 Sums V of the columns of the matrix and the density distribution h of sums before mixing. Source: own

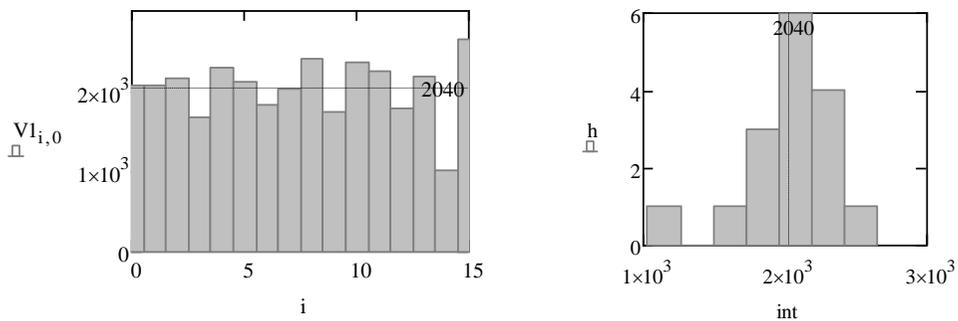


Figure 3 Sums VI the columns of the matrix and the density distribution h of sums after mixing. Source: own.

When the client uses ATM biometric data (real time data) is taken, from which identification data is extracted and together with the ATM's ID are sent into the processing center. In the center mixing of previous hash functions is performed according to the reference biometric data, ATM's data and the date of usage. At the same time the previous hash function is sent to the ATM, where the same transactions are performed, but customer's real time data is used as biometrics. Then the first half of the hash function is sent to the Processing Center, where it is compared with the same half of the center. When they coincide the second half of the hash function is sent to the ATM and compared with the rest of ATM's hash function. When they coincide their mutual authentication is considered to be passed, the client is given access to the account.

It is estimated that the permissible number of secure client's applications to ATM is $256!/256 \approx (256/e)^{256} \sqrt{(2\pi/256)} \approx 5,3 \cdot 10^{59}$ times. An application of considered hash function requires the message length of 256 bytes in the exchange protocol.

4. Conclusion

Cryptographic protection of client's biometric template for mutual authentication should provide a basic set of measures of protection of information exchange of subjects and objects for K1 class of security. Cryptographic protection is the use of hash function, where in contrast to classical hashes the session key is client's biometric template as well as identification data of ATM or mobile device.

The hash function is described in the form of a table of numbers, the sequence of mixing is determined by the set of client's biometric data, the ATM's ID and the date of transaction. Described protocol of strict mutual authentication guarantees the protection of a large number of client's applications to his/ her own account.

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The Preparation of College Students for Alternative Computer Platform

Martin Skýba¹

Abstract. It is important to realize that the use of classic information technology seems nowadays for the new generation as an overcome issue. It is so necessary to spend time on preparing professionals in economics also in the area of a use of new information technology. These systems enable more flexible approach towards information, and more flexible possibility to react on problems that are connected with company managing. The article deals with the development and usage of information technology and communication technology in business sector followed by a students' readiness to use and work on alternative platform of operating system OS X created by Apple company. Based on the study, the goal of the article is to find out the space students are willing to give to alternative computer platforms and its possible limits. The survey is in the first part directed towards students of economic faculties. The questionnaire method used was based on close questions and the follow up statistical analysis to evaluate the survey results.

Keywords: Apple, PC, iMac, OS X, tablet, mobile phone.

JEL Classification: O14, I21, I23

1 Introduction

There were approximately 360 million of people using internet in the world at the end of 2000, in 2013, when the total number of people is 7.1 billion, 2.7 billion use internet. This is roughly 39% of the world population. It can therefore be said, that the influence of the information technology on a common life of people is indisputable. Information and communication technology (further only ICT) have been playing irreplaceable role in business sector for a couple of years now. Almost all companies now use computers and have internet connection. Every year ITC enables further communication improvements and possibility to spread information among companies and a company as such. This technology also enabled brand new way of realisation of company processes. ICT and its usage offer significant job opportunities; it stimulates growth; it encourages companies to invest into innovations, and may contribute to competitiveness growth. This angle is also interesting for

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watching the development of using computers with internet connection in companies with more than 10 employees in the Czech Republic. The situation reflects table No. 1 Employees using at work computer with internet connection (in %).

Table 1 Source: ICT usage survey in the entrepreneurial sector (ICT 5-01), ČSÚ 2013

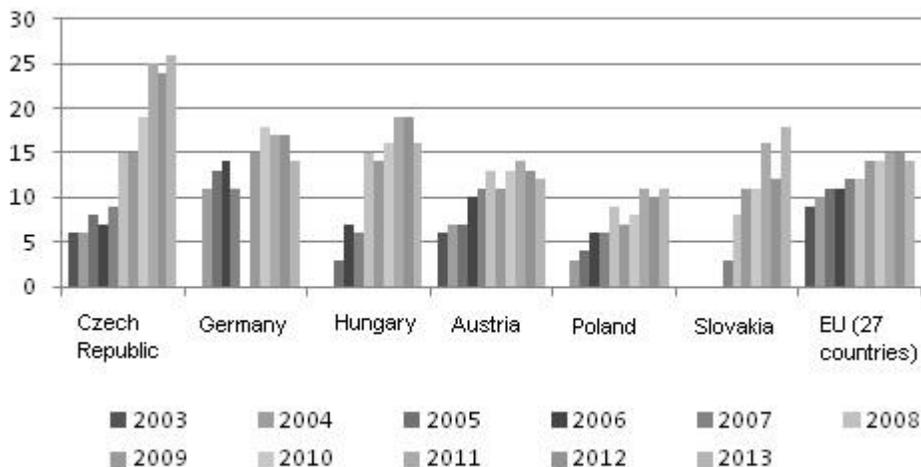
	2001	2002	2003	2004	2006	2007	2008	2009	2010	2011	2012	2013
Companies total (10+)	17,9	21	24,7	28,5	30,5	31,7	32,7	34,1	33,3	34,9	35,5	36,9
<i>Company size</i>												
10–49 employees	20,7	24,9	29,6	30,9	35,4	37,3	38,4	41	36,3	38,4	40,3	41,8
50–249 employees	17,8	21,3	25,9	29,5	32,7	32,8	33,8	35,2	34	36,1	36,4	37,3
250 and more employees	16,4	18,7	21,4	26,3	26,4	28,1	29,4	30,1	31,3	32,4	32,8	34,2

It is necessary to say that the statistical survey covered non-financial companies. The table clearly shows that in 2001 only 18% of companies with more than 10 employees used computers with internet connection within their working process, it was almost 37% in 2013. It can be predicted that the development of the information technology will support in growth this trend. Moreover, the importance of information technology in the business sector may be illustrated on a fact that while in 2001 the share of profit of online sale in companies with more than 10 employees, according to the Czech Statistical Office, was only 4%, in 2013 this share reaches 25%. Comparing these values with values of selected EU countries and with average values of the whole EU, the situation in the period 2003-2013 describes the following diagram.

The share of online sale in companies with more than 10 employees in selected countries in 2003 - 2013 (values in %).

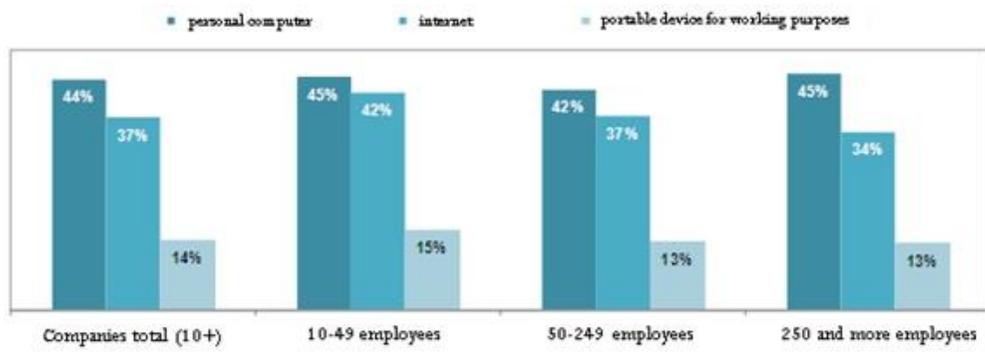
Table 2 Source: Eurostat database, available at

<http://apl.czso.cz/pli/eutab/html.h?ptabkod=tin00110> (downloaded on 21 August, 2014)



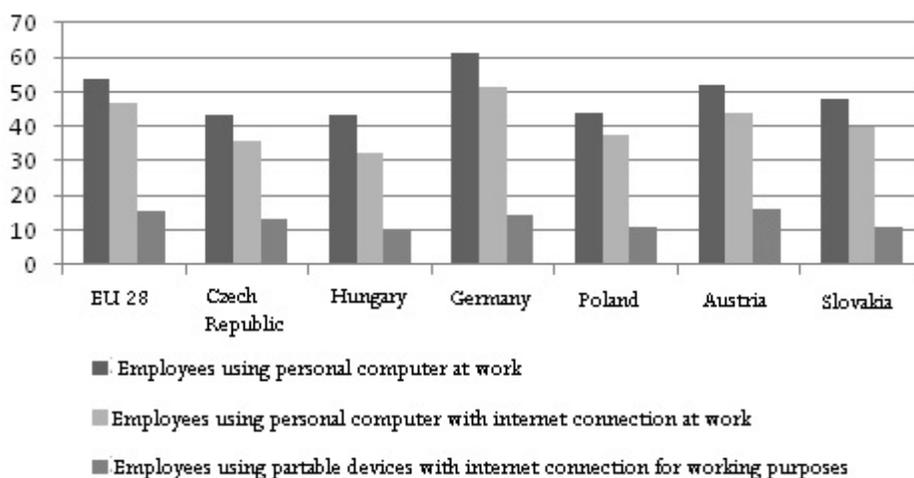
The diagram shows that the Czech Republic is on the front places when considering influence of using information technology in business sector, and it is also clear that it is comfortably above the average EU values. It is so obvious that the Czech companies are strongly motivated to adjust the ICT development. The growth of information technology influence is also markable on a share of employees in companies using chosen information and communication technology as shows the following diagram.

Table 3 Employees in CZ companies using selected ICT, January 2013 *the share on the total number of employees in a certain size and branch group (in %)



The diagram shows the Czech Statistical Office survey with a personal computer dominating the use of a classic information technology. Portable devices used for working purposes regardless the company size use about 13% employees, which represents relatively low percentage. In comparison with other European countries and average values for EU as one unit, the situation may be summarised as in the following diagram.

Table 4 Employees using computer at work



In comparison with other European countries Czech Republic has an average position when studying extend of using personal computers, the level is slightly over 40% employees, but when considering using portable devices with internet connection for work purpose the Czech Republic position itself above average. The development of portable devices with internet connection will support a growth of their usage in a business environment.

2 Providing Apple Platform Education

Faculty of Economics of VŠB-Technical University Ostrava opened in 2013 new authorised training centre within the world program of Apple Authorised Training Centre for Education according to FRVŠ project. The goal of this project is a basic improvement of a teaching process in the area of work with multimedia for bachelor and magister program students (along with Applied informatics and Marketing and business programmes), and a students' direct support on a job market. The lecture room would be used for subjects as e.g.

Elaboration of graphical information, Multimedia systems, Multimedia, and for subjects of Economic journalism program.

Apple specialises in products not supporting world standards of open systems in timeless design. Their best-known current products are iMac and MacBook, tablet iPad, smart phone iPhone, and multimedia player iPod. Apple computers run OS X, touch devices iPad, iPhone and iPod iOS. Other well-known Apple product is iTunes. iTunes is an application for organising and playing music and videos

3 Survey Studying Students' Knowledge of Apple Products – Procedure and Results

Students were given a questionnaire studying knowledge of Apple products and applications with a goal to find out the knowledge of this computer phenomena students have here in the Czech Republic.

The questionnaire answered 116 students during the years 2013 and 2014 of Marketing and business program (34 male-students and 62 female-students) and of Applied informatics program (16 male-students and 4 female-student)

Age range:	18-20 years ... 20 students
	20-22 years ... 92 students
	23-26 years ... 4 students

It cannot be strictly talked about a representative sample as all respondents had at least secondary education and some already finished bachelor degree. This group can be generally expected to have a closer relationship to information technology and a tendency to use new technologies rather than people with lower education. It can also be said that according to the Czech Statistical Office 90% of our selected age group uses personal computers, and considering a structure of education it is almost 83%. In this connection the focus on students between 18-26 years seems as most effective. The questionnaire asked 16 closed questions.

Table 5A

Do you know Apple products?	Yes	No
MAR	90	6
API	16	4

Table 5B

Do you own any Apple product?	Mac, MacBook	iPad	iPhone	iPod	None
MAR	0	4	10	6	82
API	0	4	4	4	12

The answers show that the general knowledge of the existence of Apple platform is rather large as the survey proved the majority of students (91%) know about the existence of Apple. At the same time 81% of respondents claim they do not have any Apple device, which on the other hand does not limit a potential of possible usage of this platform. It is not necessary for the teaching process that students own this technology to be able to learn how to use and effectively work with such technology. The remaining 19% of students own at least one of the touching device, only 8 students own iPad (7%), and none of the students own personal computer of laptop. That means Apple device owns every fifth student. In this connection the numbers do not differ in studying programs, but we should realise the questioned group of students of Applied informatics was significantly lower. Theoretically stated the need to use Apple products would be higher in this program.

Table 5C

How much would you be willing to spend on new laptop or tablet?	To 10 ths CZK	10-15 ths CZK	15-20 ths CZK	20-25 ths CZK
MAR	20	50	16	10
API	4	8	6	2

Table 5D

Where do you buy multi-media technology?	Online	*	Specialised store	**
MAR	32	28	28	8
API	12	4	4	0

* I look at the goods in brick stores and buy it online

** in big stores like Datart, Elektroworld, ..

Table 5E

What is your source of information about new technology?	Online	Friends	School
MAR	80	16	0
API	18	2	0

The survey revealed that finances are not limiting a purchase of a new device, 10 – 20 thousand crowns are willing to pay 69% of students for a new one. The personal questioning also revealed the majority of respondents are willing to invest into laptop or tablet if it is directly connected with the access to information not only for studying purposes but also for free-time activities. The future question could be: Why do not young people buy Apple products?

The largest source of new technology information is for respondents (84%) internet as it is also their most frequent place of a purchase (65%). This context shows an interesting fact, the behaving of Applied Informatics students and Marketing students does not differ.

Table 5F

Do you think the new technology at schools may raise interest in education?	Yes	No
MAR	92	4
API	18	2

Table 5G

Your opinion on IT quality at the university.	excellent	very good	good	sufficient	insufficient
MAR	21	48	27	0	0
API	4	12	4	0	0

Table 5H

Would you be interested in lectures using Apple iMac?	Yes	No	No opinion
MAR	73	1	22
API	16	0	4

Students believe (95%) that the new technology at schools would support the interest in further studying. They would see teaching with iMac computers interesting; this is an opinion of 77% of respondents. The survey also revealed

that the Faculty of Economics VŠB-TU is very well equipped with the modern technology. Along with the intention to use this technology in the lower stages of educational process the need of its usage would probably raise on all the higher levels (see appeal No. 51 of Operational Education program for competitiveness of submitting individual projects in the area of a support of a further education of teachers and lecturers of schools and school facilities that should raise a competence of pedagogical workers of basic and secondary schools when integrating information and communication technology into teaching).

Table 5I

What is iTUNES?	Software for video cuts	***	Software for picture editing	No opinion
MAR	0	87	0	9
API	0	20	0	0

*** application for organising and playing multimedia files

Table 5J

Apple tablet is called:	Mac	iPad	iPhone	iPod	No opinion
MAR	4	88	0	0	4
API	2	18	0	0	0

Table 5K

Is it possible to use OS Windows on Apple Mac computer?	Yes	No	No opinion
MAR	70	18	8
API	20	0	0

Table 5L

How do we call the lower line of icons in Apple OS?	finder	dock	menubar	No opinion
MAR	2	21	21	52
API	0	5	1	14

Questioning the possibility to run on Apple Mac computers operation systems 78% respondents gave positive answer which was correct. The

knowledge of operation systems is quite low (22%) which corresponds with the above mentioned, the Apple computer has only few of them.

Students know iTunes (92%) – application for organising and playing digital music and videos in computer, and also multimedia computer of a tablet type by Apple (91%).

Table 5M

Who are the most frequent users of Apple computers?	University teachers	Graphics	Pc games players	Common users	No opinion
MAR	0	44	10	30	12
API	0	15	0	4	1

Half of the respondents believe that Apple computers are used mostly by graphic designers.

Table 5N

The OS you use on your computer	OS X	Windows 8	Windows 7	Win Vista	Win XP
MAR	0	15	74	4	3
API	0	5	15	0	0

Table 5O

The OS you use on your phone:	Android	iOS (iPhone OS)	Windows Phone	Other
MAR	59	8	13	16
API	13	0	3	4

Table 5P

I connect my phone to internet via:	Only WiFi	GSM	WiFi and GSM	Satellite connection	I do not connect
MAR	50	3	34	0	9
API	8	8	0	0	4

Students in their computers use operation system Windows by Microsoft, newer versions such as Windows 7 and Windows 8 (94%). This is a fact that is based on a common usage of this operation system and also due

to the need to communicate on official level where a respond is usually required in some of MS OFFICE product.

8 students stated they use iOS in their mobile phones while in other question 14 of them claimed to be using iPhone. This answer only proves the fact that students mostly do not bother with the operation system their device work with. Students mostly use operation system Android (62%). 89% use their mobile phones to connect to internet.

The survey proved students know Apple products. Only few, however, use them, including students of informatics. Regarding the very low knowledge of Apple systems, they will be asked to answer the questionnaire at the end of the course. All tables of the 3rd chapter were created Source: (Martin Skýba, 2014).

4 Conclusion

The goal of this article was to map an extend of a will to use alternative computer platforms and its limiting factor. The questionnaire survey was realised on Faculty of Economics of VŠB-TU and showed that in the target group exist high level of using this modern computer and mobile information technology and also quite a tendency to use other than Windows systems. The need to concentrate on alternative operation systems is connected especially to current trend of implementing mobile information technology throughout platforms to lower educational levels, that is why the intention to implement Apple products at Faculty of Economics of VŠB-TU is more than necessary. The questionnaire only confirmed low knowledge of OS X and iOS platforms among students, and it is therefore good that the reaction of the university was to design an Apple lecture room

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Dynamic Network Analysis Architecture for Heterogeneous Unstructured Text Data

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Abstract. There are several analytical tools for data processing with different aims in different domains, analyzing specific data by specific algorithms, providing new views of data. These tools are usually narrowly focused on analysis part, but the whole process is more complex than just algorithm of specific analysis. This paper provides survey and describes basic four layer architecture of complex analytical tools.

Based on survey findings we introduce concept of new architecture of social network analysis based knowledge base of unstructured text data. The tool will be used in project in homeland security domain, provided by the Ministry of Interior of the Czech Republic.

Keywords: social data analysis architectures, big data, homeland security, unstructured text analysis.

JEL Classification: L86

1 Introduction

A crucial analytical task in number of scientific and technological domains is to retrieve information from text data, extracting extra information from content, getting not explicitly stated facts. The challenge in this task is the size, complexity of data and frequency of updates, which are also factors close to the term of *Big Data*.

Big Data describes challenge to handle data of unprecedented volume, variety, velocity and veracity (Sathi, 2012). Success in this task is the key condition for analysis of this data and for all analytical tools, which give some extra value to the data, highlighting its usability in today's world.

Application areas of *Big Data* and analytical tools are also very close, primarily according to significant synergy of these domains. As possible use cases can be mentioned:

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- **Marketing:** Enrichment of traditional data sets by social media data to get more complex picture of customer's needs and prediction of future trends.
- **Business processes:** Optimization of business processes is very often influenced by *Big Data*, e.g. integration of GPS sensors into logistics companies.
- **Health Care:** Processing of all smart watchers and wearable devices helps for better understanding of links between lifestyle and diseases. Analytics of discussion forums and social networks can help in monitoring and prediction of epidemics and disease outbreaks.
- **Security and Law Enforcement:** Detection, prediction or even prevention of terrorist actions, cyber-attacks or criminal activity. Support for crime investigation.

There are many tools, more or less specialized in specific domains and specific use cases. Text analysis for extraction of data content into more suitable form, social network analysis (SNA) for survey of entities and relationships, sentiment evaluation for trends of selected topics, e.g. its' popularity. These tools also differ in source data they can process. Despite the number of these tools there is still strong demand for new analytical tools – either specialized, or more complex, integrating or enriching existing solutions (Ministr & Racek, 2011).

Second chapter gives overview over existing analytical tools. Next part describes basic principles of each of four layer architecture, usually used in complex tools for data processing. Fourth chapter introduces architecture of SNA based knowledge tool.

2 Existing analytical tools

There are multiple heterogeneous projects for data analysis in different areas with different aims. We will closely discuss few representatives.

There are two major projects dealing with data processing challenges in general. SMILA³ is a framework for creating scalable server-side systems for processing of large amounts of unstructured data in area of search, linguistic analysis, information mining. GATE⁴ is a complex open source solution for

³ <http://www.eclipse.org/smila/>

⁴ General Architecture for Text Engineering, <https://gate.ac.uk/>

text analysis (Hamish, et al., 2011), providing component based architecture for large-scale Natural Language Processing (NLP) research.

These projects show up-to-date need of these general platforms and also point out disadvantage of necessity of narrow domain focus of these tools. There is another study, discussing demand for these tools and importance of scalable Data as a Service for enriching traditional text mining techniques.

SEMO, a platform for Customer Social Networks Analysis is another project for integration of Social Networks and Customer Relationship Management domains (Garcia-Crespo, et al., 2010). The whole platform is based on Semantics and emotion mining.

CrimeNet provides advanced structural analytical techniques that allow extraction of network knowledge from large volumes of criminal data (Xu & Chen, 2005). It focuses on network creation, network partition, structural analysis and network visualization. All of these tasks are performed within analyzes of static data sets, not in evolving networks.

There are also analytical tools developed by governments and security agencies, mostly kept secret. We can mention ICREACH as a representative, surveillance engine for information retrieval from the United States government's data stores, working with lightweight set of key meta data of every record for easier manipulation (Gallagher, 2014). It processes data like emails, phone calls, cellphone locations or Internet chats. It accesses and indexes large volumes of communications collected by agencies like FBI or CIA for investigations.

3 General Architecture of Complex Analytical Tools

A typical architecture of complex analytical system consists of four layers: Data Acquisition, Data Persistence and Management, Data Analysis, Presentation (Figure 1).

3.1 Data Acquisition

Data acquisition is complex problem, which has to be solved in all areas of data processing (Han, et al., 1996). The first stage of the whole process, called *data preprocessing*, consists of four steps: data cleaning, integration, selection and transformation.

Within tools for information retrieval we can consider wide range of heterogeneous sources like Internet discussion forums or chats, inquiries, advertisements, news, Internet auctions, emails or social networks. Some of these source keepers provide API (typically sources, which also provide its content to third party applications for any reason -- like social networks, advertisements, emails) for easier access. But there is also a wide group of sources, accessible directly over web. For data acquisition from web pages are used tools called web crawler and web scraper.

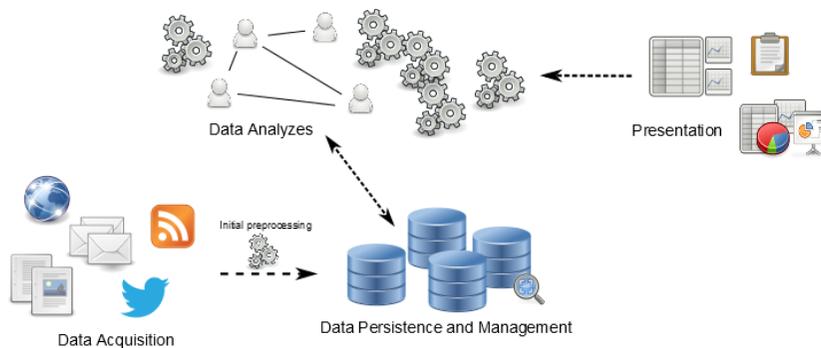


Figure 1 General four layer architecture of complex analytical tool.
Source: own.

3.2 Data Persistence and Management

This layer is responsible for storage and management (data and information retrieval) of data, which were obtained from heterogeneous data sources. It is closely related to domains like *Big Data*, NoSQL databases and text information retrieval, which are discussed in following subsections.

Big Data

Considering data size and structural complexity, the question of *Big Data* phenomenon and its proximity in this domain reveals. To correctly understand what *Big Data* means, it is often described as group of four attributes: Volume, Velocity, Variety and Veracity (Sathi, 2012; Zikopoulos, et al., 2011).

NoSQL Databases

Above mentioned *Big Data* phenomenon showed necessity of tools for storage of this data. It has led to increased interest of people in non-relational databases, frequently called NoSQL databases (Leavitt, 2010). These databases include hierarchical, graph and object-oriented databases and its

primary advantage is that they can handle unstructured data such as word-processing files, e-mails, multimedia, etc., more efficiently than traditional relational databases. This is due to features of NoSQL databases, like dynamic schema, auto-sharding, replications and integrated cache.

Text Information Retrieval

Text information retrieval refers to the process of searching for information within documents or document meta data. It is looking for relevant documents, not just checking simple matches to patterns, using retrieval models. There are available libraries or whole solutions -- indexing and searching applications. Further will be mentioned main candidates, which are usually used as text retrieval solutions -- Solr⁵ and ElasticSearch⁶, both are built on top of Apache Lucene⁷.

3.3 Data Analysis

Data analysis tries to discover useful information, using analytical and logical reasoning to examine each component of the analyzed data. There is variety of specific methods, focused on different aspects, e.g. data mining and text analytics, trends, visualizations, decision support systems or business intelligence.

This layer is responsible for the key functionality; it is the purpose of existence of the whole system. We are focused on domain of SNA, using techniques of text processing as an enrichment of data for the primary analysis. Among these considered supportive text analyzes belongs *content analysis* (Ashton, et al., 2014), *sentiment analysis* (Khan, et al., 2014) and *entity identification and matching* (Koppel, et al., 2009).

SNA

SNA studies social relationships in terms of network theory. It is mapping and measuring all possible relationships between people or selected entities in general (Scott, 2000). SNA is frequently used in information science and sociology and nowadays also in other domains, such as medicine, health care,

⁵ <https://lucene.apache.org/solr/>

⁶ <https://www.elasticsearch.org/>

⁷ <http://lucene.apache.org/>

management or homeland security (Garcia-Crespo, et al., 2010; Xu & Chen, 2005; Borgatti, et al., 2009; Gallagher, 2014).

Evolutionary network analysis is a special branch of SNA, responding to dynamic social networks, e-mails, biological networks and social streams (Aggarwal & Subbian, 2014). The basic difference is that modeled network isn't static; it evolves and reacts to changes in a source domain. There are several applications of evolutionary network analysis, such as trend analysis in social networks or dynamic link prediction.

3.4 Presentation

The top layer of the system is a presentation layer, which usually exposes user interface or some API. It is usually mapped into lower layers, providing results of analyzes and processed data.

An effective presentation of data is still a big challenge. And in this case we also have to consider aspects of *Big Data* representation and visualization, which also brings some specific limitations (Gorodov & Gubarev, 2013). There are many studies and tools presenting different approaches in this area, e.g.

Another way of data presentation is a provision of stored information and integration (or export) with other information systems for further processing. Although we have several major formats of structured data (relational databases, XML, JSON, etc.), the integration isn't usually simple and straightforward. This is caused by different data structures or attribute names of entities in both systems (Rahm & Bernstein, 2001).

There are some tools for static and evolving network analysis in narrow source data environments, so as knowledge bases built on top of graph principles, but we are not aware of any complex tool for combination of these aspects in heterogeneous data source environment in one platform.

4 New Architecture Proposal

The aim of our research is to contribute to information retrieval from unstructured text data from sources with high level of data structure diversity. We identified that although there are several information systems and tools in this domain, there is no specialized tool for SNA, using its data (uniting from

different data sources) as a knowledge base, providing user interface for information retrieval in one platform. This knowledge base could be also used as a central tool for further export of this information to other information systems – serving as a platform for data enrichment by originally incompatible data structures.

Hence we focus on development of architecture and solution, which will provide general knowledge base, built on principles of slowly evolving networks, merging data with complex data structures into one document based data storage. Providing universal platform for integration analyzes results with original records, so as user interface for information retrieval or API – for data enrichment of other information systems (Figure 2).

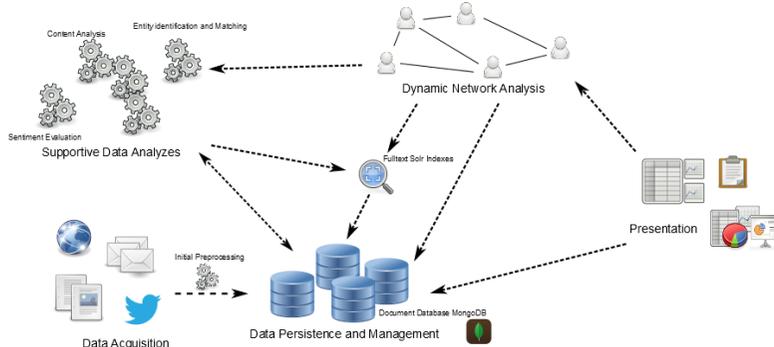


Figure 2 Proposed complex architecture of SNA based knowledge base. Source: own.

5 Conclusion

This system will be part of complex solution of applied research of Ministry of Interior of the Czech Republic for Automatic Recognition and Identification of Objects in the Internet and the Existing Systems of Police, focused on PSEUD⁸ (AIOISIS), the Czech Republic. The whole system is being developed by research group with members from different domains.

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⁸ <http://pseud.policie.cz/wps/portal/>

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Feature Based Opinion Mining Collated with Real Values of Examined Features

Katarzyna Wójcik¹, Janusz Tuchowski²

Abstract. Sentiment analysis or opinion mining is field of research that can have significant impact on today's business. Increasing number of consumers' reviews created the need of its automatic analysis. This issue is gaining popularity for both – researchers and entrepreneurs, for whom consumers' reviews are important source of business information.

There are three main areas of opinion mining: opinions classification, feature based opinion mining, comparative sentences analysis.

For each of those areas one or few text mining approaches can be used. This paper is focused on feature based sentiment analysis in which not the sentiment of the whole opinion is analyzed but how particular features of opinion's subject are seen. For each feature real value is added. It allows to collate values of the same feature for different products with sentiment of this feature.

Keywords: sentiment analysis, patterns, opinion mining, text mining, classification, ontology

JEL Classification: C15, C38, C61, C62

1. Introduction

Sentiment analysis or opinion mining is field of research that can have significant impact on today's business. Increasing number of consumers' reviews created the need of its automatic analysis. This issue is gaining popularity for both – researchers and entrepreneurs, for whom consumers' reviews are important source of business information.

There are three main areas of opinion mining: opinions classification, feature based opinion mining, comparative sentences analysis. For each of those areas one or few text mining approaches can be used. This paper is focused on feature based sentiment analysis in which not the sentiment of the whole opinion is analyzed but how particular features of opinion's subject are

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Feature based opinion mining collated with real values of examined features

seen. For each feature real value is added. It allows to collate values of the same feature for different products with sentiment of this feature.

2. Sentiment analysis

Sentiment analysis or opinion mining refers to the application of natural language processing, computational linguistics, and text analytics to identify and extract subjective information in source materials.

Generally speaking, sentiment analysis aims to determine the attitude of a speaker or a writer with respect to some topic or the overall contextual polarity of a document. The attitude may be his or her judgment or evaluation, affective state, or the intended emotional communication (Wikipedia EN - Sentiment_analysis, 2014).

In the field of sentiment analysis there are three main areas (Liu, 2007):

- Sentiment classification: assignment of sentiment to whole opinion or division of opinions into groups on the basis of its polarity; usually two or three groups are used – positive, negative and sometimes neutral opinions
- Featured-based opinion mining and summarization: discovering what aspects of product users like or dislike.
- Comparative sentence and relation mining: analysis of sentences comparing directly one object to another

2.1. Opinions

Reviews are a specific type of textual data. They have a subjective character - they express the attitude of opinions' authors to the objects of the opinions. In some services verbal opinions are supported by points or stars representing the value of opinion.

Opinions that can be found in the Internet can be divided into three groups according to their form (Liu, 2007):

Form1: advantages (pros), disadvantages (cons) and summary

Form2: advantages (pros) and disadvantages (cons)

Form3: no rules or restrictions, free form

The form of opinion determines in some approaches methods of its analysis.

2.2. Text Mining Approaches to Sentiment Analysis

There are few text mining approaches to sentiment analysis (Lula and Wójcik, 2011):

- Word-based approach – it is assumed that the meaning of the opinion (also its sentiment) is carried by separate words; so that the sentiment is assigned to every word in opinion
- Pattern-based approach – it is assumed that the sentiments are carried by phrases/expressions instead of separate words so the sentiment is assigned to identified phrases
- Ontology-based approach – in this approach ontology is used to present domain knowledge about the subject of opinion; it allows showing the structure of product or service which is rated in opinion
- Statistical learning approach – in this approach training set (containing opinions with sentiments given) is required; on this basis the model learns how to assign polarity to new opinions

There are some significant differences between those approaches. They can be used in different types of sentiment analysis. For each area the best approach can be identified (Wójcik and Tuchowski, 2013). Often it may be useful to combine different text-mining approaches to sentiment analysis to improve the results.

3. Feature based opinion mining

Featured-based opinion mining covers discovering what aspects of product users like or dislike. Not the whole opinion is examined but its parts that refer to listed features of product or service. In feature based opinion mining three different text mining approaches to sentiment analysis can be used: word-based, pattern-based and ontology-based approach. In previous papers authors described them as addition to main topic of research. This paper is focused on featured-based opinion mining gathering all previously mentioned materials and adding comparison of different approaches. It also contains attempt to identify possible mixtures of different approaches helping to improve the results reducing efforts needed to be taken. **Word-based approach**

A tag cloud (or word cloud) is a visual representation for text data, typically used to depict keyword metadata (tags) on websites, or to visualize free form text (Wikipedia EN - Tag_cloud, 2014). Tags are usually single words, and the importance of each tag is shown with font size or color.

Cloud of tags can be used in feature-based sentiment analysis. We assume that feature which appears in cons cloud is its disadvantage while feature on pros cloud is product's advantage. Before cloud of tags can be prepared the removal of words from stoplist must be done. Those words can darken the results achieved while using this method (Wójcik and Tuchowski, 2013).

3.2. Ontology-based approach

Ontology is a formal and shared specification of a domain of interest. It formally represents knowledge as a set of concepts within a domain together with the relationships between those concepts. Classes (concepts) in ontology can have hierarchical structure.

Ontology also contains a set of objects (individuals, instances of concepts) which represent real items or beings from a given domain. The concepts may have attributes expressing their properties. Ontology can be used to describe the domain and to reason about the entities within that domain.

The ontology as graph-like construction makes feature based opinion mining easier to conduct. Ontology can be used in sentiment analysis in different ways. In most popular approach single opinion can be presented as an instance of ontology (Kontopoulos et al. 2013). The main characteristics of the subject of opinion can be presented as its attributes in the ontology. Then the polarity of each feature must be determined either for single opinion or for the whole set of opinions(Wójcik and Tuchowski, 2014). In a special case of this approach for every node two additional leafs representing positive and negative sentiment are added (Wei and Gulla, 2010).

3.3. Pattern-based approach

Pattern-based approach allows identifying certain phrases in opinions. To those phrases sentiments can be assigned. Advantage of this approach is possibility to detect phrases that modify sentiment like negation, nullification, strengthening and others. In feature-based sentiment analysis patterns help to

identify product's features and combine them with polarized words attached to them.

In this approach the key thing is to define rules. One must decide if the rules will be connected with particular product or service or if they will be more universal. In most solutions mechanisms based on regular expressions are used. Also in this approach sentiment dictionaries are required. The problem that must be taken into consideration is that some words have positive meaning in one context and negative in another.

4. Empirical analysis

During research the simulation analysis was conducted. Its aim was to collate sentiments assigned to chosen features with their real values. The pattern-based approach was chosen.

In the research process the following stages of analysis can be distinguished: 1 – extraction of opinions and products specifications from the Internet, 2 – features selection, 3 – dictionaries construction, 4 - feature-based opinion mining, 5 - collation of features sentiments with their real values.

4.1. Opinions examined in research

The first step of research concerns extraction of opinions about Smartphones. In this case reviews about subsequent models from the same family were chosen. All 737 opinions were extracted from cokupic.pl via ceneo.pl. The analyzed opinions were all written in Polish language. Figure 3 presents exemplary opinion. It can be seen that the opinion is in the first form: it contains pros (1), cons (2) and summary (3). However in this case rather pros and cons summarize the opinion included in the plain text. Each review is also supported by overall mark expressed by stars (4).

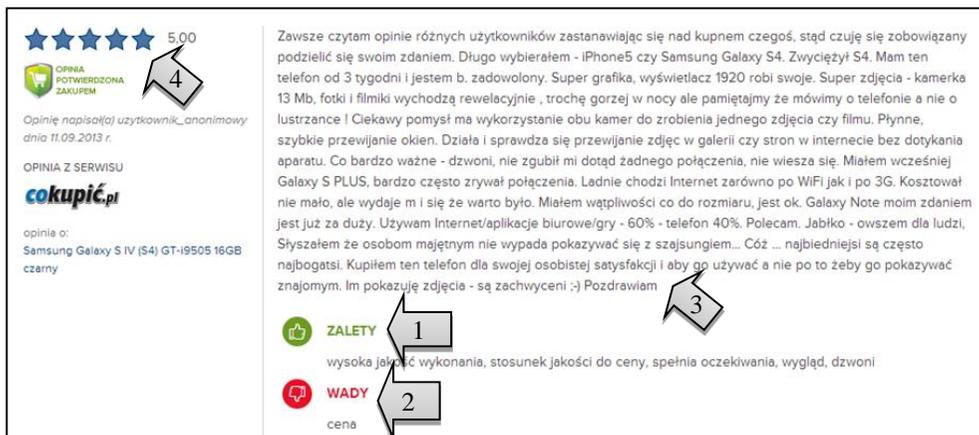


Figure 3 Exemplary opinion extracted for the purpose of research, Source: <http://www.ceneo.pl>

4.2. Pattern-based approach experiment

Pattern-based approach implies using some kind of rules or patterns based on regular expressions. The first thing that had to be done during research in this area was to find the application enabling creation and interpretation of that kind of rules of patterns. In literature authors found application created by Institute of Computer Science of Polish Academy of Sciences.

Spejd (ang. *Shallow Parsing and Dezambiguation Engine* – spade³, ang. *Shallow Parsing and Eminently Judicious Disambiguation* - spejd⁴) is a tool for simultaneous morphosyntactic disambiguation and shallow parsing. The Spejd formalism is essentially a cascade of regular grammars. Unlike in the case of other shallow parsing formalisms, the rules of the grammar allow for explicit morphosyntactic disambiguation statements, independently or in connection with structure-building statements, which facilitate the task of the shallow parsing of ambiguous and/or erroneous input (Buczyński and Wawer, 2008). For shallow parsing it uses National Corpus of Polish (pl. *Narodowy Korpus Języka Polskiego*)

³ At first, application was going to be called Spade, but there exist another shallow parsing application under this name. Then authors decided to polonaise its name phonetically. Sometimes they are also using spade symbol (♠) instead of application name.

⁴ When the application name was changed also the meaning of abbreviation was changed.

Firstly Spejd was used in research to tag parts of speech and to left only nouns. In this step also stemming was conducted. On this basis the most frequently appearing features were chosen for experiment.

In next stage of research two types of rules were defined:

- 8) rules modifying sentiment of single words
- 9) rules combining identified features with their polarized neighbors

Buczyński and Wawer in their papers define four types of sentiment modifying structures (Buczyński and Wawer, 2008):

- Negation – reversing the polarity
- Nullification – expressing lack of certain quality or property
- Limitation – expressing that positive or negative sentiment has only a very limited expand
- Negative modification – combination of negative adjective with positive noun

Another rule modifying sentiment is its strengthening. There are some words expressing that something was very good or bad

Also on this stage two dictionaries were used. First of them contained positive and second negative words. All words were in their base form. To each word there was sentiment assign. Values of sentiment were integer numbers in the range [-10;-1] for negative and [1;10] for positive dictionary. Both dictionaries were created for the purpose of this research and expanded during experiment.

Some words couldn't be put into any of dictionaries because they have different polarity depending on the context. They must be analyzed separately. Those are words like: high/low, fast/slow, long/short etc.

Table 2 Aggregated sentiments of chosen features of exemplary smartphones, Source: own elaboration

Feature		Samsung Galaxy				positive/negative	trend
		S II	S III	S4	S5		
aparatur (camera)	sentiment	5,00	5,16	5,41	8,25		
	Mpx	8	8	13	16		
bateria (battery)	sentiment	-1,10	-1,68	-0,07	4,50		
	mAh	1650	2100	2600	2800		
ekran (display)	sentiment	3,25	5,81	6,66	6,25		
	PPI	218,00	306,00	441,00	432,00		
procesor (CPU)	sentiment	4,80	2,50	5,00			
	GHz	1,20	1,40	1,60	2,50		

The next step in this experiment was to count total sentiment of each indicated feature. For this purpose authorial application in Java was used. For each model the averages of sentiments assigned to particular features were counted. Results are in Table 2. Empty cell signifies lack of polarized phrases connected to particular feature. Column positive/negative shows if attitude of customers to certain feature was positive or negative. Column trend shows how this sentiment changes through consecutive models.

The last step was the collation of features sentiments with their real values. The features were limited to those with numerical values. Column trend contains also changes in real value of the feature.

5. Conclusions and further research plans

It can be observed in Table 1 that there is some kind of similarity in trend of sentiment and real value for the some features. To draw more firm conclusions more detailed experiments should be performed.

In further research authors are going to use statistical methods to take also non-numerical features into consideration. Some features can be describe by more than one parameter. Our next goal is to aggregate those parameters into one value to be able to collate it with sentiment. Also multiple regression can be useful tool to examine dependencies between values and sentiments of features. The set of opinions will also be expanded as well as sentiment dictionaries.

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