COGNITION AND CREATIVITY

SUPPORT SYSTEMS

Studia Ekonomiczne

ZESZYTY NAUKOWE WYDZIAŁOWE

UNIWERSYTETU EKONOMICZNEGO

W KATOWICACH

COGNITION AND CREATIVITY

SUPPORT SYSTEMS

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Katowice 2013

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w Katowicach 2013

ISSN 2083-8611

Wersją pierwotną „Studiów Ekonomicznych" jest wersja papierowa

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INTRODUCTION

Our perception of the creative formation of organizations has changed dramatically during the past years. For a long time, creativity was considered in terms of managing a small business or being an artist. However, creativity is not directly associated with the particular context. We can consider essentially context-free organizational creativity. Nearly the same was for cognition. Previously, cognition was linked with abilities to perceive and recognize, nowadays it is developed as foundation of artificial intelligence. Cognition and creativity are equally likely to be present in corporations' development efforts and in the identification of new markets and technologies as in the project of public organizations or in the organization of universities. Creative activities are taking place when neither the goal nor often the initial conditions are known at the start, but constructed during the process. Taking into account the discussion above, the research articles included in this book use the terms cognition and creativity to refer to an individual or a community of individuals that realize their business supported by ICT in their operational environments.

The aim of this book is to improve our understanding of cognition and creativity support system environments. The various research articles analyse creative and innovative activities in the case studies or just through provision of academic discussions. The book's focus is on identifying and understanding the factors relating to the working environment that are conducive to human creativity and cognition.

The book is likely to be of interest to students and scholars in a number of research fields as well as to business policy decision makers concerned with research, teaching and policy measures for the development of cognitive information systems and creativity support system environments.

The thirteen research articles forming the book illustrate various approaches to the analysis of cognition and creativity support systems. The research articles were discussed at the international sessions within the 28th Conference on Organizational Support Systems at University of Economics in Katowice. The construction of cognition and creativity support systems involves the development of agile organizations and is located in the area of interdisciplinary research. The

research papers reflect on organizational creativity in terms of discovery and exploitation of enterprise opportunities. In this book, cognitive process is a creative process, in which information is utilized to develop a completely new knowledge structure. Business creativity is the result of searching of knowledge in the available resources, including technological innovations, markets, available production.

Key topics include creativity and cognition in the following research areas:
–   semantic web for e-Government,
–   knowledge evaluation, knowledge life cycle, and knowledge workers,
–   mobile technologies in modern organization,
–   multiagent decision support systems,
–   sensitivity analysis,
–   social recruiting,
–   enterprise architecture design,
–   workflow modelling,
–   educational services, e-examinations and gamification in e-learning,
–   prosumer awareness,
–   software agent application.

We would like to show our appreciation of the efforts of reviewers and the publishing staff who helped us deliver the book.

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E-EXAMINATIONS FROM STUDENT'S PERSPECTIVE – THE FUTURE OF KNOWLEDGE EVALUATION

Introduction

Process of transferring knowledge and skills is strictly associated with the measurement of its effectiveness. It's hard to imagine teaching without checking the results and evaluation of students. At the same time, the current educational system is based on the traditional paradigm existing for many years. In this model we have face-to-face contact between tutor and student. The consequence of this situation and old habits is a big resistance and difficulty to implement new educational solutions. On the other hand, technological progress may not be stopped and young generation expects changes in the current education system. This also is closely linked with examination system and the change of existing traditional paper evaluation into e-exams. The aim of this article is to deepen the knowledge of existing examination forms and to describe student's opinions on different forms of knowledge check. The article presents authors research results in this area.

1. Testing and assessment as basic operations in knowledge evaluation

Knowledge evaluation is inherent element of education. Testing and assessment operations evaluate students' knowledge, skills and behavior. Their main purpose is to provide feedback to students, teachers and people supervising the learning process. They can also be used to make improvements. By compar-

ing the achieved results with objectives, the effectiveness of the education process can be measured.

Testing is a process that should be carried out continuously. Its goal is to motivate students to work systematically. This action helps to acquire knowledge and skills. Very often, be taking into account the knowledge level of particular group or individual, the teacher can customize the didactical methods and forms to the specific situation and thereby achieve better learning outcomes [Be06].

According to the definition given by W. Okoń, assessment is expressing opinions using degrees or descriptive feedback. It can be carried out occasionally or regularly, during or after the activity. The grades are usually expressed by numbers from 2 to 5 or words pass/fail or know/do not know.

An assessment examiner opinion – positive or negative – about the person, object or action. It should be noted that the assessment of human actions or any items may contain subjective elements. They arise from social relationships and the impact of personal education [Ok03].

There are two types of assessment [Be06]:
– emotional (especially moral and esthetic), in which the subjective elements are more important,
– utilitarian (practical), where to determine person's skills and knowledge we compare the results with the existing scale or reference system; that is why this method is more objective.

Testing and assessment have many functions:
– didactical – aimed to organize students' knowledge and to identify how to remove any errors,
– educational – associated with development of students' attitudes, responsibilities, and their overall development,
– diagnostic – allows to plan further development of the learner, analyze the learning process and take the appropriate actions that are necessary,
– motivational – provides the positive attitude towards lifelong learning,
– selective – used to identify particularly gifted or outstanding persons,
– control – allows to determine the level of achievement in relation to the requirements written in curriculum,
– methodological – supporting improvement of the educational process through analysis of teaching activities; it allows to identify and to implement appropriate corrections to educational process.

Testing and assessment must be organized with the following good practices. All individuals involved in the process must know, understand and accept the exist-

ing procedure. Evaluation criteria must be clear and objective, which excludes their wrong interpretation. When set and accepted, they may not be changed until the end of the course. Due to the fact that each student has different experience, personality and living situation, these factors should also be taken into account. Keep in mind that the evaluation has great importance and impact. It can serve as a reward; motivate to work and to expand knowledge or skills. Wrong or unfair grade can ruin the effects of education and demotivate for further action. Good and fair assessment takes into account the progress made during the learning process, individual commitment and contribution of work. Each grade should serve as a feedback and contain the teacher's comments and suggestions for further work. In such case learning will be more effective [Be06]. In the evaluation process it is crucial to engage learners to self-control and self-check. Individual monitoring of the learning process increases the awareness and contributes to more systematic work.

2. Different evaluation methods

The selection of evaluation methods should be different and dependent on the type of subject, time and place. Preliminary assessment, before the learning starts, allows to determine the initial level of the group. Current assessment, carried out during the study, helps to keep high motivation. Final assessment shows learning results and students' progress. All evaluation results should now be added together to determine the final grade. Both initial and current assessment are often different from the final assessment. They often express the difficulties that students meet during their studies.

The various testing and assessment methods are appropriate in different situations, subjects, knowledge and skills. In the literature some different classifications can be found. W. Kobyliński proposes the following evaluation categories [So59]:

a. Conventional methods, which include:
   – oral, face-to-face exams,
   – written paper exams,
   – practical work,
   – proper usage of source materials,
   – observations.

b. Testing methods:
   – selection tests – single or multiple choice tests,
   – fill the gaps tests that require to write the missing words or elements,
   – tests that are a combination of two previous groups.
c. Machine methods, using special examinations machines, hardware and software.

W. Okoń in his classification took into account the type of communication with the environment and highlighted [Ok03]:
   – oral knowledge check,
   – written paper exams,
   – use of books (mainly in the humanities subjects),
   – practical assessment,
   – human observation during their work.

Taking into consideration presented classifications we may notice that they are incomplete. They include only traditional evaluation methods. With the development of IT technology and telecommunication new, electronic methods appear. E-exams are getting more and more popularity among teachers and students.

3. Description of online exams

The most frequently used electronic forms of evaluation are single choice tests, multiple choice tests, drag and drop exercises, fill in the gaps exercises, ordering exercises, numerical and computational tasks. Figure 1 presents the example of application that allows creating online exams using different types of questions.
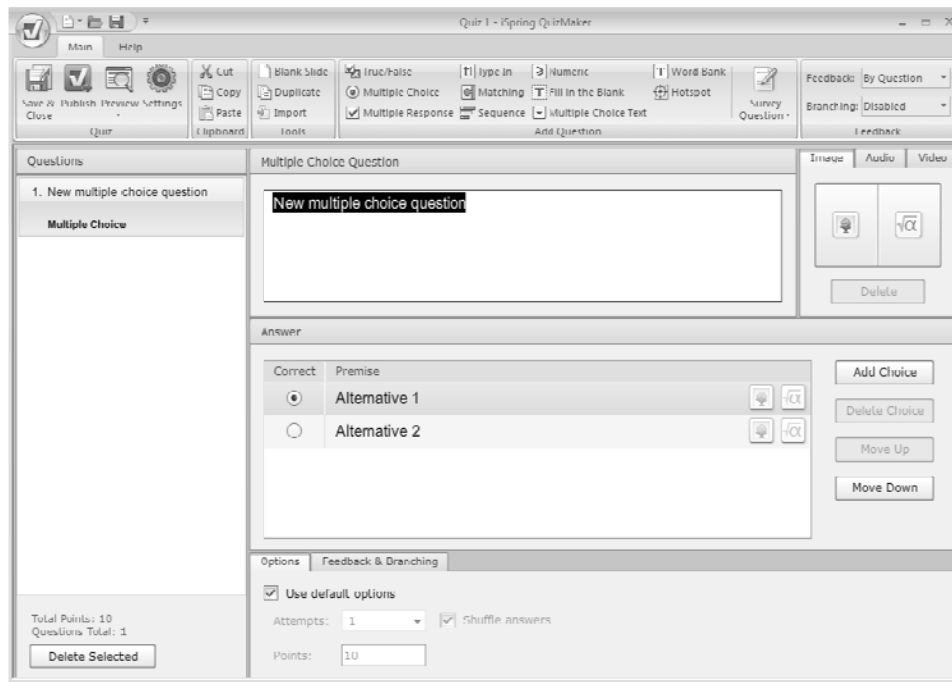
Fig. 1. iSpring Quiz Maker add-in to Microsoft PowerPoint

The characteristic feature of all mentioned exercises is strictly defined structure. It allows automating the evaluation process. The system checks automatically all questions by comparing user's answers with defined key. This makes it possible to get the result immediately after completing the exam and to receive personalized feedback. The teacher is not needed here. All created questions may be used in different situations, courses and exams.

The second group of evaluation forms includes text exercises (short answer, essay) and file response exercises that give a chance to prepare the answer in a file and publish it in the examination system. They are not structured as questions in the first group. They allow to prepare individual answer for given question, describe a solution to a problem, comment the topic. They do not limit the user. The unique character of such questions on one side is advantage but on the other side there is no key with the good solutions. That is why the teacher involvement is necessary here. He must open all the answers and submitted files, analyze them and then give grades and write the feedback and comments for each individual student. In big groups with huge number of users this process may be very demanding and time consuming. Figure 2 illustrates sample essay task and list of possible question types in Blackboard e-learning platform.
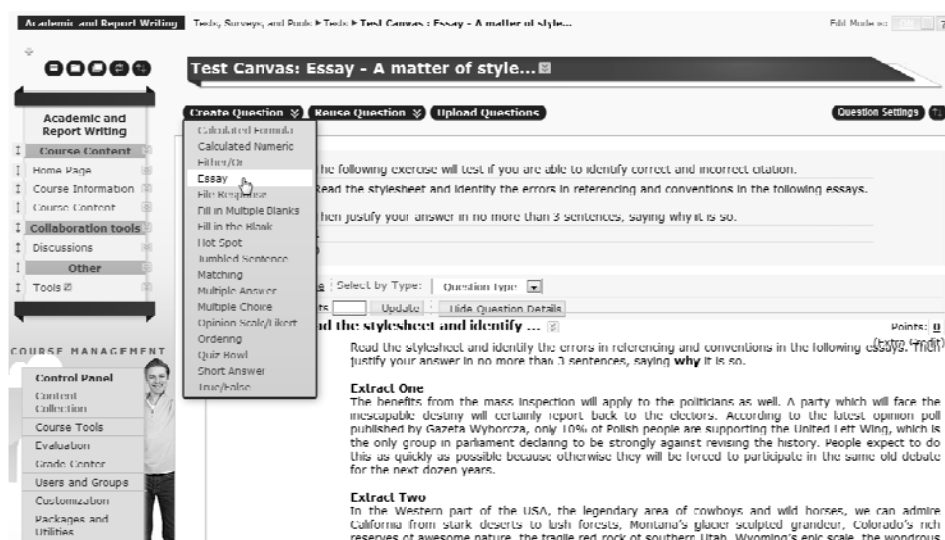
Fig. 2. List of question types build-in Blackboard learning platform

It should be noted that many of the e-learning solutions make it possible to create advanced and sophisticated exams. Using special software course designers may produce customized and uncommon questions like crosswords (see: Figure 3). They may include different types of questions in one exam. It is also possible to limit access to different modules of the course. Until the user achieves particular result from exam, some course content will be not available to the student. This process increase student's involvement and systematic learning.

E-exams are very useful when it is necessary to evaluate at the same time large group of people. They use the unified grading criteria. This eliminates subjectivity and provides a sense of justice. The students do not have to wait long for their grades and teacher role is limited. All results are saved in a central database. That is why it is easy to analyze and compare them with learning objectives. They are available on demand.

Electronic evaluation has also some disadvantages and limitations. They should be kept in mind when deciding on its implementation. Very often it is not possible to justify formulated opinions. In most question types the user can choose among given answers. There is no place to write any comments. The probability of guessing the answers, cheating and use the help of others may also be a problem. For some students such tests can be more stressful because they have difficulties in writing long texts using keyboard. Most people are accustomed to traditional forms of assessment. A major problem for electronic as-

sessments is also difficulty to provide reliable results, comparable with traditional exams. Table 1 presents advantages and disadvantages of online assessments from students, teachers and university perspective.
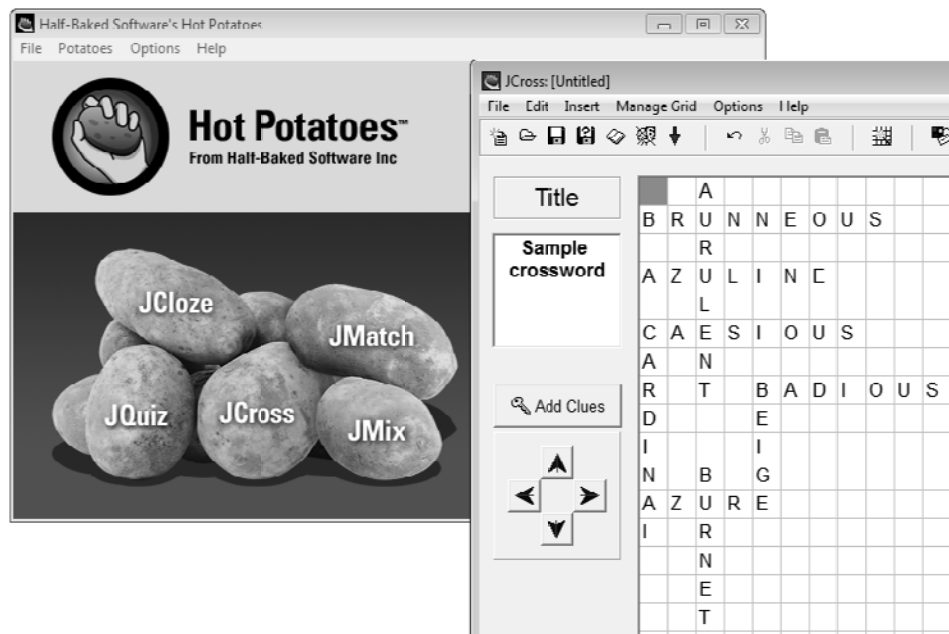
Fig. 3. Creating crossword using Hot Potatoes application, JCross module

Due to the type and functionality existing online examination programs can be divided into two groups: computer assisted assessment and computer based assessment. The first applications allow to group and manage students answers, helping teacher during checking and grading activities. The second group generates random tests, checks the answers and saves the results in data base without teacher's involvement.

With technological progress we may observe that available assessment solutions and technology are becoming more and more powerful. It is now possible to track the person activities using the camera and microphone, block other software, popup windows, generate randomized individual sets of questions, set examination window, limit available time for a response and number of attempts. All those methods are very useful but still they do not guarantee full control over the whole process and they do not eliminate cheating. To ensure high reliability of the results, certification exams must be conducted under the supervision of the teacher or selected person in traditional computer laboratory [BrWoBoRuWe06].

Table 1

Pros and cons of e-examinations

	Advantages	Disadvantages
Teachers	– reduced work load in most cases – once created, question may be used in different courses – possibility to distribute multiple versions of the exams and assignments without having to manually monitor which students got which tests – generated reports help to identify learning problems – audio and video elements may be added to make exam more practical – eliminate human errors in grading	– technology is not always reliable – results may be lost if a system breaks down – some expertise is needed to create exams – online examination is not suitable for essay writing or cognitive thinking testing – more work if individual feedback for every student is needed
Students	– transparency and effective preparation for exams – possibility to solve practice tests – Internet-based assessments may be done at friendly environment – instant result – higher grade of objectivity – possibility to receive feedback onexamination result – all results are saved in grade book	– no room for explaining the answer or getting partial credit – answers on online assessments can only be right or wrong – it is not possible to present person's line of thinking when selecting the answer – for some people more stressful because of problems with fast writing using keyboard or Internet connection
University	– greater flexibility with respect to location and timing – reduced examination costs – eco-friendly, no papers and photocopies – less storage space is needed to keep the exams. All data can be stored on a single server – rationalization of selection of students and of placement tests – support of the administration by an effective and integrated management of examinations	– huge implementation costs of assessment system or e-learning platform – some trainings for students and teachers are needed

Source: Own research.

4. Student's opinions about e-examinations

From 2009 to 2011 the author of this article carried out the study, whose main objective was to assess and compare the effectiveness of traditional education, blended learning and e-learning. The research was made at the University of Information Technology and Management in Rzeszow. It involved 292 students from the Faculty of Economics. Results from that research show what students think about different types of assessment, how they perceive e-exams, their main drawbacks and limitations. All these information may provide a valuable argument when deciding on their implementation.
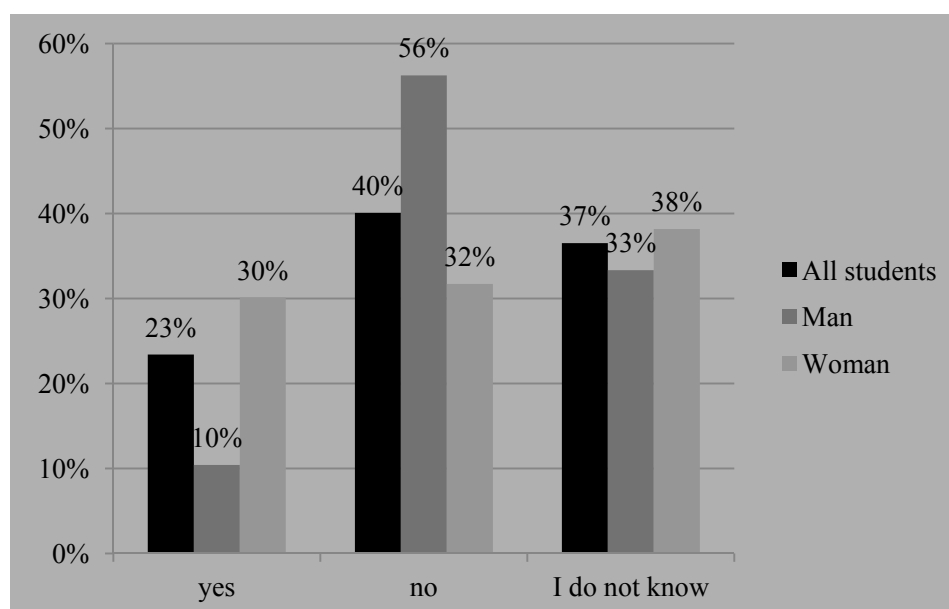
Fig. 4. E-exams are more stressful than traditional
Source: Own research.

In one of the questions the students indicated whether online exams are more stressful than traditional writing assessments. Figure 4 presents their answers about that issue. 23% of people agreed with that statement. They believe that e-exams can be more stressful because they have some difficulties in using computer software, they are accustomed to traditional knowledge verification. 40% of students have opposite opinion. They think that both forms are equally stressful. One-third of respondents had no opinion on this matter. Comparing the

results by gender, it should be noted that that women sees electronic exams much more stressful than men. The difference here was about 20%.

Similar results were obtained about difficulty of e-exams (see: Figure 5). 18% of students consider them to be more difficult than the traditional exams. 41% of the respondents think that the level of difficulty of both examination forms is the same. In this question there were also big differences between men and women. Only 11% of men believe that online exams are more difficult than traditional, while this percent was two times higher (22%) for women.
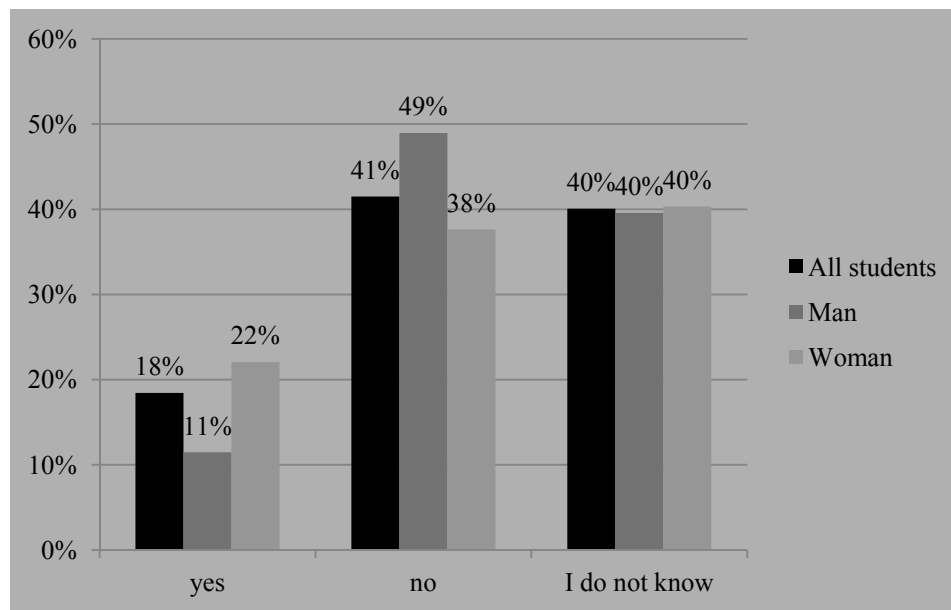
Fig. 5. E-exams are more difficult than traditional
Source: Own research.

After determining whether electronic exams are either stressful or difficult than traditional students in the following question indicated if they want online assessments at their university. Figure 6 presents their answers. In total, 45% of respondents strongly agreed or tend to agree for that. On the contrary, the oppo-site opinion have 19% of students. The differences in gender were also present here. 57% of man compared to 40% of woman and would like to have online as-sessments. 14% of man and 21% of woman do not like that exams and they want traditional knowledge verification methods.
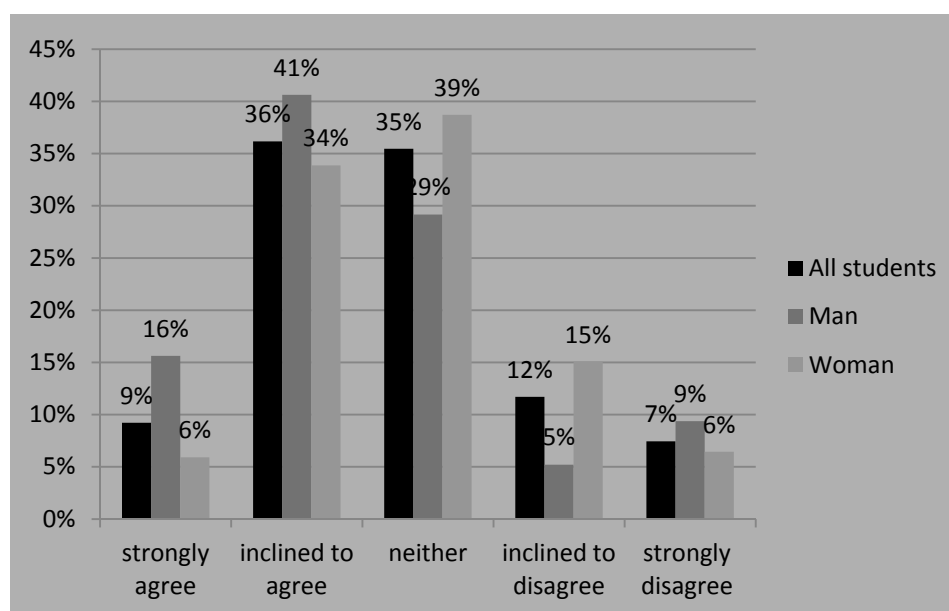
Fig. 6. Students' preferences for implementing e-exams at the university
Source: Own research.

The last question in this section of the survey was about students preferences for different forms of examination depending on questions types (see Figure 7). In all cases, a written exam is the most preferred form of knowledge verification. This method has huge advantage over different forms in all types of questions. E-exams may be an alternative for traditional in most of the cases except open questions, where oral exam was more accepted.
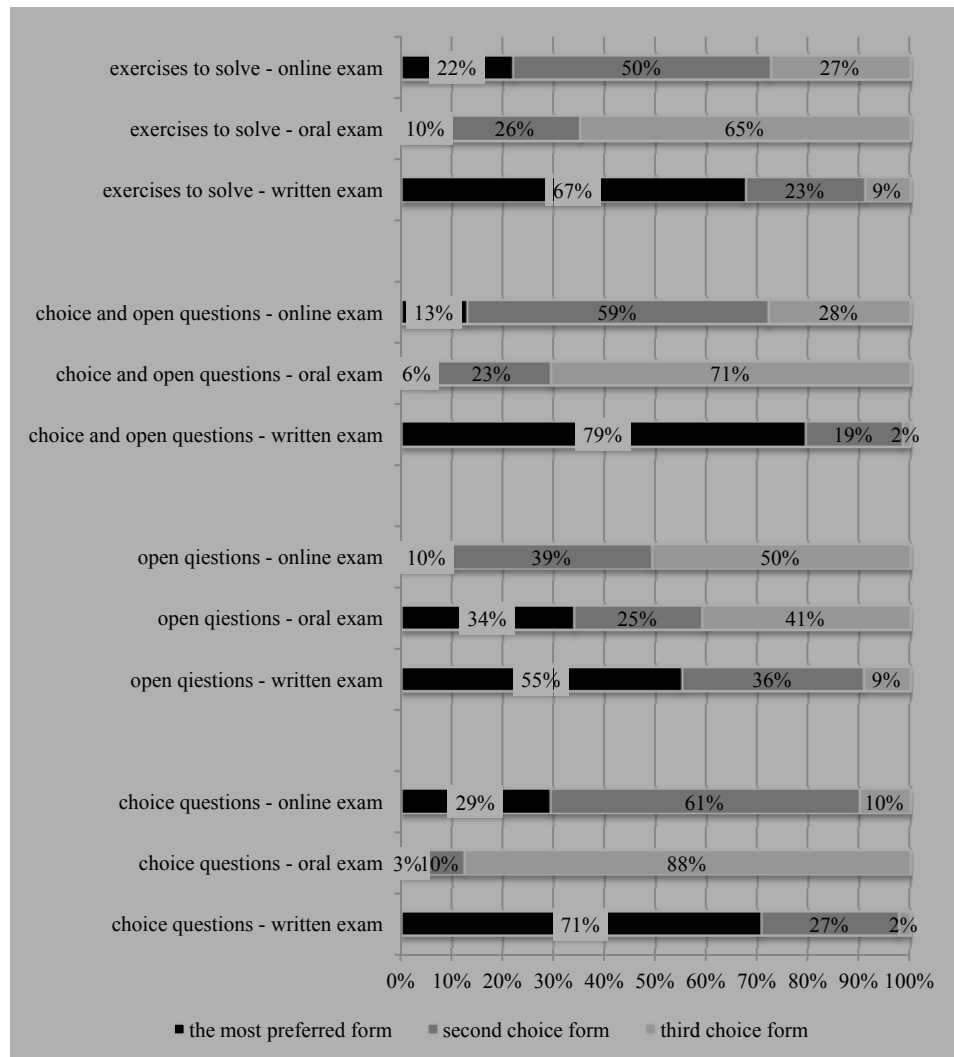
Fig. 7. Students' preferences for different form of evaluation related to question
    type
Source: Own research.

The survey results show that students are ready for e-exams. Majority of
people believe that they are not more stressful of difficult than traditional ones.
Most students want online assessments to be implemented at their university. For
most respondents e-exams may be an alternative form knowledge verification. It
is the second choice form, just after traditional written exams.

Conclusion

Online assessment is gaining more and more popularity. Its advantages are very encouraging for students, teachers and universities. In most of the cases they exceed their weaknesses. Combined with e-learning they offer new educational possibilities for different groups of people. They are the answer for changing word, new mobile technologies and students' mobility. Described research results support the opinion that students are ready for this form of knowledge verification. The remaining question is how to ensure the reliability of achieved results and avoid cheating. Until this is not solved, key exams will have to be done at university facilities with a supervisor. But this issue does not eliminate e--exams. They also can be used but in computer laboratory.

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E-EGZAMINY W OPINII STUDENTÓW
– NOWA METODA WERYFIKACJI WIEDZY

Streszczenie

Rozwój e-learningu jest ściśle związany z koniecznością weryfikacji zdobywanej w ten sposób wiedzy i umiejętności. Celem niniejszego artykułu jest charakterystyka e-egzaminów oraz odpowiedź na pytania, jaka jest przyszłość tej formy egzaminacyjnej i jak postrzegają ją studenci. Przedstawiono w nim wyniki badań Autora w tym zakresie. Opisano tu również sprawdzanie i ocenianie, jako podstawowe czynności oceny procesu kształcenia, dostępne metody weryfikacji wiedzy i umiejętności oraz zalety i wady egzaminów elektronicznych.

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A COMPARATIVE ANALYSIS OF CONFLICTS RESOLVING METHODS IN MULTIAGENT DECISION SUPPORT SYSTEMS

Introduction

Present socio-economic conditions seem to favor fast and accurate decisions as one of the most important elements of company competitiveness. Company decision makers typically operate under the constraints of uncertainty and risk, since results of most decisions in turbulent environment cannot be readily foreseen or can only be appraised with a marginal level of probability. Consequently, the decision-making processes are more and more complex.

Decision processes in modern companies are often supported by IT decision support systems (DSS), also in the form of multiagent systems, i.e. systems based on several agent applications that analyze data and present the user with optimal decisions in response to particular problems. Multiagent systems allow for rapid collection and processing of data, but the ultimate choice of decision is in the hands of the user, as a person responsible for the decision making process and its results. Multiagent decision support systems offer considerable reduction of decision time, since they replace the user in the arduous task of selecting and processing of information. Multiagent DSS can also draw conclusions and make suggestions based on collected data.

However, in practical application of multiagent DSS, some tasks may generate conflicts between the constituent agents. The problem of selecting appropriate conflicts resolving methods in multiagent DSS has not yet been addressed in professional literature nor the economic practice, although this type of problem seems crucial in system development and should be addressed in the early stage of system design.

Therefore this paper presents an attempt at evaluation of conflicts resolving methods employed in multiagent DSS, based on comparative analysis of methods and determination of their benefits and shortcomings.

It should be noted, that conflicts, for example, may arise if individual agents operate under different decision support methods [SoHe12], while input information used for decision-making process is drawn from heterogeneous sources. Conflicts may also result from contradicting objectives or methods employed in individual agents. Consequently, individual agents may suggest different decisions or solutions. In the face of conflict, the DSS is unable to provide a single solution (i.e. one that satisfies criteria defined by user as process parameters, for example – a rate of return on investment at a given risk level). Consequently, the user is faced with an extra task of manually analyzing and selecting an appropriate decision from the array of suggestions postulated by individual agents. This is, obviously, a time-consuming process and decisions made in this way bear the risk of being outdated. In the turbulent environment of modern economy, decisions must be made in (or close to) real time. Moreover, decisions based on incomplete information are burdened with high level of risk. Therefore, conflicts in multiagent systems may have a negative effect on company operation.

In this context, it seems that automatic conflict resolving should be regarded as one of the most important features of an effective decision support systems. DSS employs many different methods of conflicts resolving, and their effectiveness largely depends on suitability of a particular method for decision-making context, and the structure of the DSS. For example, decisions involving organization of features of an object under analysis require different methods of conflicts resolving than those in the realm of financial management. Other determinants include the type of multiagent DSS or its size (the number of agents).

Results of comparative analysis of conflicts resolving methods may be used as basis for their selection in particular applications (tasks) and their suitability for different types of multiagent decision support systems. The selection can be made early in the design process, offering considerable improvement of system effectiveness.

Types and the methods of resolving of conflicts in multiagent systems

Proper functionality of multiagent systems requires accurate interpretation of the type of conflicts identified or anticipated in the course of system operation. Liu [LGMB98] identifies the following types of multiagent system conflicts:

1. Conflicting goals – if two goals cannot be reached within the same timeframe, they are considered to be in conflict (a good example of such conflict is an exclusive lock on a resource used by two agents). This type of conflict requires modification of agent goals.
2. Conflicting plans – if one agent's post-action conditions conflict with pre-action conditions of another agent, while timeframes defined for both actions overlap (for example, when one agent moves X file from B directory to C directory, while another agent moves X file from A to B). This type of conflict requires modification of agent plans.
3. Conflicting beliefs – for learning agents, if the process of reasoning results in conflicting goals or conflicting plans (for example, when two agents, acting independently, arrive at the conclusion that they have the right of exclusive use of the same resource A). This type of conflict requires modification of the reasoning processes.

According to Nguyen [Nguy02], the above types of conflict in multiagent systems are also accompanied by knowledge conflicts, resulting from inconsistent or contradicting knowledge of individual agents [KaNg00]. Knowledge conflicts occur when the same real world objects and the same features are attributed different values by conflicting parties. This type of conflict can be exemplified by different decisions on portfolio structure postulated by agents of a system designed to support financial investment decisions.

Conflicts classification allows for identification and design of various conflict resolving methods, such as:

a) negotiation methods,
b) deductive-computing methods, based on:
   – game theory,
   – classical mechanics,
   – operational studies,
   – behavioral and social sciences,
   – choice,
   – consensus.

Professional literature provides various definitions of negotiation methods. For example, in [DyLe06], negotiation is defined as "any communication process that results in mutually acceptable agreement". In [ShKY99, Jenn01], negotiation is defined as a process involving two or more agents, with parties communicating with one another, exchanging information and declaring their

objectives, in an attempt to reach a compromise or arrive at mutually acceptable agreement on beliefs, plans of action or objectives that cannot be reached unaided or if unaided realization of which may prove impractical. In the course of the negotiation process, agents exert influence on one another, in an attempt to induce certain actions.

Conflict resolving in multiagent systems can also be based on deduction and computation methods. A good example of this trend is the use of methods evolved from game theory. Game theory is a discipline of science closely related to the problems of cooperation and conflict resolving in multiagent systems. It involves construction of mathematical models of conflicts and cooperation as elements of human interaction. Game theory models are highly abstract representations of various everyday interactions involving different goals and preferences [RoKr12].

Methods based on classical mechanics are another subset of deductive-computational group [Teyl06]. Those methods are employed in multiagent systems that require cooperation between a large number of agents – hundreds or even thousands of agents – such as in systems designed to reach highly distributed and dynamic goals (those typically include a large number of agents) [RoKr12].

Conflicts resolving methods based on operational studies involve the search for best ways of design and implementation of organization systems, typically operating on limited resources [Całc00]. Agents cooperating within the DPS framework (distributed problem solving) can be viewed as examples of such organization systems, therefore they can employ techniques and methods designed and identified through operational studies as applicable for human organizations. Operational studies apply to problems involved in calculation of set division and set coverage representations [HeNg07], representing NP-complete class of problems. Solutions postulated by operational studies can be used to tackle problems of coalition formation in DPS operating on a given set of agents and a list of tasks, i.e. identifying assignments to agent groups (or individual agents, if the task can be accomplished by a single agent).

Often, in the case of solving inadequately structured problems, a range of informal conflicts resolving methods are employed as basis for agent cooperation. These include formalization and application of solutions originated in behavioral sciences and sociology [SaKa12]. Analyses and studies of human behavior, human cooperation and coordination of human activities, developed by social sciences, offer a number of models used to describe human organizations and communities. These heuristic models can be employed to good effect in the context of non-structured and unpredictable multiagent environments, to de-

scribe cooperation and coordination between agents based on well-studied and verified models of human interactions.

Theory of choice developed in the context of sociology and social sciences [Abba09] dates back to antiquity and deals with sociological methods of decision support. Let us assume that a given set Z (e.g. a set of objects0) represents a subset of a larger set of X. Choice, in this example, involves a selection of a subset Y out of set Z, based on a range of criteria. In decision-making scenario, set Z represents a set of decisions generated by other methods, set X represents a set of acceptable decisions, and subset Y represents a decision presented to the user.

Theory of consensus stems directly from the theory of choice. In literal terms, consensus stands for agreement. Thus, in the context of consensus theory, the actual choice does not necessarily represent a subset of Z, and is not necessarily presented in the same structure or form as elements of the Z set [Nguy02]. Therefore, decision presented to the user does not necessarily represent an actual decision established on the basis of decision support methods. It may just as well be a unique decision formed on the basis of those suggested by the system. Initially, the theory of consensus referred to structures organized in a linear or partial order. Later on, it was applied to more complex structures, such as divisions, hierarchies, n-trees, as well as multi-attribute and multiple-valued structures (the latter referencing also decision structures) [SoHe11]. Consensus methods are applied for the purpose of determining such solutions to a given set of data which best represent the original versions generated by the system or those that represent a compromise accepted by all parties involved in generation of preliminary versions of potential solutions. Consensus determination is a multi-stage process. The first stage involves careful analysis of Z set structure, i.e. the structure of decisions generated by individual decision support methods. The next step is the determination of distance between individual elements of the Z set. Consensus determination involves selection of a set (i.e., decisions) found minimally distant from all other subsets of the Z set (according to a range of criteria).

After these preliminary observations, let us now proceed to discussion on the results of comparative analysis of conflicts resolving methods.

Comparative analysis of conflicts resolving methods

Comparative analysis of conflicts resolving methods is an extremely important element of the discourse, since – as already mentioned – correct choice of methods early in system design helps adjust the process to the type of task at

hand and to the characteristics of the multiagent system used. Proper selection of method ensures effective reconciliation of potential conflicts between agents and, consequently, warrants proper identification a single solution that brings tangible benefits to the user. The analysis was conducted on the basis of the following criteria: type of conflict addressed, benefits, flaws, the range of method application. Results of comparative analysis are presented in Table 1.

Results of the analytical study show that, due to a large variety of potentially applicable methods of conflicts resolving in multiagent systems, design teams face a difficult decision of selecting the most adequate method, suited both to system architecture and the type of problems being addressed by the system. Proper method selection ensures proper resolving of future conflicts. As shown in Table 1, both negotiation and consensus methods offer best conflicts resolving capacity.

Table 1

Results of comparative analysis of the conflicts resolving methods

Method/types of conflicts	Benefits	Shortcomings	Scope of the applications
Negotiation Conflicts: goals, plans, knowledge	Getting a good compromise, and property conflict resolving in consequence; possibility of communication between agents; agents can generate arguments, to support his adopted point of view on the case, agents can influence each other in their views; possession by agents information about other agents	High computational complexity; the agent must have the skills for the submission of proposals and counter proposals to accept or decline offers of other agents; If the information about other agents is incomplete, incomplete, this agent may represent a valid offer to other agents; agent must allow changes to the objectives, plans, beliefs or knowledge structure without any external pressures	All kinds of problem and all types of systems
Game theory Conflicts: goals, plans,	With a small number of agents it is possible to obtain a good compromise; abstract models of game theory can be used as a basis for interaction protocols agents in multiagents systems	High computational complexity; require a large number of, often quite complex calculations and a lot of time is being sacrificed on the communication between agents	Used in systems where agents are striving to maximize the goal, systems can consist of a small number of agents or interactions between them are limited to a small number of it

Classical mechanics Conflicts: beliefs, knowledge.	Low computational complexity; the possibility of using large scale multiagents systems; do not require communication links between agents; the properties of the system as a whole can be analyzed using statistical techniques	Conflicts are solved not always correctly; designers of these systems must determine in advance certain principles and protocols of interaction agents	Used when required is cooperation between a large number of agents, when agents work together to reach a common, distributed, used for example in support the production processes in large companies
Operational studies Conflicts: goals, plans, knowledge	Getting a good compromise, and property conflict resolving in consequence; possibility of resolving NP-complete problems	High computational complexity; performance significantly decreases with increasing size of the system; agents must have the ability to use large computing power processors	Usually used in conditions of limited resources; applies, inter alia, to the problems of forming the coalition, where given a set of agents, and a collection of tasks that they must perform together, looking for, a way of allocating each task to a group of agents that perform this task
Behavioral and social sciences Conflicts: beliefs, knowledge	Getting a good compromise, and property conflict resolving in consequence; agents have the communication skills, builds on the experience and expertise developed by many scientists	High computational complexity, the number of agents in this type of systems that may not be a large; before using the simulation should be carried out	Used in solving the poorly structured problems and in the systems that are usually automatic systems agents react with other automated agents as well as with people
Choice Conflicts: goals, plans beliefs, knowledge	Low computational complexity	Conflicts are solved not always correctly; using the choice method decision-maker receiving the decision generated by one of the methods of decision making support, other methods are not taken into account	All kinds of problem and all types of systems
Consensus Conflicts: goals, plans beliefs, knowledge	Low computational complexity; getting a good compromise, and property conflict resolving in consequence; allow to quick decision determining; allow you to change the status of agent knowledge under different conditions; all parties to the conflict to be taken into account; allow for the reduction in the level of risk	Not all conflict situations are susceptible to consensus; elaboration of heuristic algorithms, which allow to resolving conflicts related to NP-complete problems, is difficult	All kinds of problem and all types of systems; applied, for instance, to experts conflicts resolving, conflicts in temporal database, multiagents conflicts, restoring consistency of replicated data, supporting the decision process

Source: Own work.

It should be noted, however, that consensus methods, as opposed to negotiation methods and similarly to methods based on classical mechanics, do not require large computing power. The remaining methods of conflicts resolving represent a tradeoff between good resolving potential and large computing complexity.

Let us emphasize at this point that the choice of the most appropriate conflicts resolving approach ensures proper operation of the multiagent DSS, i.e. its capacity to produce the most suitable decision, bringing tangible benefits to the end user and the organization. Conflicts resolving in multiagent systems ensures that decisions generated by the DSS are best for the user, that is – they best satisfy all user-defined criteria.

Conclusion

To sum up, it must be noted that conflicts are an inherent element of mostly all multiagent systems. Proper classification of conflicts is of great significance, particularly in multiagent systems design to support decision-making processes, since their functionality has a direct effect on user decisions and – ultimately – affects the organization as a whole. Such conflicts should be resolved automatically, otherwise the system will be unable to provide correct solutions. This is why system design teams should examine and select best conflicts resolving methods early in design process. Implementation of new methods in existing systems may be problematic, since it requires coding modifications of individual agents. Proper selection of conflicts resolving method ensures effective operation of the DSS, offering users the most beneficial solutions to problems at hand. If this aspect of system operation is neglected, users may face the problem of being unable to make prompt and adequate decisions since the system may produce an incorrect decision or an array of applicable solutions that requires further analysis and time-consuming selection on the part of the user.

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ANALIZA PORÓWNAWCZA METOD ROZWIĄZYWANIA KONFLIKTÓW W WIELOAGENTOWYCH SYSTEMACH WSPOMAGANIA DECYZJI

Streszczenie

W artykule dokonano analizy porównawczej metod stosowanych w rozwiązywaniu konfliktów wiedzy w odniesieniu do wieloagentowych systemów wspomagania decyzji. Dobór odpowiedniej metody, w zależności od rodzaju konkretnego zadania oraz od charakteru wieloagentowego systemu wspomagania decyzji, jest niezwykle istotny już na etapie jego projektowania, gdyż w konsekwencji może prowadzić do zwiększenia skuteczności wspomagania procesu podejmowania decyzji.

W pierwszej części artykułu przedstawiono rodzaje konfliktów w systemach wieloagentowych. Następnie dokonano przeglądu metod rozwiązywania konfliktów. W końcowej części artykułu przeprowadzono analizę porównawczą tych metod ze szczególnym uwzględnieniem ich zalet i wad oraz zakresu zastosowania.

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SENSITIVITY ANALYSIS AND OPTIMIZATION ON SOME MODELS OF ARCHETYPES USING VENSIM – THEORETICAL ISSUE

Introduction

The main purpose of System Dynamics is to try discover the "structure" that conditions the observed behaviour of the system over time. System Dynamics try to pose "dynamic" hypotheses that endogenously describe the observed behaviour of system. One of such way is building so called "systems archetypes", popularized by Senge [Se90], Wolstenholme [Wo03; Wo04], many others. The proposal of mathematical structure for systems archetypes was first presented by Bourguet-Diaz and Perez-Salazar [BoPe03] and Kasperska [Ka06; Ka09]. In our paper, we choose such archetypes like: eroding goal, fixes that fail, success to the successful, accidental adversaries. It is know that growth, decline, goal seeking and oscillation are consequences of feedback loop dynamics [Fo61; Fo69; Fo71; Fo72; Fo75; Co91; Co94; Co96; Co98; St00; St02]. Such tool like sensitivity analysis by Vensim allow to investigate systems archetypes in aspect of "goodness" of structure and parameters to create desired behaviour, which is the introduction to optimization process as well. Optimization of SD models has a long history from first trials by Winch [Wi76; Ke77; Ke80; Ke83], then by Coyle [Co96; Co98].

Authors of this paper have undertaken the problem of optimization SD models in many papers [Ka02; Ka05; KaMa05; KaMa06; KaSło03; KaSło05]. First we use COSMIC and COSMOS (1994) and then Vensim (2002). The Vensim has many interesting possibilities concerning the realization of sensitivity and optimization experiments. Monte Carlo multivariate sensitivity works by sampling a set of numbers from within bounded domains. To perform one multi-

variate test the distribution for each parameters specified is sampled, and the resulting values used in a simulation. When the number of simulation is set, for example, at 200, this process will be repeated 200 times. In order to do sensitivity simulation you need to define what kind of probability distribution value for each parameter will be drawn from. The simplest distribution is the Random Uniform Distribution, in which any number between the minimum and maximum values is equally likely to occur.

The sensitivity testing of parameters is very interesting from methodological point of view, because such testing can be the entrance for optimization, because allows to detect: sensitivity parameters, bounds of their variations and of course can help to choose the objective function.

The aim of this paper is the presentation of some new results of authors investigation in the area of simulation and optimization with use of source models of archetypes in System Dynamics convention and with use of simulation language Vensim and Monte Carlo method.

Some models of systems archetypes.
Structures, mathematical equations, simulation of behaviour

In literature of SD there are many examples of systems archetypes [Se90; Wo03; Wo04; BoPe03; BeKa12].

The structures are well known, but the mathematical equations are not so popular, and because of this there are lack of simulation experiments specially the optimization experiments, on models of archetypes. First authors present some chosen models of archetypes, on the base of proposals of Bourguet-Diaz, Perez-Salazar and on the base of own works on the field [KaMa06]. And then in article we will undertake the trial of sensitivity analysis and optimization on these models.

Like the object of experiments the following archetypes were choosing:
- Eroding Goal,
- Fixes that Fail,
- Success to the Successful,
- Accidental adversaries.

Let's present these structures. First structure is illustrated on Figure 1. This structure is consisted of two balancing loops: B1, B2. To express the changes in such system the following differential equations are created:

$$\dot{x}_1(t) = \frac{-1}{T_1} x_1(t) + \frac{1}{T_2} x_2(t)$$

$$\dot{x}_2(t) = \frac{1}{T_1} x_1(t) - \frac{1}{T_2} x_2(t)$$

with conditions:
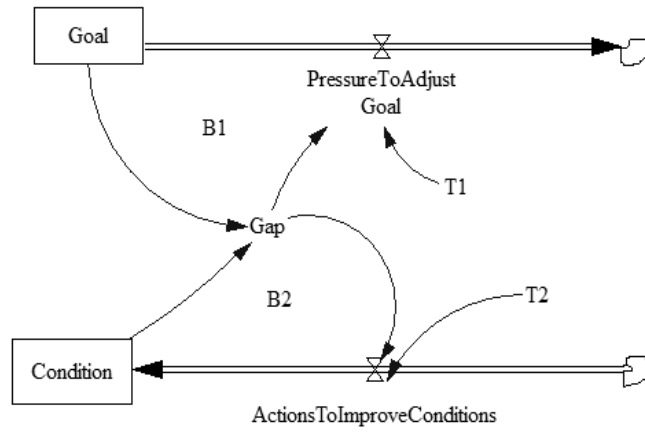
$$x_1(0) = x_{10}$$
$$x_2(0) = x_{20}$$

Fig. 1. Block diagram for Eroding Goal archetype
Source: Own results.

On the base of Bourguet-Diaz, Perez-Salazar the example is presented with the values: $T_1 = 5$, $T_2 = 10$, $x_{10} = 100$, $x_{20} = 40$. The results of simulation are presented on Figure 2.

Fig. 2. The dynamics of behaviour of Eroding Goal archetype
Source: Own results.

In our paper „Sensitivity analysis and optimization on some models of archetypes using Vensim – experimental issue" we will present the results of sensitivity analysis on this model of archetype. Now, let concentrate on second archetype called "Fixes that Fail". That structure is presented on Figure 3.
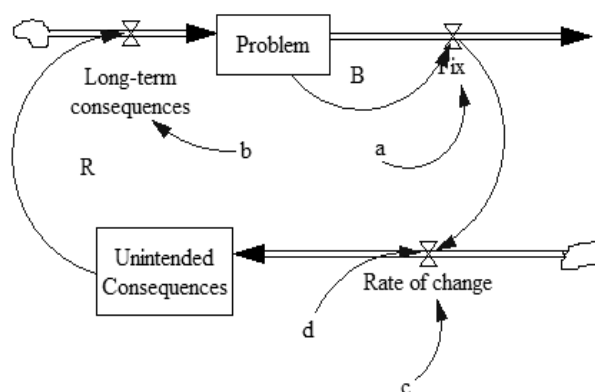
Fig. 3. Block diagram for "Fixes that Fail" archetype
Source: Own results.

This structure is consisted of two loops: B, R (balancing and reinforcing). To express the changes in such system the following differential equations are created:

$$\dot{x}_1(t) = -ax_1(t) + bx_2(t)$$
$$\dot{x}_2(t) = cx_1(t-d)$$

with conditions:

$$x_1(0) = x_{10}$$
$$x_2(0) = x_{20}$$

Where *d* is the delay in time units and *a, b, c* are proportionally parameters. On the base of Bourguet-Diaz, Perez-Salazar the example is presented with the values:

$$a = 0.5, \quad b = 0.5, \quad c = 0.4, \quad d = 5, \quad x_{10} = 50, \quad x_{20} = 0.$$

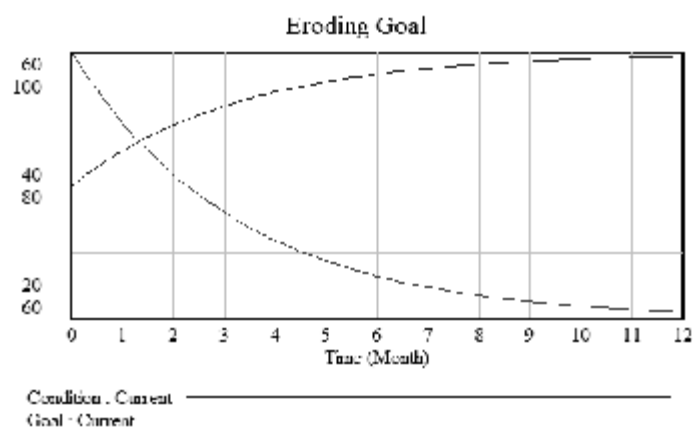The results of simulation are presented on Figure 4.
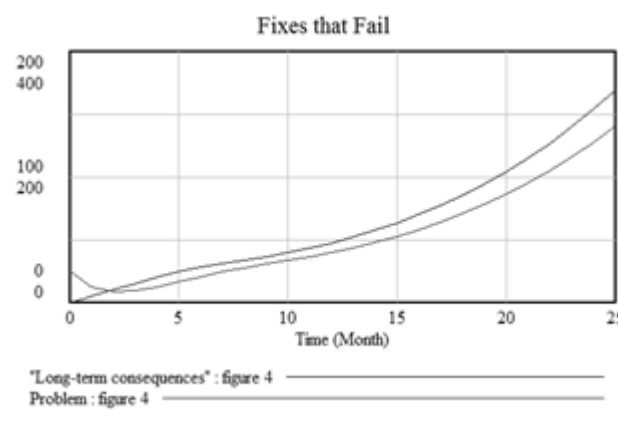
Fig. 4. The dynamics of behaviour of "Fixes that Fail" archetype
Source: Own results.

In paper „Sensitivity analysis and optimization on some models of archetypes using Vensim – experimental issue" we will present the results of sensitivity analysis on this model of archetype. Now, let concentrate on third archetype called „Success to the Successful". Figure 5 presents the structure of this archetype.
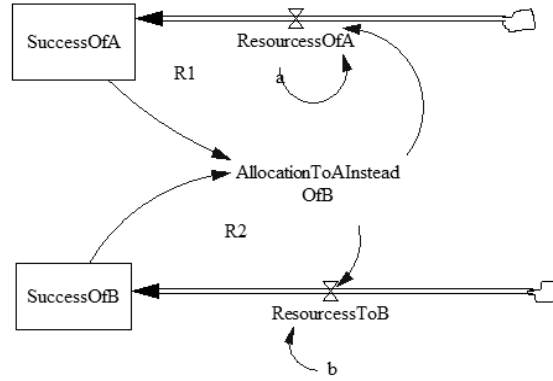
Fig. 5. Block diagram for "Success to the Successful" archetype
Source: Own results.

The structure is consisted of two reinforcing loops: R1, R2. To express the changes in such system the following differential equations are created:

$$\dot{x}_1(t) = ax_1(t) - ax_2(t)$$
$$\dot{x}_2(t) = -bx_1(t) + bx_2(t)$$

with conditions:

$$x_1(0) = x_{10}$$
$$x_2(0) = x_{20}.$$

On the base of Bourguet-Diaz, Perez-Salazar the example is presented with the values: $a = 0.1, \quad b = 0.1, \quad x_{10} = 5.5, \quad x_{20} = 4.5.$ The results of simulation are presented on Figure 6.
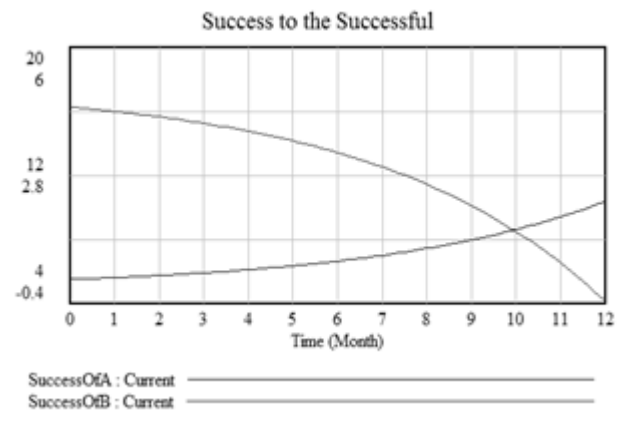
Fig. 6. The dynamic of behaviour of "Success to the Successful" archetype
Source: Own results.

The fourth archetype is archetype named "Accidental adversaries". Figure 7 presents the structure of this archetype.
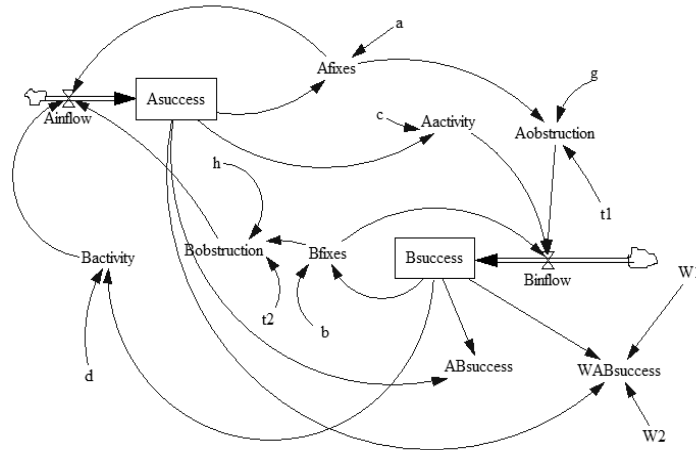
Fig. 7. Block diagram for "Accidental adversaries" archetype
Source: Own results.

In literature of the field there was lack of the mathematical model of this archetype. First author take this trial in paper [KaMa06]. It seems simple. Let x_1 will be the success of A, and x_2 – the success of B. So the equation are as follow:

$$\dot{x}_1(t) = -ax_1(t) + dx_2(t) - bgx_2(t - t_2)$$
$$\dot{x}_2(t) = -bx_2(t) + cx_1(t) - ahx_1(t - t_1).$$

The parameters: *a, b, c, d, g, h* express the balancing and reinforcing factors of loops (see: Figure 7). The parameters: t_1, t_2 are the time delays. We simulated the dynamics of this archetype, taking the values of parameters:

$$a = 0.4, b = 0.4, c = 0.2, d = 0.2, g = 0.6, h = 0.6, t_1 = 5, t_2 = 10 \text{ ,}$$

and the initial values of levels:

$$x_1(0) = 250$$
$$x_2(0) = 150.$$

The results of simulation are presented on Figure 8.
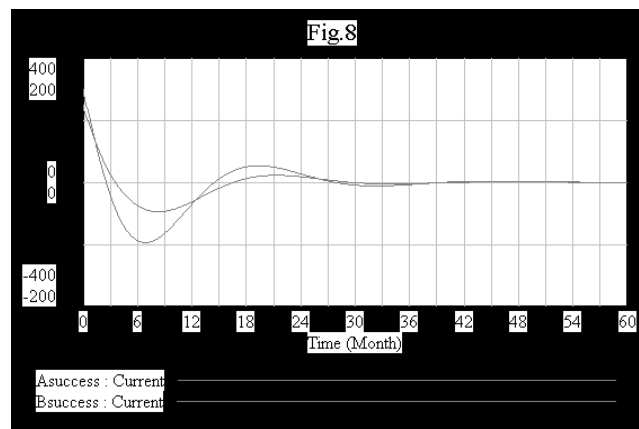
Fig. 8. The dynamics of behaviour of "Accidental Adversaries" archetype
Source: Own results.

The next archetype is archetype "Limit to Growth". This is one of the version of such archetype, Figure 9 presents its structure.
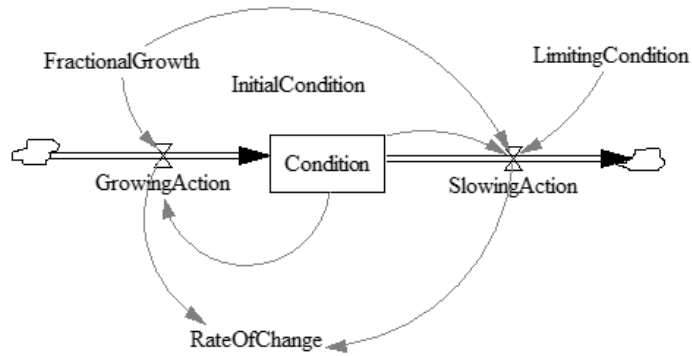
Fig. 9. Block diagram for "Limit of Growth" archetype
Source: Own results.

The structure is consisted of two loops: R (reinforcing) and B (balancing). To express the changes in such system the following differential equation is created:

$$\dot{x}(t) = ax(t) - ax(t)\left[1 - \frac{L - x(t)}{L}\right]$$

reordering:

$$\dot{x}(t) = ax(t) - \frac{a}{L}x^2(t)$$

thus:

$$\dot{x}(t) = a\left(1 - \frac{x(t)}{L}\right)x(t)$$

with condition:

$$x(0) = x_0.$$

On the base of Bourguet-Diaz, Perez-Salazar the example is presented with the values:

$$L \text{ (limit of growth)} = 100$$

$$a \text{ (fractional growth)} = 0.1$$

$$x_0 = 1.$$

The results of simulation are presented on Figure 10.
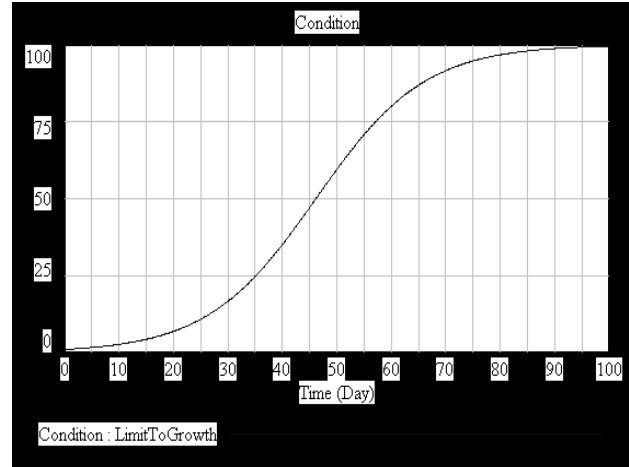
Fig. 10. The dynamics of behaviour of "Limit of Growth" archetype
Source: Own results.

Now, let present in theoretical part of our research, the precise mathematically formulation of solutions of chosen archetypes.

Precise mathematical formulation of solution of chosen archetypes – models of systems archetypes

This is very important because in literature of the field there are sometimes mistakes in such formulation.

The „Eroding Goal" archetype, saying precisely mathematically, is a first – order linear homogeneous differential equation.

$$\dot{x} = Ax, \qquad x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, \qquad A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}.$$

In our case:

$$A = \begin{bmatrix} \dfrac{-1}{T_1} & \dfrac{1}{T_1} \\ \dfrac{1}{T_2} & \dfrac{-1}{T_2} \end{bmatrix}.$$

It is necessary to find two linearly independent solutions: x^1 *(t)*, x^2 *(t)*.

The way of doing this is as follow. We find eigenvalues of matrix A, from characteristic equation:

$$\det(A - \lambda E) = 0$$

(det is determinant of matrix). There are:

$$\lambda_1 = 0,$$

$$\lambda_2 = \frac{-T_1 - T_2}{T_1 \cdot T_2}.$$

The eigenvectors from them:

for λ_1, $v^1 = c \begin{bmatrix} 1 \\ 1 \end{bmatrix}$,

for λ_2, $v^2 = c \begin{bmatrix} \dfrac{-T_2}{T_1} \\ 1 \end{bmatrix}$.

So, we get the fundamental matrix:

$$x(t) = \lambda_2 = \begin{bmatrix} 1 & \dfrac{-T_2}{T_1} \\ 1 & 1 \end{bmatrix}$$

and the solutions:

$$x^1(t) = e^{\lambda_1 \cdot t} \cdot v^1,$$
$$x^2(t) = e^{\lambda_2 \cdot t} \cdot v^2.$$

And there are the solution of system $\dot{x} = Ax$:

$$x_1(t) = c_1 + c_2 e^{\frac{-t}{T_2} - \frac{t}{T_1}} \cdot \left(\frac{-T_2}{T_1} \right),$$

$$x_2(t) = c_1 + c_2 e^{\frac{-t}{T_2} - \frac{t}{T_1}}.$$

Putting the values of parameters and condition like in example for "Eroding Goal" archetype ($T_1 = 5$, $T_2 = 10$, $x_1(0) = 100$, $x_2(0) = 40$). We get:

$$x_1(t) = 60 + 40e^{\frac{-3t}{10}},$$

$$x_2(t) = 60 - 20e^{\frac{-3t}{10}}.$$

Doing the similar calculations we obtain for "Success to the Successful" archetype, the exact solution (for example $a = 0.1$, $b = 0.1$, $x_1(0) = 5.5$, $x_2(0) = 4.5$):

$$x_1(t) = 5 + (0.5)e^{(0.2)\cdot t},$$

$$x_2(t) = 5 - (0.5)e^{(0.2)\cdot t}.$$

Finding the exact mathematical solution for archetype "Fixes that Fail" is not so easily, because of delaying argument.

Let's remind:

$$\begin{cases} \dot{x}_1(t) = -ax_1(t) + bx_2(t) & (1) \\ \dot{x}_2(t) == cx_1(t - \tau) & (2) \end{cases}$$

where:

a, b, c – parameters,

τ – delay time.

We receive:

$$x_1(t) = x_{10} \quad \text{for} \quad t \in \left[-\tau, 0\right]$$
$$x_2(t) = x_{20}.$$

For $t \leq \tau$ from the equation (2) we obtain:

$$\dot{x}_2(t) = cx_{10}$$

and in consequences:

$$x_2(t) = cx_{10} \cdot t + x_{20}$$

so:

$$\dot{x}_1(t) = -ax_1(t) + b(cx_{10} \cdot t + x_{20})$$
$$\dot{x}_1(t) + ax_1(t) = b(cx_{10} \cdot t + x_{20}).$$

The solution for equation:

$$\dot{x}_1(t) + ax_1 = 0$$

is:

$$x_1(t) = c_1 e^{-\lambda \cdot t}.$$

And the particular solution from method of forecasting, for the equation:

$$\dot{x}_1(t) + ax_1(t) = bcx_{10} \cdot t + bx_{20}$$

has the form:

$$x_{1\,perticular} = \alpha t + \beta.$$

So from comparison we find:

$$x_{1\,perticular} = \frac{bc}{a} x_{10} \cdot t - \frac{bc}{a^2} x_{10} + \frac{b}{a} x_{20}.$$

The general solution of equation:

$$\dot{x}_1(t) + ax_1(t) = b(cx_{10} \cdot t + x_{20})$$
$$x_{1\,particular}(t) = c_1 e^{-\lambda \cdot t} + \frac{bc}{a} x_{10} \cdot t - \frac{bc}{a^2} x_{10} + \frac{b}{a} x_{20}.$$

To evaluate c_1 we use the initial condition $x_1(t) = x_1(0) = x_{10}$. So we obtain:

$$c_1 = x_{10} + \frac{bc}{a^2} x_{10} - \frac{b}{a} x_{20}$$

and:

$$x_1(t)_{general} = \left(x_{10} + \frac{bc}{a^2} x_{10} - \frac{b}{a} x_{20} \right) e^{-\lambda \cdot t} + \frac{bc}{a} x_{10} \cdot t - \frac{bc}{a^2} x_{10} + \frac{b}{a} x_{20}.$$

Remind that this was only for $t \le \tau$.

If we want find solution $x_1(t)$ for next steps, for example $t = \tau + dt$, we should come back for system:

$$\begin{cases} \dot{x}_1(t) = -ax_1(t) + bx_2(t) & (1) \\ \dot{x}_2(t) == cx_1(t - \tau) & (2) \end{cases}$$

From (2) we obtain:

$$\dot{x}_2(t) = cx_1(\tau + dt - \tau) = cx_1(dt).$$

Because $dt \leq \tau$, we can use the general solution $x_{1\,general}(t)$, so:

$$\dot{x}_2(t) = c\left(x_{10} + \frac{bc}{a^2}x_{10} + \frac{b}{a}x_{20}\right)e^{-\lambda \cdot dt} + \frac{bc}{a}x_{10} \cdot dt - \frac{bc}{a^2}x_{10} + \frac{b}{a}x_{20}.$$

The process will be repeated until we get the solutions for whole horizon for t. We see that finding the exact solutions for x_1, x_2 is not so easy at all (comparing with numeric possibilities of Vensim). Finding the exact mathematical solution for archetype "Limit of Growth" is very easy. Let's remind the equation:

$$\dot{x}(t) = a\left(1 - \frac{x(t)}{L}\right)x(t),$$

where:

L − limit of growth,

a − maximum fractional growth,

and condition: $x(0) = x_0$. $\dot{x}(t)$ means derivative of $x(t)$, so we have:

$$\frac{dx}{dt} = a\left(1 - \frac{x}{L}\right)x$$

and:

$$\frac{dx}{a\left(1 - \frac{x}{L}\right)x} = dt.$$

Putting integrals for both sides we obtain:

$$\frac{1}{a}\int \frac{L}{(L-x)x}dx = t+c,$$

$$\frac{1}{a}\int \frac{x-x+L}{(L-x)x}dx = t+c,$$

$$\frac{1}{a}\left[\int \frac{dx}{L-x}+\int \frac{dx}{x}\right] = t+c,$$

$$-\frac{1}{a}\ln|L-x|+\frac{1}{a}\ln|x| = t+c,$$

$$-\ln|L-x|+\ln|x| = a\cdot t+\widetilde{c},$$

$$\frac{x}{L-x} = \widetilde{\widetilde{c}}\,e^{a\cdot t},$$

$$x = L\widetilde{\widetilde{c}}\,e^{a\cdot t}-x\widetilde{\widetilde{c}}\,e^{a\cdot t},$$

$$x = \frac{L\widetilde{\widetilde{c}}\,e^{a\cdot t}}{1+\widetilde{\widetilde{c}}\,e^{a\cdot t}} = \frac{L\widetilde{\widetilde{c}}}{e^{-a\cdot t}+\widetilde{\widetilde{c}}} = \frac{L}{\dfrac{e^{-a\cdot t}}{\widetilde{\widetilde{c}}}+1} = \frac{L}{\widetilde{\widetilde{c}}\,e^{-a\cdot t}+1}.$$

We obtain logistic curve. How to evaluate the constant $\widetilde{\widetilde{c}}$? Remember the initial condition $x(0) = x_0$:

$$x_0 = \frac{L}{\widetilde{\widetilde{c}}+1} \quad \text{and} \quad \widetilde{\widetilde{c}} = \frac{L-x_0}{x_0}.,$$

so:

$$x(t) = \frac{L}{\left(\dfrac{L-x_0}{x_0}\right)e^{-a\cdot t}+1}.$$

This is precise solution of archetype "Limit to Growth".

The results of simulation type sensitivity analysis and optimization will be presented in paper: „Sensitivity analysis and optimization on some models of archetypes using Vensim – experimental issue", the same authors.

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ANALIZA WRAŻLIWOŚCI I OPTYMALIZACJA NA PEWNYCH MODELACH ARCHETYPÓW Z UŻYCIEM VENSIMA – UJĘCIE TEORETYCZNE

Streszczenie

Analiza, modelowanie i symulacja złożonych nieliniowych, dynamicznych i wielopoziomowych systemów ma długą historię, szczególnie w obszarze słynnej metody Dynamiki Systemowej. Współczesne języki symulacyjne, takie jak Vensim, pozwalają na łączenie symulacji z optymalizacją, co umożliwia ocenę wrażliwości parametrów w modelowanych obiektach i wybór optymalnych decyzji.

Zakres modelowanych obiektów jest bardzo szeroki: od modeli przemysłowych, po ekologiczne i ekonomiczne. Problem badawczy artykułu odnosi się do takich dyscyplin, jak: Teoria Decyzji, Teoria Organizacji, Badania Operacyjne.

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SENSITIVITY ANALYSIS AND OPTIMIZATION ON SOME MODELS OF ARCHETYPES USING VENSIM – EXPERIMENTAL ISSUE

Introduction

The main content of the paper are the results of sensitivity analysis and optimization of systems archetypes. Let's first concentrate on sensitivity analysis. The System Dynamical (SD) models contain usually many parameters. It is interesting to examine the effect on their variation on simulation output. We select some parameters and assign maximum and minimum values along with a random distribution over which to vary them to see their impact on model behaviour.

Vensim has a method of setting up such sensitivity simulation. Monte Carlo multivariate sensitivity works by sampling a set of numbers from within bounded domains. To perform one multivariate test, the distribution for each parameter specified is sampled, and the resulting values used in a simulation. When the number of simulation is set, for example, at 200, this process will be repeated 200 times.

In order to do sensitivity simulation you need to define what kind of probability distribution values for each parameter will be drawn from. The simplest distribution is the Random Uniform Distribution, in which any number between the minimum and maximum values is equally likely to occur. The Random Uniform Distribution is suitable for most sensitivity testing and is selected by default. Another commonly-used distribution is the Normal Distribution (or Bell Curve) in which value near the mean or more likely to occur that values far from the mean. Results of sensitivity testing can be displayed in different formats. Time graphs display behaviour of a variable over a period of time. The variables spread of values, at any period in time, are displayed either in terms of confidence bounds, or a separate values which combine to form individual simulation trace.

Results of experiments for sensitivity analysis
for some system archetypes

Authors have executed many experiments type sensitivity analysis on chosen archetypes. Let's present their results in graph form.

Archetype "Eroding Goal"

In archetype "Eroding Goal" there are two interesting parameters: T_1, T_2 (see: mathematical model). Authors have performed three types of investigation. First we used so called univariate type, that means "change one at time". In experiment 1 the maximum and minimum values are chosen to bound parameter T_1 and in 2 to parameter T_2 appropriately. The results of such simulation experiments are presented of Figures 1, 2, 3, 4 in form of confidence bounds for variables x_1, x_2. On the contrary in experiment 3 we used so called multivariate type, that means "change all together". Now, the parameters T_1 and T_2 were changing their values simultaneously (from the maximum and minimum appropriately). The results of such simulation experiments are presented on Figures 5 and 6 in form of confidence bounds for variables x_1, x_2.

Fig. 1. Confidence bounds for variable "Goal" (x_1) for interval (1,5) for parameter T_1
Source: Own results.

Fig. 2. Confidence bounds for variable "Condition" (x_1) for the interval (1,5) for parameter T_1
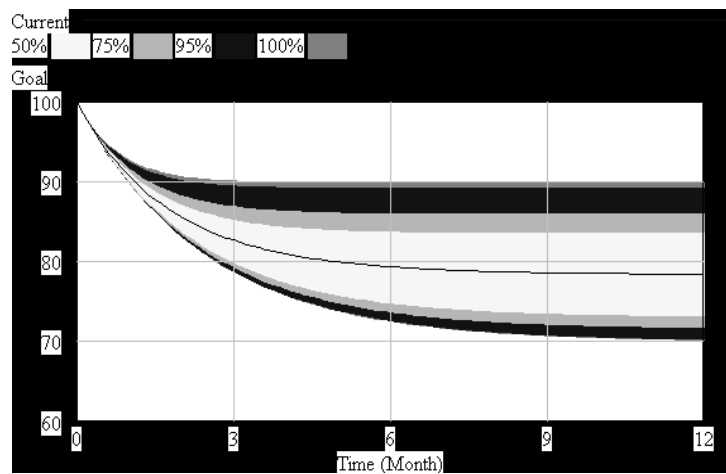
Source: Own results.

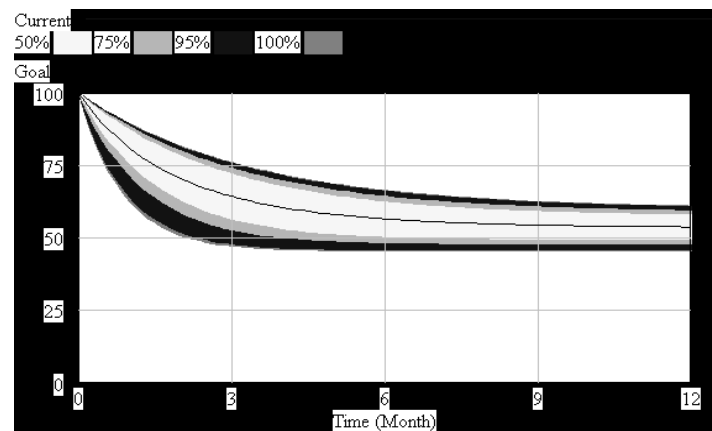Fig. 3. Confidence bounds for variable "Goal" (x_1) for the interval (5,10) for parameter T_2
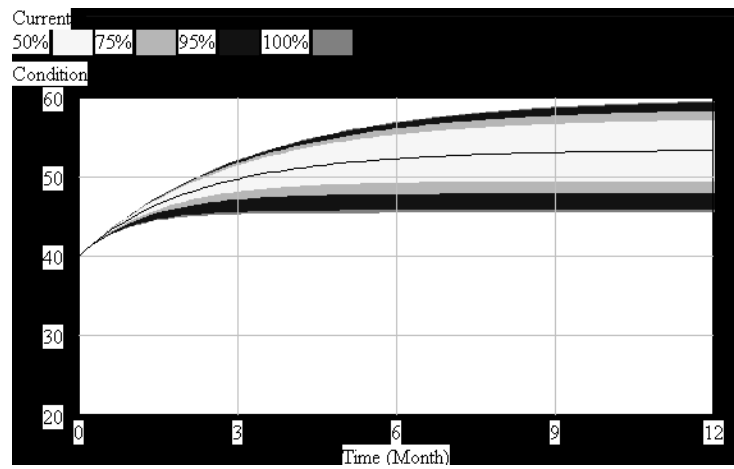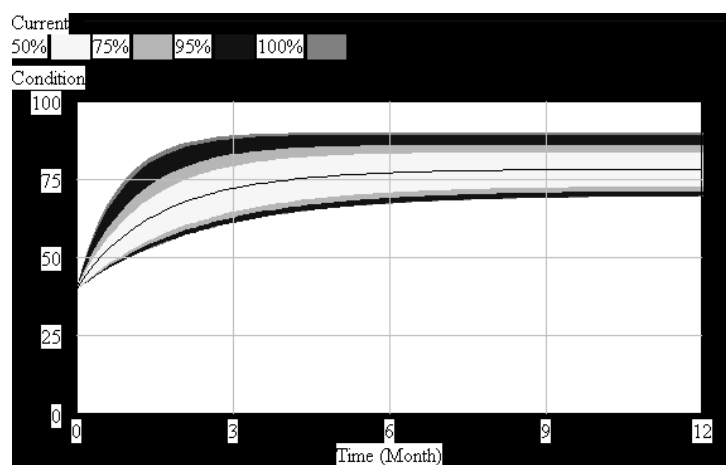
Source: Own results.

Fig. 4. Confidence bounds for variable "Condition" (x_2) for the interval (5,10) for parameter T_2
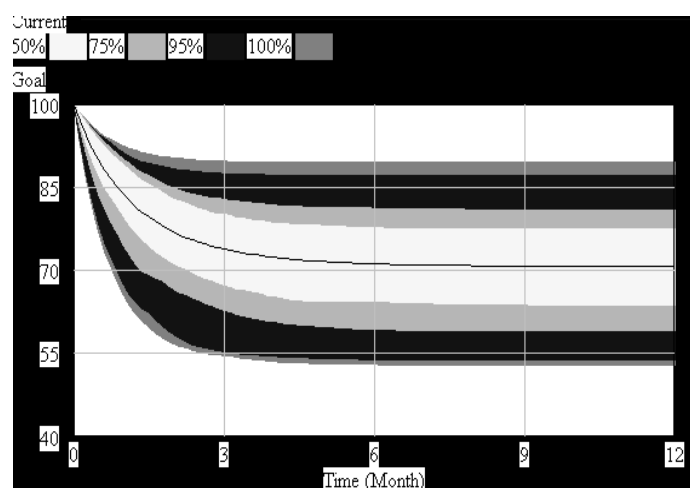
Source: Own results.

Fig. 5. Confidence bounds for variable "Goal" (x_1) for the interval (1,5) for parameter T_1 and (5,10) for parameter T_2
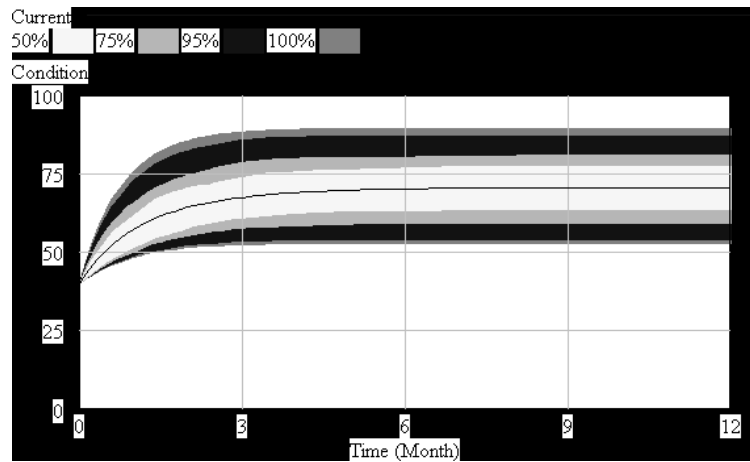
Source: Own results.

Fig. 6. Confidence bounds for variable "Condition" (x_2) for the interval (1,5) for parameter T_1 and (5,10) for parameter T_2

Source: Own results.

Time for conclusion of that results

Sensitivity analysis can be the entrance for optimization process. Such process can be done by Vensim too. Let the aim of optimization will be maximization of value of variable "Goal". In Table 1 the comparison of values of objective function for different intervals for parameter T_1 (also with parameter T_2) is given. Moreover in Table 2 we can see the influence of changing the intervals for initial values of levels "Goal" and "Condition" for searching the values of objective function. Moreover in Table 3 the comparison of influence together: T_1, T_2, x_{10} for objective function is located. In Table 4 the comparison of influence together: T_1, T_2, x_{10}, x_{20} for objective function is located. Possibilities of such effective search of values of objective function, are practically unlimited. It should be stress that like the objective function we can choose "Condition" and the optimization process will be the minimization of such objective function, that time.

Table 1

Effective search of values of objective function – comparison of some results for different intervals for parameters T_1, T_2

Archetype "Eroding Goal"		
intervals for sensitive parameters for model of archetype		values of objective function for optimization: MAX "Goal"
$T_1 \in (1,5)$		$OF = 54.5454$
$T_1 \in (1,7)$		$OF = 54.5454$
$T_1 \in (2,5)$		$OF = 49.974$
$T_1 \in (1,5)$	$T_2 \in (5,10)$	$OF = 54.5454$
$T_1 \in (1,5)$	$T_2 \in (1,5)$	$OF = 50.000$
$T_1 \in (1,7)$	$T_2 \in (5,10)$	$OF = 54.5454$
$T_1 \in (2,5)$	$T_2 \in (5,10)$	$OF = 49.974$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$OF = 42.8512$

Table 2

Effective search of values of objective function – comparison of some results for different intervals for initial values of levels

Archetype "Eroding Goal"		
intervals for initial values of "Goal" (x_{10}) and "Condition" (x_{20})		values of objective function (OF) for optimization: MAX "Goal"
$x_{10} \in (90,100)$		$OF = 39.0184$
$x_{10} \in (75,100)$		$OF = 39.0184$
$x_{10} \in (100,150)$		$OF = 71.5337$
$x_{10} \in (90,100)$	$x_{20} \in (30,40)$	$OF = 39.0184$
$x_{10} \in (100,150)$	$x_{20} \in (20,40)$	$OF = 71.5337$
$x_{10} \in (50,150)$	$x_{20} \in (30,40)$	$OF = 71.5337$
$x_{10} \in (90,150)$	$x_{20} \in (20,40)$	$OF = 39.0184$
$x_{10} \in (75,100)$	$x_{20} \in (20,40)$	$OF = 39.0184$

Table 3

Effective search of values of objective function – comparison of some results for different intervals for parameters: T_1, T_2 and initial values of level "Goal"

Archetype "Eroding Goal"			
intervals for sensitive parameters: T_1, T_2 and for initial values of "Goal" (x_{10})			values of objective function for optimization: MAX "Goal"
$T_1 \in (1,5)$	$T_2 \in (5,10)$	$x_{10} \in (90,100)$	$OF = 54.5454$
$T_1 \in (2,5)$	$T_2 \in (5,10)$	$x_{10} \in (90,100)$	$OF = 49.974$
$T_1 \in (1,5)$	$T_2 \in (1,5)$	$x_{10} \in (90,100)$	$OF = 50.000$
$T_1 \in (1,5)$	$T_2 \in (1,5)$	$x_{10} \in (100,150)$	$OF = 91.667$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$x_{10} \in (100,150)$	$OF = 78.5605$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$x_{10} \in (90,100)$	$OF = 42.8512$

Sometimes the results are intuitially quite obvious and anticipated, but such system like archetype "Eroding Goal" is partially simple. In the case of more complicated systems (with more feedbacks), the possibilities of previously searching sensitive parameters in mathematical models of systems is very valuable, and of course choosing the scopes of intervals of that parameters has the influence for searching objectives function.

Table 4

Effective search of values of objective function – comparison of some results for different intervals for parameters: T_1, T_2 and initial values of level "Goal" and "Conditions"

Archetype "Eroding Goal"				
intervals for sensitive parameters: T_1, T_2 and for initial values of "Goal" (x_{10})				values of objective function for optimization: MAX "Goal"
$T_1 \in (1,5)$	$T_2 \in (5,10)$	$x_{10} \in (90,100)$	$x_{20} \in (30,40)$	$OF = 54.5454$
$T_1 \in (2,5)$	$T_2 \in (5,10)$	$x_{10} \in (90,100)$	$x_{20} \in (30,40)$	$OF = 49.974$
$T_1 \in (1,5)$	$T_2 \in (1,5)$	$x_{10} \in (90,100)$	$x_{20} \in (30,40)$	$OF = 50.000$
$T_1 \in (1,5)$	$T_2 \in (1,5)$	$x_{10} \in (100,150)$	$x_{20} \in (30,40)$	$OF = 91.667$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$x_{10} \in (100,150)$	$x_{20} \in (40,50)$	$OF = 78.5605$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$x_{10} \in (100,150)$	$x_{20} \in (40,60)$	$OF = 48.5605$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$x_{10} \in (90,100)$	$x_{20} \in (40,50)$	$OF = 42.8125$
$T_1 \in (2,5)$	$T_2 \in (1,5)$	$x_{10} \in (90,100)$	$x_{20} \in (40,60)$	$OF = 42.8125$

Archetype named "Fixes that Fail"

In archetype "Fixes that Fail" there are three "proportionally" parameters: *a, b, c*. There is possibility of many experiments type "sensitivity analysis" with many combination on bounds for values. We have perform four. First we used univariate types for parameter *a,* than for parameter *b,* and parameter *c*. Second we used multivariate type for *a* and *b* appropriately and then for *a, b, c* simulatiously. The results of such simulation experiments are presented on Figures 7, 8, 9, 10, 11, 12, 13, 14 in form of confidence bounds for variables x_1. Similar form can be obtain for variable x_2.

Fig. 7. Confidence bounds for variable "Problem" (x_1) for the interval (0.1,0.6) for parameter "a"

Source: Own results.

Fig. 8. Confidence bounds for variable "Unintended Consequences" for the interval (0.1,0.6) for parameter "a"

Source: Own results

Fig. 9. Confidence bounds for variable "Problem" (x_1) for the interval (0.1,0.6) for parameter "*b*"

Source: Own results.

Fig. 10. Confidence bounds for variable "Unintended Consequences" for the interval (0.1,0.6) for parameter "*b*"

Source: Own results.

Fig. 11. Confidence bounds for variable "Problem" (x_1) for the interval (0.1,0.5) for parameter "c"

Source: Own results.

Fig. 12. Confidence bounds for variable "Unintended Consequences" for the interval (0.1,0.5) for parameter "c"

Source: Own results.

Fig. 13. Confidence bounds for variable "Problem" (x_1) for the intervals: (0.1,0.6)
for parameter "*a*", (0.1,0.6) for parameter "*b*", (0.1,0.5) for parameter "*c*"
Source: Own results.
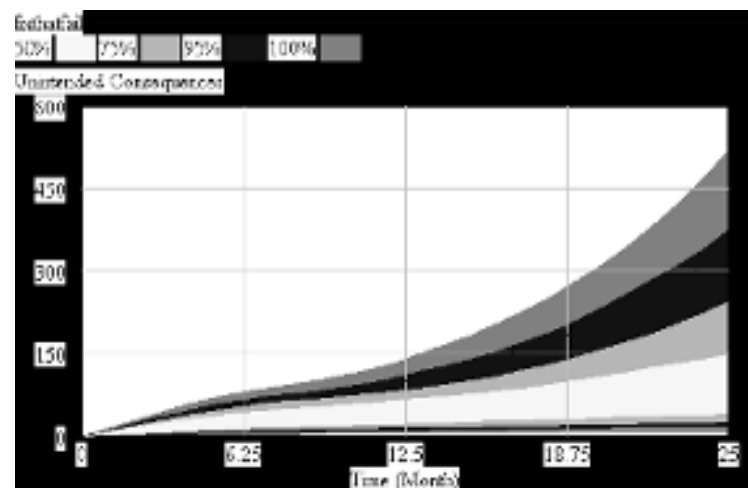
Fig. 14. Confidence bounds for variable "Unintended Consequences" for intervals:
(0.1,0.6) for parameter "*a*", (0.1,0.6) for parameter "*b*", (0.1,0.5) for parame-
ter "*c*"
Source: Own results.

We can do similar optimization experiments for archetype "Fixes that Fail"
like for archetype "Eroding Goal". In that case the objective function "Problem"
can be choose, and different intervals for sensitive parameters: *a, b, c,* will show
their influence for objective function.

Archetype "Success to the Successful"

In archetype "Success to the Successful" there are two "proportionally" parameters: *a, b*. There is possibility of many experiments type "sensitivity analysis".

The three of them were chosen. First we used univariate types for parameter *a* and *b* appropriately. And then we have used multivariate type for both parameters: *a* and *b*.

The results of such simulation experiments are presented on Figures 15, 16, 17, 18, 19, 20 in form of confidence bounds for variables x_1, x_2.

Fig. 15. Confidence bounds for variable "SuccessOfA" for the interval (0.01,0.1)

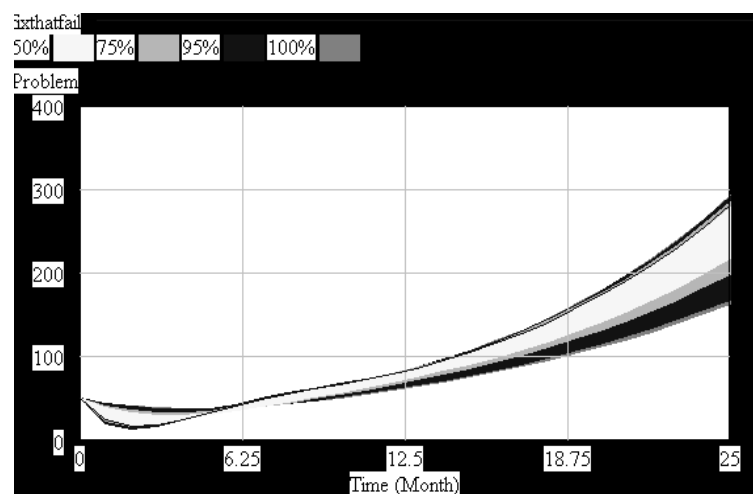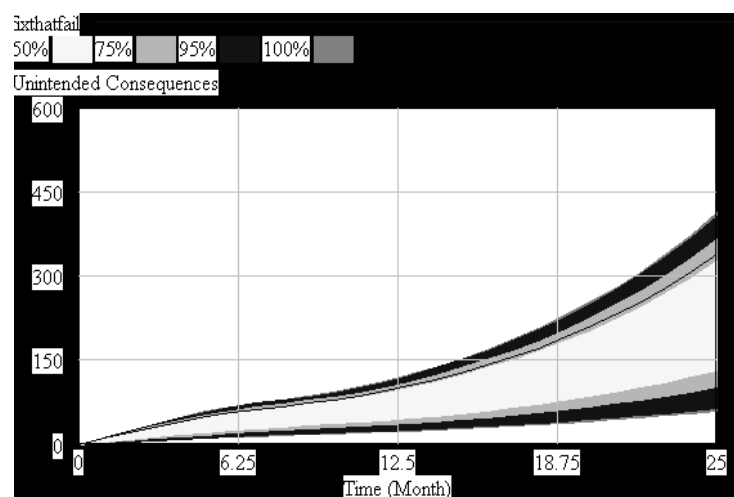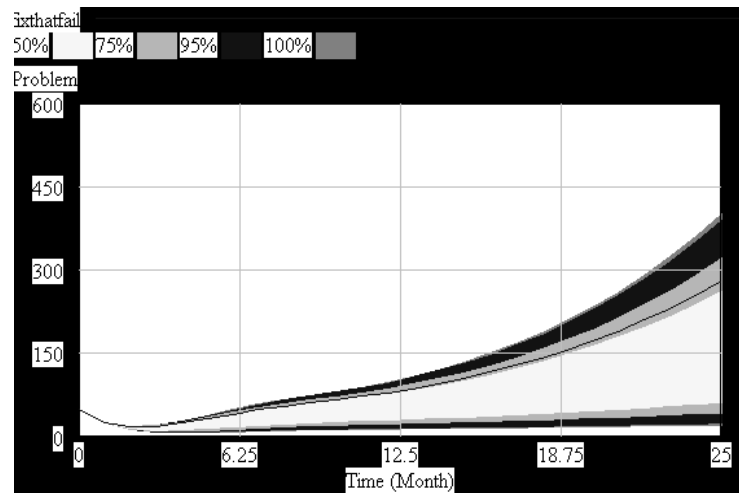for parameter "*a*"

Source: Own results.

Fig. 16. Confidence bounds for variable "SuccessOfB" for the interval (0.01,0.1)
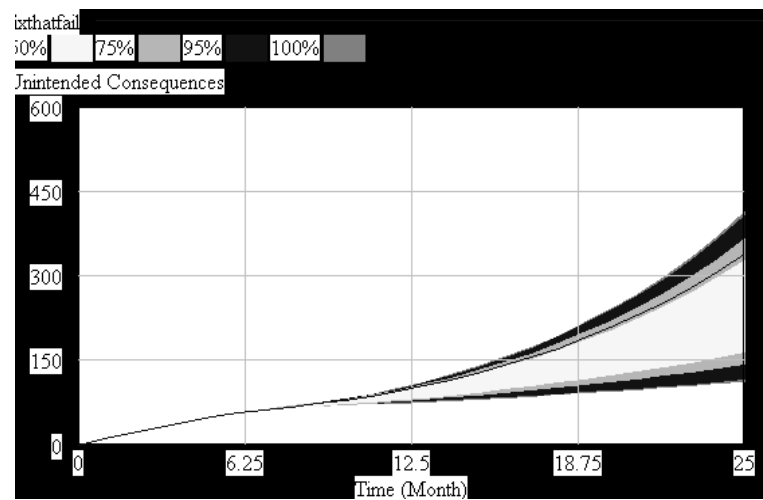for parameter "*a*"

Source: Own results.

Fig. 17. Confidence bounds for variable "SuccessOfA" for the interval (0.01,0.1)
for parameter "*b*"

Source: Own results.

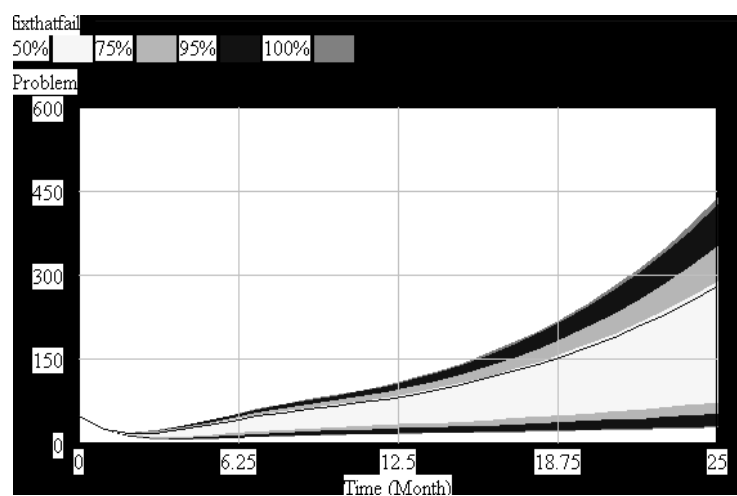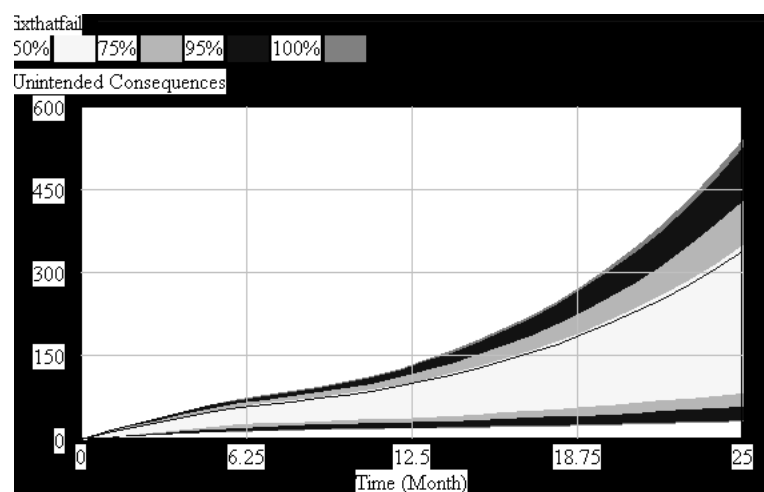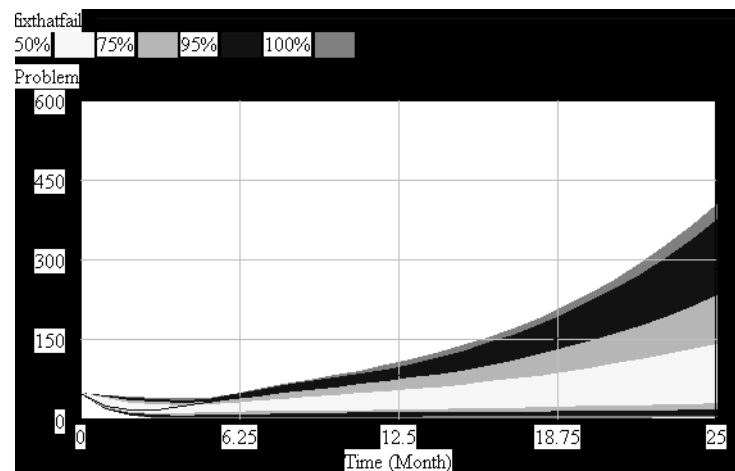Fig. 18. Confidence bounds for variable "SuccessOfB" for the interval (0.01,0.1)
for parameter "*b*"

Fig. 19. Confidence bounds for variable "SuccessOfA" for the intervals: (0.01,0.1)
for parameter "*a*" and (0.01,0.1) for parameter "*b*"

Fig. 20. Confidence bounds for variable "SuccessOfB" for the intervals: (0.01,0.1)
for parameter "*a*" and (0.01,0.1) for parameter "*b*"
Source: Own results.

Archetype "Accidental Adversaries"

In this archetype there are many parameters: *a, b, c, d, e, f, t₁, t₂*. Authors have performed many experiments type "sensitivity analysis". Some of them we described below.

First we used so called univariate type, that means "change one at time". In experiment 1 the maximum and minimum values are chosen to bound parameter "*a*" and in experiment 2 to parameter "*b*" appropriately.

The results of such simulation experiments are presented on Figures 21, 22, 23, 24 in form of confidence bounds for variables x_1, x_2. On the contrary in experiment 3 we used so called multivariate type, that means "change all together". Now, the parameters *a, b, c, d, e, f,* changing their values simultaneously. The results of such simulation experiments are presented on Figures 25, 26 in form of confidence bounds for variables x_1, x_2. Interesting experiments number 4 was performed. That time the maximum and minimum values wore chosen to bound parameters: t_1, t_2. The influence to dynamics of variables x_1, x_2 is presented on Figures 27, 28.

Possibilities of sensitivity analysis are practically unlimited and this is entrance for optimization experiments. Like the objective function we choose multicriterial function type:

$$OF = w_1 Asuccess + w_2 Bsuccess$$

And we performed such types of optimization:

A. Maximum of *Asuccess* (that means $w_1 = 1$, $w_2 = 0$).

B. Maximum of *Bsuccess* (that means $w_1 = 0$, $w_2 = 1$).

C. Maximum of sum of *Asuccess* and *Bsuccess* ($w_1 = 1$, $w_2 = 1$).

D. Maximum of sum of *Asuccess* and *Bsuccess* (*Bsuccess* is a kind of penalty) ($w_1 = 1$, $w_2 = -1$).

E. Minimum of *Asuccess* (that means $w_1 = 1$, $w_2 = 0$).

F. Minimum of *Bsuccess* (that means $w_1 = 0$, $w_2 = 1$).

G. Minimum of sum of *Asuccess* and *Bsuccess* ($w_1 = 1$, $w_2 = 1$).

The results of such types of experiments are presented on Figures 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41.

There are interesting conclusions.

The dynamics of variable x_1, x_2 is a result of "cooperation" of loops in structure of archetype. For example on Figures 33, 34 we can see the results of dominating outer loops **R1** and **R2** (see: the structure of archetype), which in consequences gives the exponential growth of variables: x_1, x_2. Contrary on Figures 38, 39 we can see the influence of balancing loops **B1, B2** together with the acting of "obstructions" (delaying) factors in structure. The results of such acting is a damping oscillations characteristics of variables x_1, x_2.
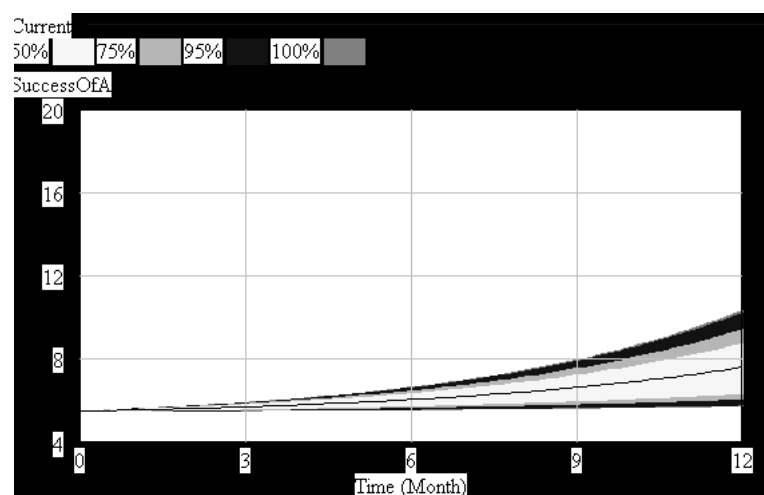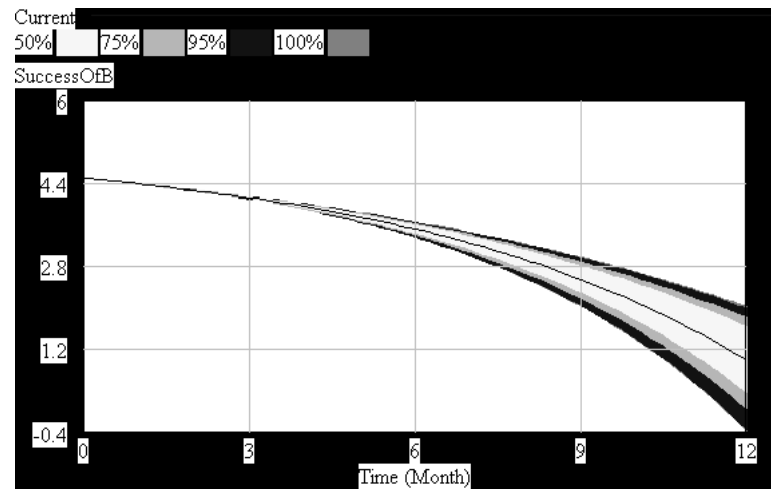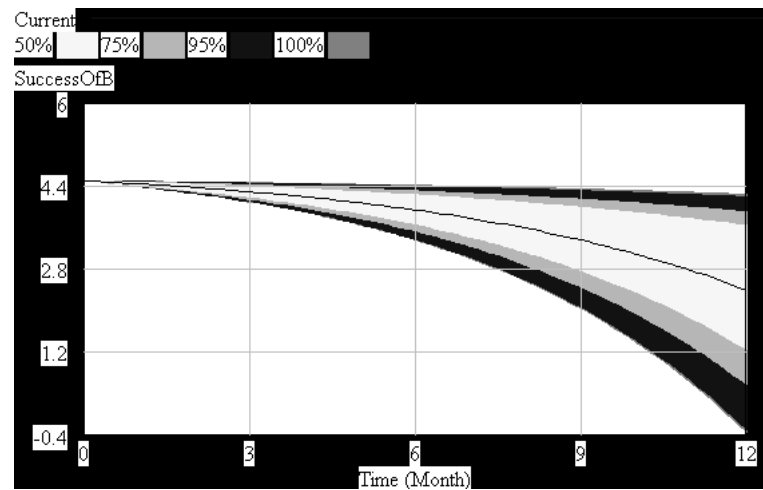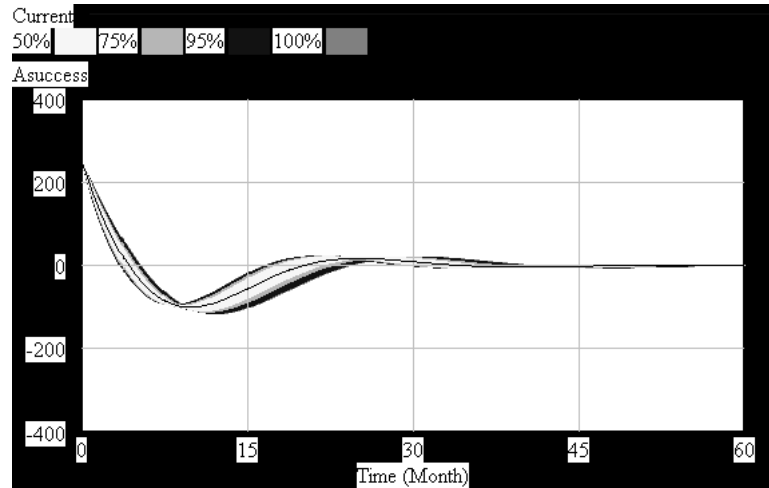

Fig. 21. Confidence bounds for variable "Asuccess" for the interval: (0.2,0.4) for parameter "a"
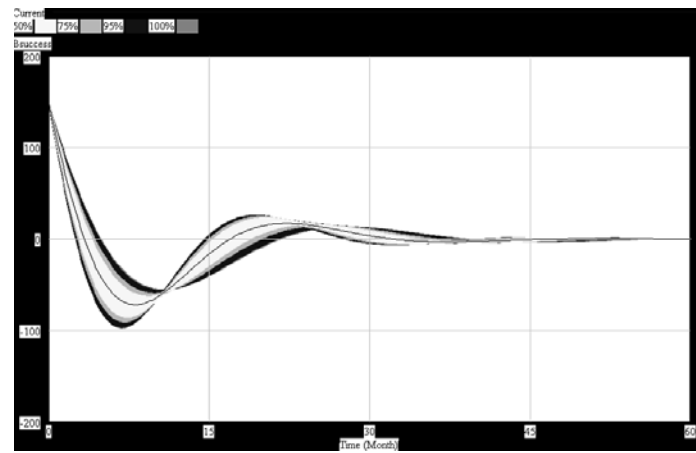
Source: Own results.

Fig. 22. Confidence bounds for variable "Bsuccess" for the interval: (0.2,0.4) for parameter "a"
Source: Own results.
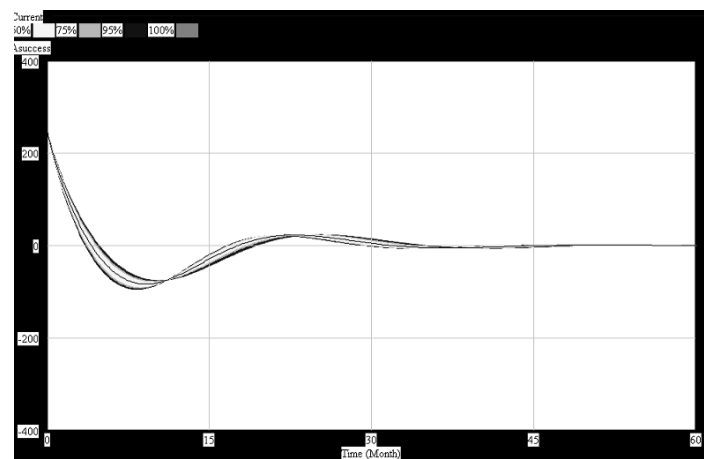
Fig. 23. Confidence bounds for variable "Asuccess" for the interval: (0.2,0.4) for parameter "b"
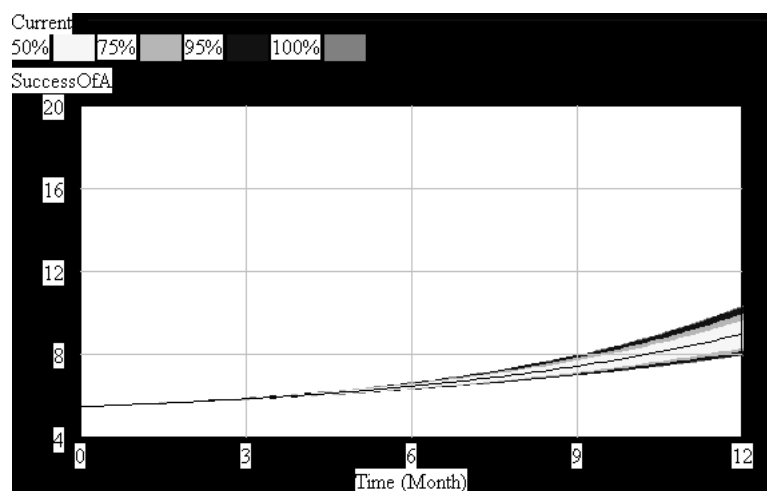Source: Own results.
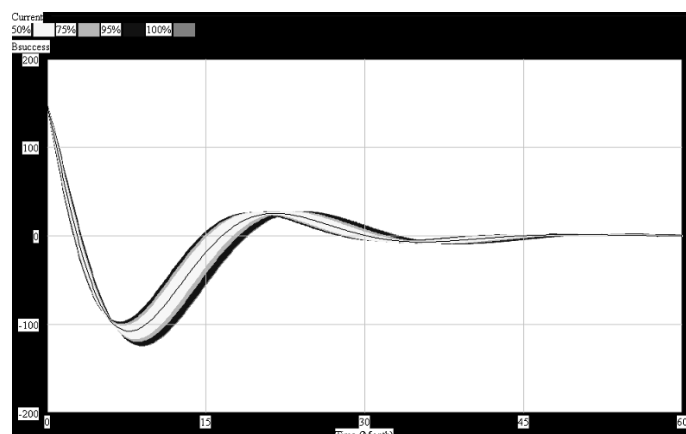
Fig. 24. Confidence bounds for variable "Bsuccess" for the interval: (0.2,0.4) for
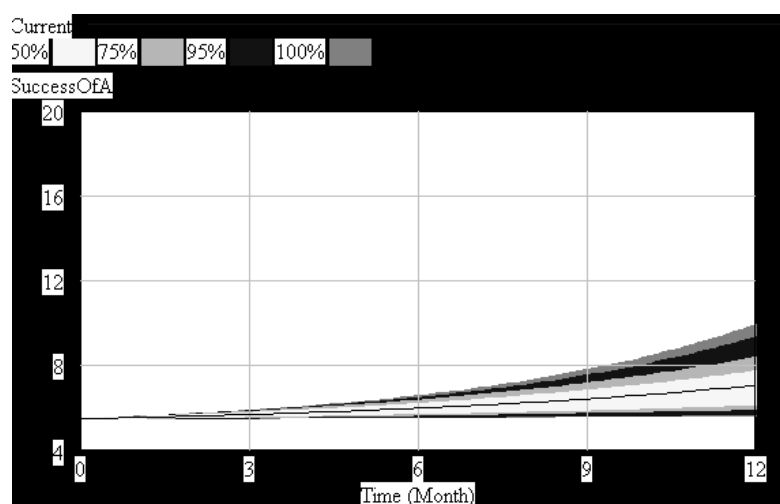   parameter "b"
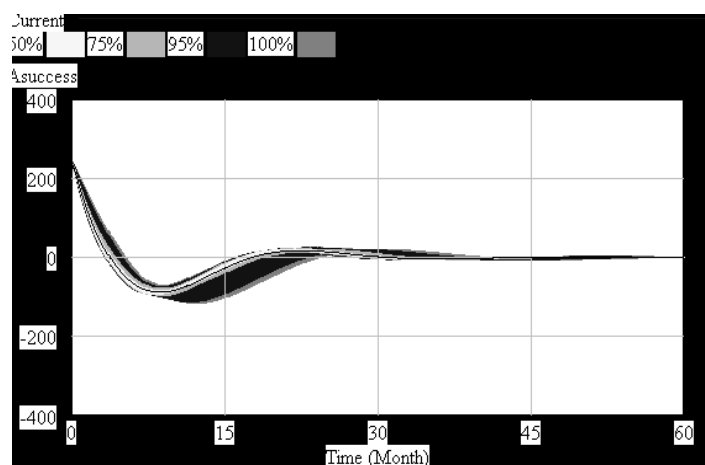
Source: Own results.

Fig. 25. Confidence bounds for variable "Asuccess" for the intervals for parameters:
        $a \in (0.2, 0.4)$, $b \in (0.2, 0.4)$, $c \in (0.1, 0.2)$, $d \in (0.1, 0.2)$, $g \in (0.4, 0.6)$, $h \in (0.4, 0.6)$
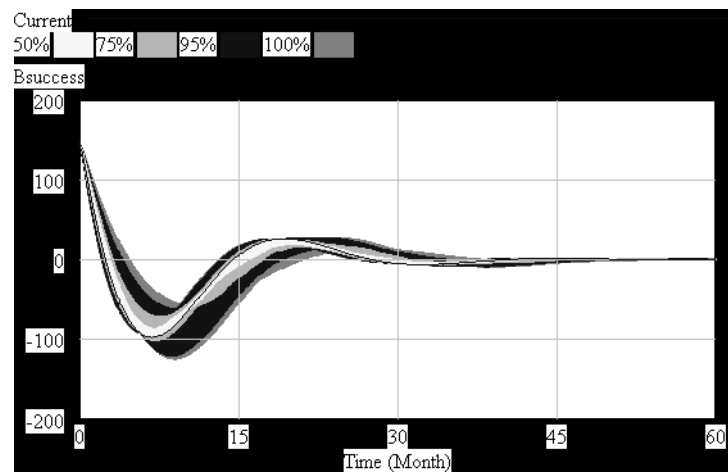
Source: Own results.

Fig. 26. Confidence bounds for variable "Bsuccess" for the intervals for parameters:
$a \in (0.2, 0.4), b \in (0.2, 0.4), c \in (0.1, 0.2), d \in (0.1, 0.2), g \in (0.4, 0.6), h \in (0.4, 0.6)$
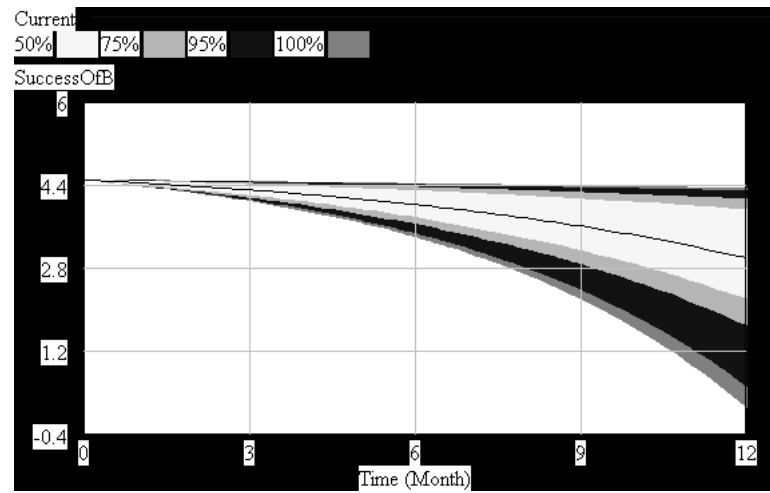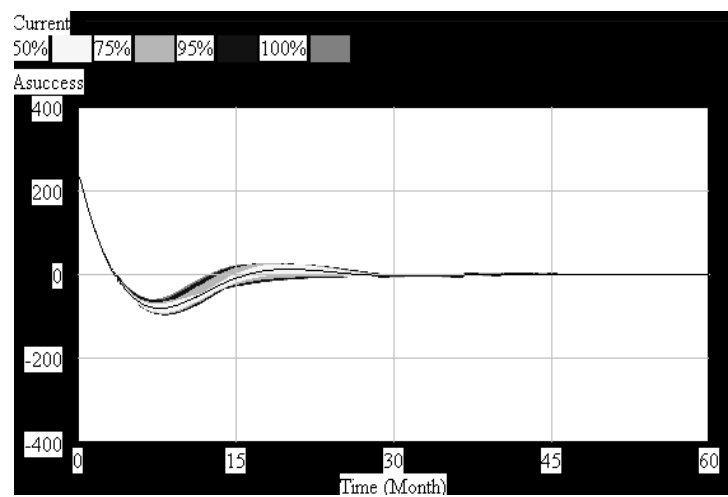
Source: Own results.

Fig. 27. Confidence bounds for variable "Asuccess" for the intervals: (1,5) for parameter t_1, and (5,10) for parameter t_2
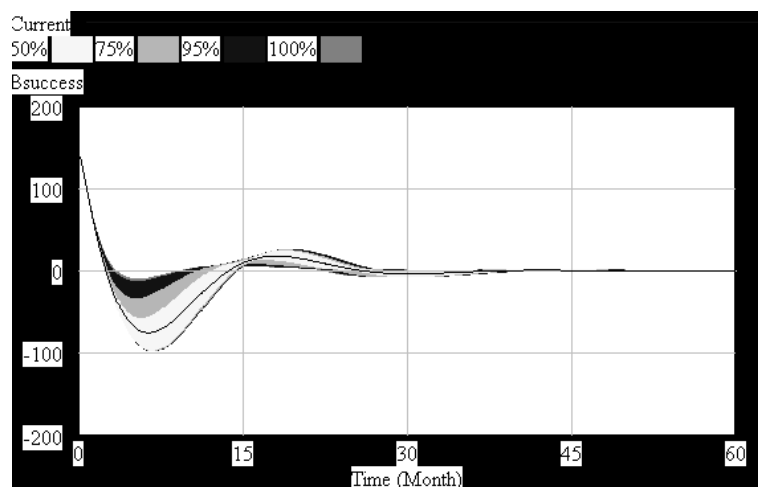
Source: Own results.

Fig. 28. Confidence bounds for variable "Bsuccess" for the intervals: (1,5) for parameter t_1, and (5,10) for parameter t_2
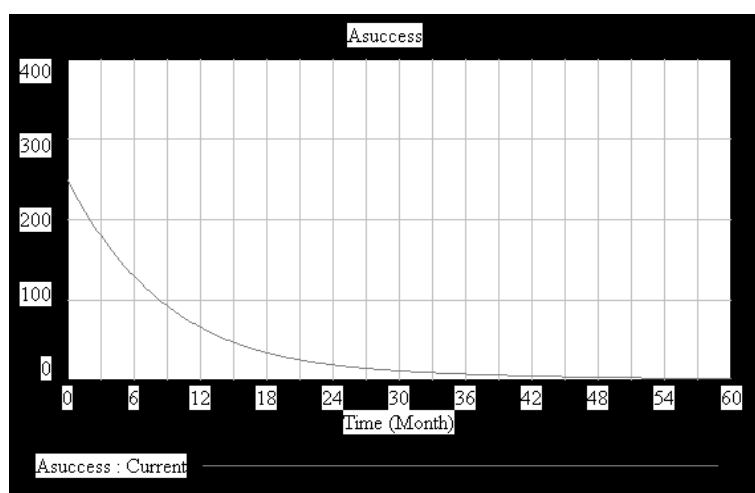
Source: Own results.

Fig. 29. The dynamics of variable *ASuccess* for objective function: *OF = Asuccess* for "Accidental Adversaries" archetype
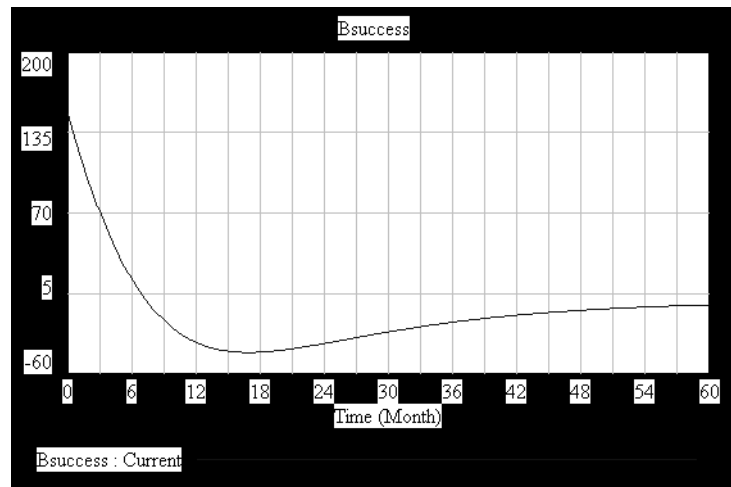
Source: Own results.

Fig. 30. The dynamics of variable *BSuccess* for objective function: *OF = Asuccess*
for "Accidental Adversaries" archetype
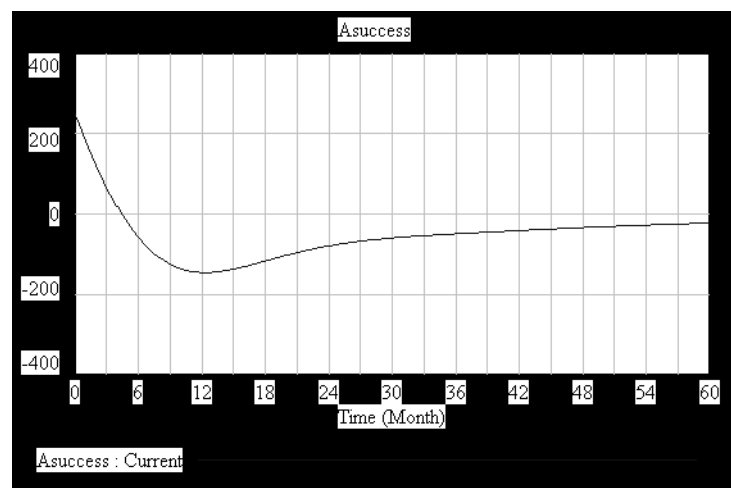
Source: Own results.

Fig. 31. The dynamics of variable *ASuccess* for objective function: *OF = Bsuccess*
for "Accidental Adversaries" archetype
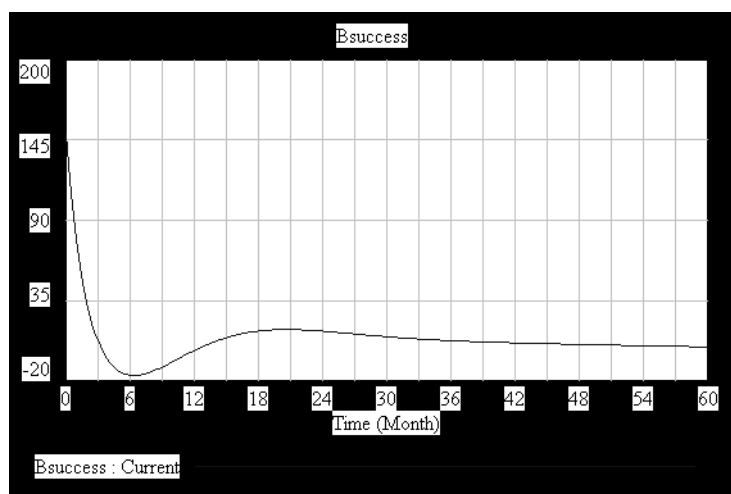
Source: Own results.

Fig. 32. The dynamics of variable *BSuccess* for objective function: *OF = Bsuccess*
        for "Accidental Adversaries" archetype
Source: Own results.
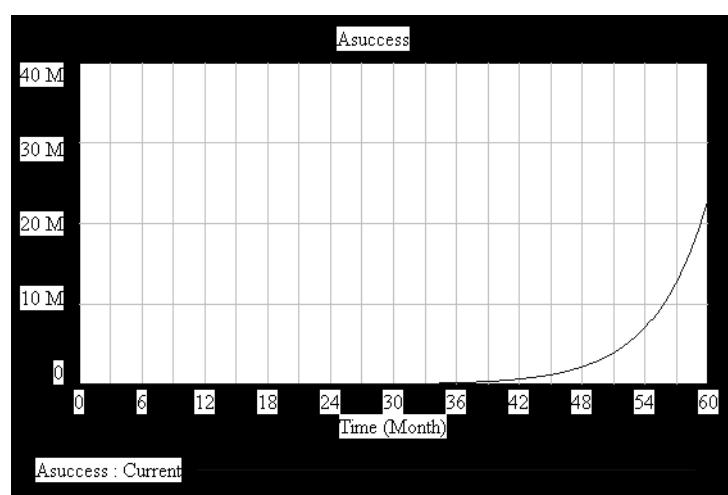
Fig. 33. The dynamics of variable *ASuccess* for objective function: *OF = Asuccess +*
        + Bsuccess for "Accidental Adversaries" archetype
Source: Own results.
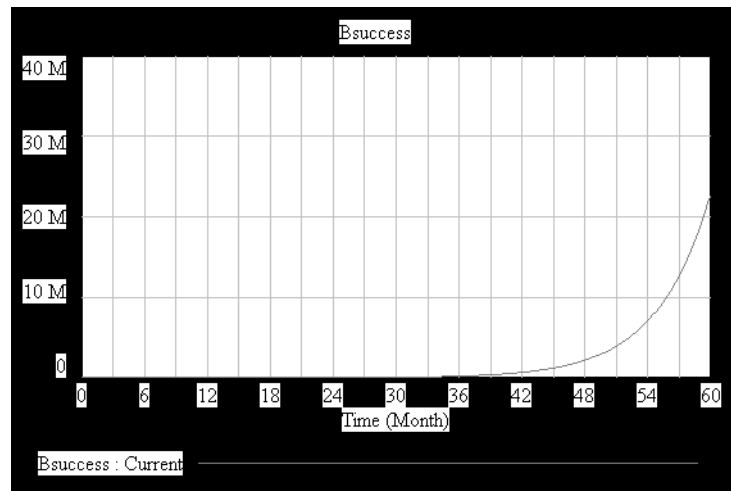
Fig. 34. The dynamics of variable *BSuccess* for objective function: *OF = Asuccess +*
+ Bsuccess for "Accidental Adversaries" archetype
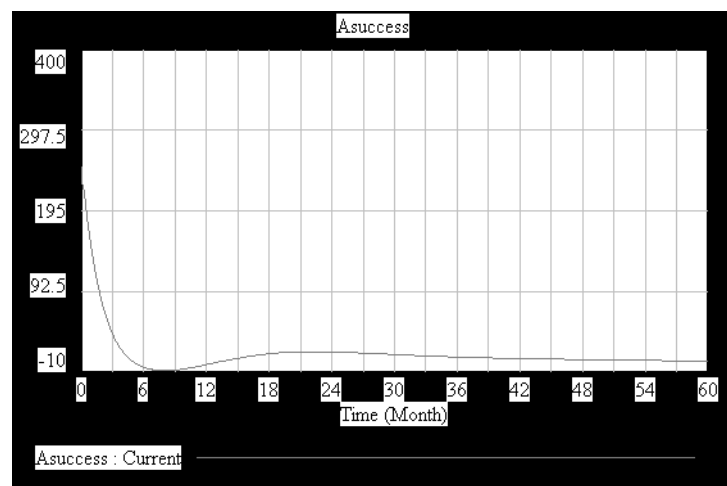
Source: Own results.

Fig. 35. The dynamics of variable *ASuccess* for objective function: *OF = Asuccess –*
– Bsuccess for "Accidental Adversaries" archetype
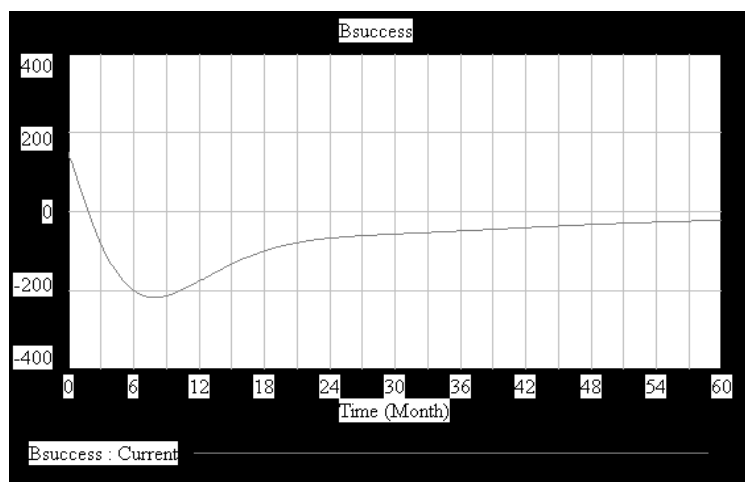
Source: Own results.

Fig. 36. The dynamics of variable *BSuccess* for objective function: *OF = Asuccess –*
– Bsuccess for "Accidental Adversaries" archetype
Source: Own results.
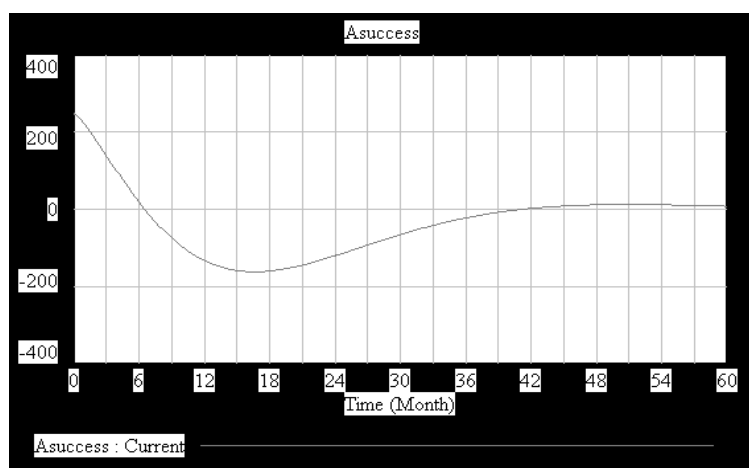
Fig. 37. The dynamics of variable *ASuccess* for objective function: *OF = Asuccess*
(minimization) for "Accidental Adversaries" archetype
Source: Own results.
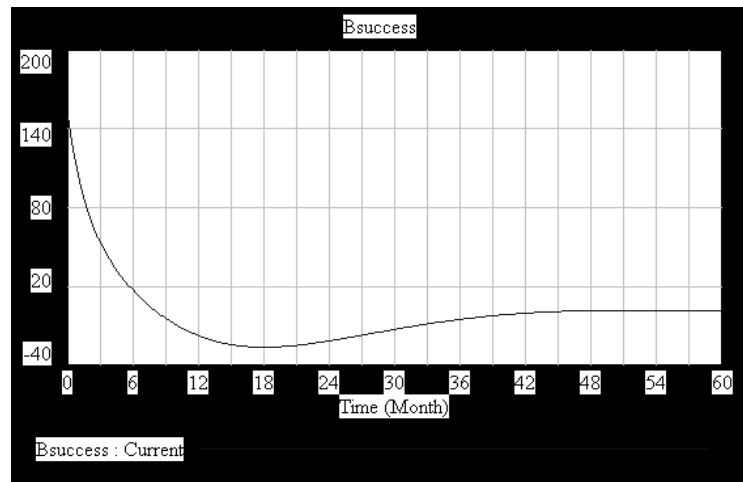
Fig. 38. The dynamics of variable *BSuccess* for objective function: *OF = Asuccess*
(minimization) for "Accidental Adversaries" archetype
Source: Own results.
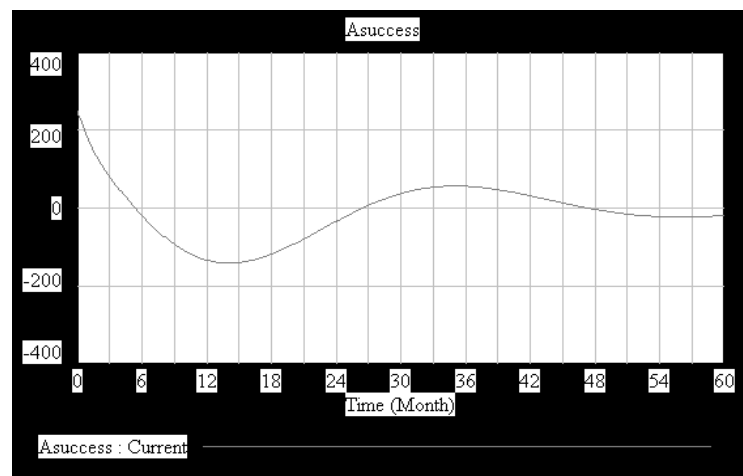
Fig. 39. The dynamics of variable *ASuccess* for objective function: *OF = Bsuccess*
(minimization) for "Accidental Adversaries" archetype
Source: Own results.
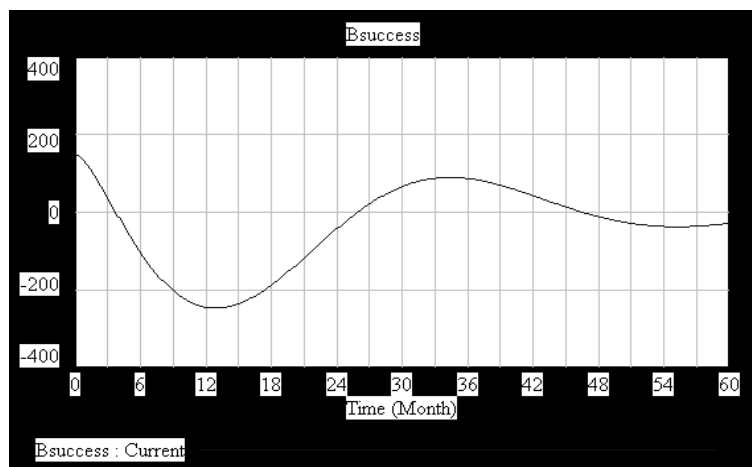
Fig. 40. The dynamics of variable *BSuccess* for objective function: *OF* = *Bsuccess*
(minimization) for "Accidental Adversaries" archetype
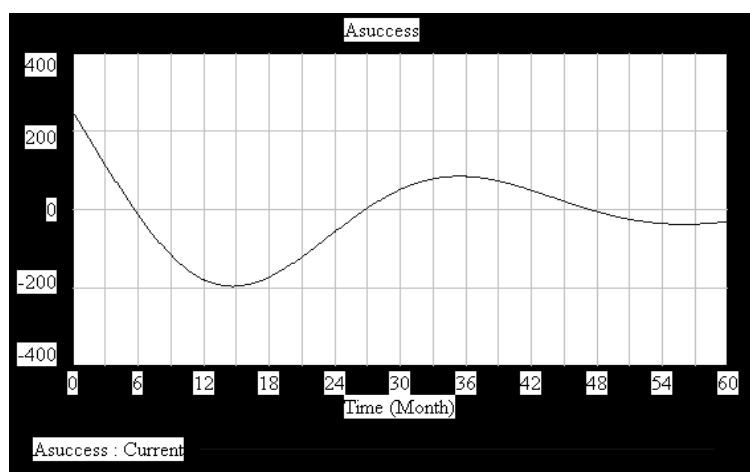
Source: Own results.

Fig. 41. The dynamics of variable *ASuccess* for objective function: *OF* = *Asuccess* +
+ *Bsuccess* (minimization) for "Accidental Adversaries" archetype
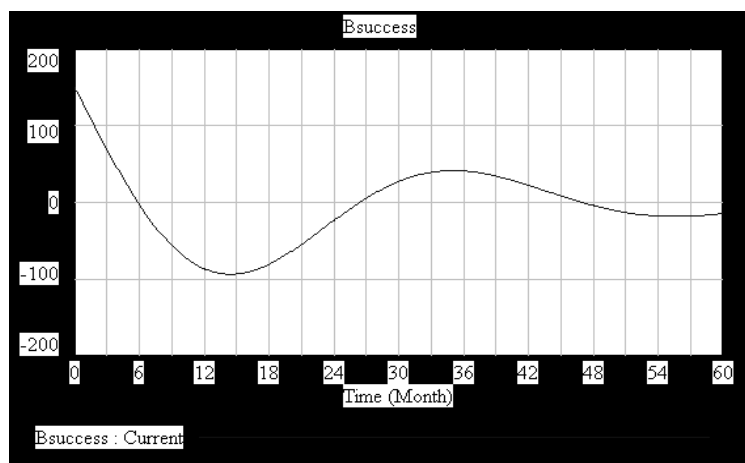
Source: Own results.

Fig. 42. The dynamics of variable *BSuccess* for objective function: *OF = Asuccess +*
+ Bsuccess (minimization) for "Accidental Adversaries" archetype
Source: Own results.

In Table 5 the comparison of results of optimization, for different type of objective function, is located. We can see the difference in searching optimum values of parameters and of course for objective function too.

Table 5

Comparison of results of optimization for different types of objective function, for Accidental Adversaries archetype

Type of optimiza-tion	Results on fi-gures	Optimum values for parameters	Optimum value for ob-jective function
MAX *Asuccess*	*Fig. 29* *Fig. 30*	$a = b = 0.1$ $c = d = 0$ $g = 0.6$ $h = 0.1$	2387.6
MAX *Bsuccess*	*Fig. 31* *Fig. 32*	$a = 0.1$ $b = 0.5$ $c = d = 0$ $g = h = 0.6$	508.983
MAX *(Asuccess + Bsuccess)*	*Fig. 33* *Fig. 34*	$a = b = 0.1$ $c = d = 0.3$ $g = h = 0.1$	237364

Table 5 continued

MAX *(Asuccess - Bsuccess)*	*Fig. 35* *Fig. 36*	$a = 0.5$ $b = 0.1$ $c = d = 0$ $g = h = 0.6$	5183.12
MIN *Asuccess*	*Fig. 37* *Fig. 38*	$a = 0.1$ $b = 0.5$ $c = 0.089919$ $d = 0.3$ $g = 0.1$ $h = 0.6$	2032.69
MIN *Bsuccess*	*Fig. 39* *Fig. 40*	$a = 0.5$ $b = 0.1$ $c = d = 0.3$ $g = h = 0.6$	2283,72
MIN *(Asuccess + Bsuccess)*	*Fig. 41* *Fig. 42*	$a = 0.179673$ $b = 0.5$ $c = d = 0.3$ $g = h = 0.6$	1552.48

Comparison of optimum values of parameters, for different types of optimization, allows for some remarks:

1. The exponential growth in experiments type: MAX (*Asuccess+Bsuccess*), is a result of domination of reinforcing loops (see: the structure of model, Figure 7, and see the value of parameters: $c = d = 0.3$).

2. When *Bsuccess* is a kind of "penalty" for objective function (see: MAX (*Asuccess-Bsuccess*), then algorithm choose small fixing for B (*b = 0.1)* big fixing for A (*a = 0.5*), switching out the "activities" (*c = d = 0*) and switching on "obstacles" (*g = h = 0.6*).

3. When we consider minimization of sum *Asuccess* and *Bsuccess* then big "obstacles", are switching on (*g = h = 0.6*) and interesting value of "fixing" parameters are chosen (*a = 0.179673, b = 0.5*).

The precise watching of changing dominance loops for both: *Asuccess, Bsuccess* is practically no possible. Because of this such experiments are very interesting from methodological point of view. The structure of "Accidental Advisory" archetype contains two delays, and because of this the precise solving such set of different equations with delayed arguments [Bo10; Ha77; HaSt88], is

very complicated. Authors very slowly read the literature of this subject, so now it is not possible to say something about stability of such structure like for this archetype. This is interesting subject for future study.

Final remarks and conclusion

The aim of this paper was a presentation of some new results of authors investigation in the area of sensitivity analysis and optimization for some system archetypes. First we presented mathematical models of chosen archetype, like:
– Eroding Goal,
– Fixes that Fail,
– Success to the Successful,
– Accidental Adversaries,
– Limit to Growth.
Then we executed many experiments type sensitivity analysis and optimization, using simulation language Vensim.

Specially we presented the comparisons of value of objective functions for different intervals of values of sensitive parameters and intervals for initial values of levels. On the base of results, especially on the base of exact mathematical solution from some models of archetype, we can discussed the problem of stability for these archetypes. This problem is very interesting from methodological point of view. Authors plan to undertake the searching of stability in next papers.

Now, some conclusions are as follow:
1. The more complicated system (more feedbacks), the most interesting is the role of parameters and initial values of levels, especially for process of searching the optimization value of objective function.
2. The chosen intervals of that parameters can be narrowing (for investigating the stability (or chaos), or widen for process of optimization.
3. Different objective function (with weight for multicriterial function) can model different priorities, with penalty factors for constrains.

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ANALIZA WRAŻLIWOŚCI I OPTYMALIZACJA NA PEWNYCH MODELACH ARCHETYPÓW Z UŻYCIEM VENSIMA – UJĘCIE EKSPERYMENTALNE

Streszczenie

Artykuł jest kontynuacją artykułu pt. „Analiza wrażliwości i optymalizacja na pewnych modelach archetypów z użyciem Vensima – ujęcie teoretyczne" tych samych autorów. Na bazie możliwości języka symulacyjnego Vensim przeprowadzono wiele eksperymentów i zaprezentowano w postaci „przedziałów ufności", które są bardzo ładną wizualizacją trajektorii zmiennych modeli.

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Wrocław University of Economics

MOBILE TECHNOLOGIES AS INFRASTRUCTURAL SUPPORT FOR COMPANY INTERNAL COMMUNICATION PROCESSES

Introduction

Globalization, intense competition, and dynamics of changes in economic phenomena and processes have forced companies to explore new ways of improving their operational capacity, with the view of profit maximization. Company internal communication is one of the more promising areas of such improvement, offering potential effectiveness boost if done in a correct, efficient and consistent manner.

This paper discusses mobile technologies as an important factor of potential improvement and enhancement of internal communication processes. Barriers to integration of mobile technologies with internal communication processes are also discussed, together with postulated solutions aimed at minimizing such barriers.

The nature and significance of internal communication processes in companies

Company information systems are based on communication processes. Communication is, therefore, a prerequisite for company functioning, ensuring proper task completion on both operating and management level.

Communication, in general context, is defined as a bilateral process by which information is exchanged between the sender and the recipient through a common system of symbols and channels of exchange, as a means of connecting people [Stan09, p. 44]. In the context of company operation, communication

is defined as a process by which proper contact is established between its various organizational structures, in the form of intentional transfer of information.

Communication process, as stated above, involves and integrates two parties [Poto08, p. 14]:

– the sender – the party that initiates the process by formulating a message in a common coding system and transmitting it with intent and through selected communication channels to the recipient,

– the recipient – the addressee of such message, perceiving the coded message through his or her senses.

Furthermore, the process under study incorporates the following elements [Poto08, p. 14]:

– the message – a batch of information presented in an encoded form,

– the code – a distinct system of signs, shared between both parties, and ensuring correct interpretation of the message (language, together with associated logical, esthetic and social codes),

– the channel – the form of contact between communicating parties (oral, written, visual),

– the information gap – a gap representing the difference between informational content required by the recipient and the actual content presented to him or her,

– interference – disruptions of psychological, material, energetic, external or organizational nature, that affect the process,

– feedback – reversal of the communication process, representing the recipient's reaction to the sender's message,

– frame of reference – situational context that places both parties of the process in a definite spatial and temporal frame.

The most fundamental task of company internal communication is to provide complete information on company present situation and future plans. In addition, internal communication is an important instrument for shaping company organizational culture and for preventing internal crises. It is also closely correlated with external communication, serving as a platform for negotiating its content. The use of communication influences company image. The way organization members evaluate their company strongly influences their attitudes. A favorable opinion about company helps the employees identify with it. Moreover, good knowledge of company helps them formulate their own opinion on company functioning and induces active attitudes and pursuits [Biel06].

Proper and effective flow of internal communication – both between employees and between management and subordinates – is of fundamental importance for company operation and, as such, strongly affects company financial effectiveness and employee involvement. According to Watson Wyatt report of 2010, companies that place considerable weight on internal communication offer, on average, 47% more return on investment to their shareholders [Jabl11]. In the light of the above, internal communication is an extremely important aspect of economic activities, but – at the same time – a compound phenomenon, closely related to the arduous task of shaping human behavior using dedicated sociological and psychological techniques in many areas of communication.

Areas of company internal communication

The complexity of company internal communication processes is a result of many factors. The most significant factors at play are: the redundancy of communication roles depending on communication context and the variety of technological aspects that shape modern work environment. However, any attempt at formalizing the processes requires relative structuring of the two, e.g. by adopting formal typologies. This paper focuses on two such topologies, construed on the basis of communication direction and communication context, respectively.

Thus, identification of basic areas of company internal communication based on direction of communication allows to distinguish between vertical (up or down the organization's chain of command) and horizontal communication.

Upward vertical communication covers the whole area of communication with superiors, regardless of the actual distance between the respective levels of organizational structure, and may apply both to information transfer and relation building [Cybu11]. Information transferred in this area typically addresses current problems and postulated changes or improvements.

Downward vertical communication covers the area of bilateral contact between superiors and subordinates and, similarly to the previous area, involves information transfer and relation building, but – in this context – strictly from the superior's viewpoint [Cybu11]. It may take on the form of company publications, billboards, intranet, e-mails and memorandums. Information passed through these channels should be significant, reliable, topical, comprehensible and adjusted to recipients' capabilities [Roga09]. It must be noted that messages transmitted in this area should be carefully selected and presented in proper frame of time and space,

so that they are properly assimilated and relevant to recipients' range of duties (or useful in shaping recipients' role in the organization).

Horizontal communication, on the other hand, involves transfer of information between employees on the same level of organizational structure or between members of *ad hoc* task groups and project teams. Communication in this area typically places the emphasis on coordination of activities and distribution of duties among team members, reporting of partial results, as well as reporting and solving problems observed in the course of cooperation.

Another noteworthy division of communication areas is the distinction between direct and indirect communication as areas related to the context of the communication process. Direct communication entails personal contact between sender and recipient, in the form of conversations, discussions, meetings, councils, interviews, etc. [Szym04, p. 27], while indirect communication employs additional means of communication to facilitate such contact. The most important inconvenience of indirect communication is the propensity for delays and interferences which may have a negative effect on the quality of communication process. Similarly, direct communication is burdened with the inconvenience of forcing both parties to be present in the same frame of time and space. These barriers to communication present a great challenge for persons and departments responsible for human relations and communication processes in companies.

The role of mobile technologies in improving company internal communication processes

Company internal communication processes should be subject to continuous improvement, due to high dynamics of modern business environment, increased market competition and perfect market transparency in respect to activities undertaken by other economic entities. The above factors force companies to increase their staff flexibility and to respond promptly to changes in market environment. Growing competences of company personnel clearly support these trends, but they should be supplemented by communication and information technologies to eliminate or greatly reduce barriers to communication, particularly in the context of time and space constraints. New technologies offer vast selection of communication solutions, largely eliminating the problems of geographic distance and low quality of transmission. Modern IT systems make good use of intranet and corporate portals. Basic communication services, such as telephony and the Internet, are also used more effectively. However, company in-

ternal communication remains surprisingly resilient to mobile technologies, despite its vast potential of improving communication processes in companies. Mobile technologies offer companies more liberty in dealing with communication problems, by facilitating access to key information and improving contact with mobile staff. In effect, company decision-making capabilities and operational effectiveness are greatly improved. Companies operating under competitive pressure can use modern technologies to improve their flexibility in response to market changes. In fact, mobile technologies are reported to have a notable effect on company competitiveness [GuSS09, pp. 11-23]. It must be noted, however, that application of modern technologies (in this case – mobile technologies) in the context of outdated management processes can only have a detrimental effect upon company operation [HaCh96]. Therefore, upgrading of technological infrastructure should always be accompanied by organizational improvements.

Certain features of mobile technologies make them particularly useful in the process of improving company internal communication [KuŁy11]. These include:
- portability – reduced dimensions coupled with relatively high computing power,
- multifunctionality, multimediality and interactivity – combining several functions in one device offers cost reduction with increased functionality and business utility,
- globalization of communication – communication and information exchange are largely independent of geographic constrains,
- universality – rapid spread of technologies, coupled with rapid dissemination of new services among users, creates new standards of the trade,
- modality – potential for upgrading and adding new functionality through additional modules prolongs the lifetime of mobile devices.

Tackling the problem of adaptability of mobile technologies in the area of communication should be based on the principal observation that mobile devices are already gaining dominance in the sphere under study. The Office of Electronic Communications in Poland reports that mobile technologies are, by far, the most popular form of communication in companies – in 2011, employees of 73.2% of Polish companies under study used this technology on daily basis, compared to 56.3% of companies using fixed telephony and 48.4% reporting the use of e-mail communication. In addition, one in six companies (15.6%) used instant messaging and 7.2% reported the use of Internet/intranet VoIP communication [UKEl11].

Mobile technologies offer support for all areas of company internal communication (downward and upward vertical, as well as horizontal communication), and in many forms. The most universal technology at present – that of mobile telephony – can be used both in the form of voice communication and text messaging (SMS and multimedia MMS). Mobile Internet access from mobile devices can also add VoIP functionality to the list. Some modern mobile devices offer also videoconferencing capabilities via built-in front-facing camera. A new class of mobile devices – smartphones – powered by advanced mobile operating systems, create a modern communication environment through the use of multifunctional applets and clients, including communication software (Skype, mobile versions of popular social media).

Communication functionality can also be improved through the use of alphanumerical, two-dimensional QR codes (*Quick Response*). By scanning a QR code, mobile users can gain instant access to dedicated information resources. NFC technology (*Near Field Communication*) opens up the potential for exchanging information between mobile devices via proximity contact. Geolocalization technologies are another important feature of mobile devices, offering enhanced communication context through automatic recognition of geographic location of devices.

Mobile technologies are also an important element of large communication systems for companies (*Unified Communications*), i.e. solutions that integrate all available telecommunications channels to facilitate contact and cooperation between employees regardless of their physical location [Neti13]. OpenTouch Conversation app, available on iPad devices, is a good example of a Unified Communications solution for mobile devices, with support for the following functions [Alca12]:

- one client and a single interface for all functions: videoconferencing, telephony, VoIP, chat sessions, online presentations and document sharing,
- full support for transfer of active communications sessions between multiple devices,
- intuitive interface, divided into 3 main areas: *Conversation Wall* (history of interactions with support for initiating new contacts), *List of Favourities* (a dedicated area for placing key contacts and selecting forms of interaction with them), and *Stage* (where the current interaction takes place),
- easy access to corporate address list, with option to initiate contact with selected users,
- comments and *whiteboarding* (a shared noticeboard) for teamworking,

 – opening additional forms of communication during an active communication session,
 – redirecting and answering communication requests from other devices,
 – full management of user status and communication routing principles,
 – setting up ad-hoc conferencing sessions and populating the list of participants via drag-and-drop functionality,
 – unified e-mail client with full access to history and management of messages.

SnappComms suite is another example of a unified mobile communications solution for companies, with following functionality [PRWe12]:
 – emergency alerting – messages requiring prompt reaction are transmitted (pushed) to all devices associated with a given user until acknowledged,
 – full support for message confirmation and scheduled intervals,
 – scheduled transmission and automatic expiry of out-of-date messages based on user-defined criteria for easy filtering of relevant communication,
 – reporting of 'read' status per message,
 – gamification elements – quizzes, surveys, apps and video feed to mobile devices,
 – reporting of gamification results.

The above solutions significantly improve productivity of mobile employees by providing a broad spectrum of communication forms tailored to specific needs and contexts. Functionality of such solutions shows that communication processes in companies can be addressed in an integrated and effective manner.

Barriers to integration of mobile technologies
with company internal communication processes
and postulated remedies

Introduction of modern technologies in companies is but one of many elements that influence their effectiveness in the era of mobile communication. However, as attested by the practice of economic activities, mobile technologies are typically approached in the context of elementary, short-term utility, with no regard for their long-term benefits and the wide context of application. Companies often fall prey to 'technological trap' of upgrading technologies for the sake of novelty and instant appeal, concentrating on attractive look, functionality and accessibility of particular solutions, instead of focusing on unification of goals from the organizational viewpoint. Such approach bears a lot of problems, the most important being [Aror12]:

   – limited effectiveness of IT system redesign attempts addressed to mobile employees; time pressure, short attention span and other needs specific to mobile employees require a distinct design approach, much different from solutions tailored for office use,

   – ineffective use of resources, resulting from the tendency to produce mobile applications (or other mobile solutions) for each and every task at hand – even if such detailed solutions bring tangible improvement in terms of company effectiveness, the strain of design and implementation largely overshadows their potential benefits.

To sum up the above deliberations, it must be noted that the most viable approach in this context is to start with a precise analysis of objectives, followed by determination of best technological solutions to meet the required goals, as opposed to the common practice of introducing new technologies for every possible use, with no regard for measurable economic and organizational benefits of the change.

Thus, any initiative involving mobile technologies and their application in company internal communication processes should be preceded by careful analysis of the following aspects [Aror12]:

1. What business benefits are expected in relation to the change being introduced?

2. What is the principal objective of communication (informing employees, disseminating important task-related information, educating, promoting bilateral contact, providing instruments for effective organization of work schedule and tasks)?

3. What form of mobile technology is most suitable for the purpose defined above?

Another important element of the process of building mobile communication in companies is the analysis of current use of mobile technologies. This may take the form of an audit of opinions from all departments directly involved in design of company communication environment. Such an audit should address the following questions [Holt12]:

1. What forms of mobile communication are used for professional purposes by employees on all levels of company organization?

2. What forms and patterns of mobile communication are used by employees for individual purposes, outside the scope of their professional duties; is it possible to translate these behaviors into professional setting as means of improving company effectiveness?

3. Are the employees ready and willing to utilize mobile technologies for professional purposes, such as checking company news and information, and what factors influence their propensity to use mobile communication in professional context?

4. Are the employees aware of company tools, resources and policies in respect to the use of mobile technologies?

5. Are the employees ready to adopt and embrace new technologies? What can be done to improve their readiness and acceptance in this respect? What can be done to promote the use of new technologies on daily basis?

6. Are the employees willing to participate in design and development of mobile solutions?

7. What information should be passed on to other departments (safety measures)? Are the employees sufficiently informed on all matters related to intellectual property rights and responsible use of new technologies?

An audit of opinions, coupled with the aforementioned strategic approach and the focus on utility of mobile solutions, will provide good basis for proper design of internal communication processes in companies. In addition, the resultant decisions will satisfy the safety requirements and promote responsibility among employees – a particularly important aspect in the face of fierce competition and non-ethical practice of industrial intelligence.

Let us reiterate that even the most advanced instruments should be put in the proper context of communication strategy across company. The main focus should be on satisfying the principal objectives of communication processes. Any other tasks and objectives, such as the choice of particular functionalities, technologies or applications should be subordinated to the main strategic considerations. Only this approach will warrant economic benefit in long-term perspective.

Conclusion

Summing up the above deliberations, it must be noted that mobile communication based on the use of modern mobile technologies is an extremely important factor in design of company internal communication policy. On the one hand, it improves the relevance and topicality of the communicated content, by offering conditions for prompt reaction to current issues, problems and market opportunities. Moreover, proper design of mobile communication processes improves employee integration and involvement in company matters. To be effective, however, mobile technologies should be employed based on predefined objectives of intra-

organizational communication processes, and the area of internal communication should be subject to audit analysis to make sure that mobile solutions are integrated with company global strategy of business objectives.

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TECHNOLOGIE MOBILNE JAKO INFRASTRUKTURALNE WSPARCIE PROCESÓW KOMUNIKACJI WEWNĘTRZNEJ W PRZEDSIĘBIORSTWIE

Streszczenie

Czynniki wewnętrzne odgrywają coraz bardziej istotną rolę w kształtowaniu strategii biznesowych przez przedsiębiorstwa, dla których kluczowym obszarem skutecznego funkcjonowania na rynku staje się aktywna i wydajna komunikacja

wewnętrzna. W artykule podjęto próbę ukazania jednej z dróg doskonalenia procesów komunikacji wewnętrznej poprzez zastosowanie mechanizmów komunikacji zdalnej oraz geolokalizacji, możliwych do uzyskania dzięki wykorzystaniu technologii mobilnych.

W artykule przedstawiono naturę i znaczenie procesów komunikacji wewnętrznej, jak również scharakteryzowano podstawowe jej obszary. Następnie dokonano analizy wpływu technologii mobilnych na procesy komunikacji wewnętrznej i wskazano przykłady ich doskonalenia z wykorzystaniem omawianych technologii. Przedstawiono również bariery integracji technologii mobilnych i procesów komunikacji wewnętrznej, a także zaproponowano rozwiązania ukierunkowane na minimalizację tych barier.

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THE SEMANTIC WEB SPECIFICATIONS FOR DISTRIBUTED STORAGE OF GOVERNMENT DATA

Introduction

The information assets of the public sector can give opportunity to improve the maturity level of public functions, as well as improve the quality of services for citizens and businesses. For reuse of information resources is necessary to create the environment for storage in standardized forms and infrastructure for data access of end users and systems. Now most of assets published on the websites, applications, and databases are not suitable for usage in a machine-readable mode. On Russia example of the informatization of public sector on agency level can be realized by deferent application, agency can choice the type of application, technology by implementation information technology (IT) projects. The consequence of this is the data model is predetermined by business-logic of specific applications and technology.

At the regional level, where the region's authorities performed the identical function but have differences in the organizational structure and sets of the functions performed by individual business units, there is a significant technological inconsistencies that do not allow present the understandable picture on the next levels of the hierarchy.

Open data dictionary DCAT

The most services of public administration have cross-agency connections, different departments operate on the same objects, performed different operation. To perform the agile analysis of public data the government sector needs linked data, organization of data records so, that any object has unique identifier.

The usage of that tool can allow us to organize a binding transaction data about the object to one data set and improve the efficiency of information exchange.

The technological base of data binding is the URI (Uniform Resource Identifier): Identifies the resource, which will provide information about the term of the controlled vocabulary or object and assigned a URI. For each base object and can be determined by the URI based on http protocol. This means that user or application received data of the object with URI, he can see the description of the term or object by URI address. This data format allows understanding the semantic of these data for the user and the software agent.

For example, if some company has a unique URI it can allow us to obtain all actions of company life cycle: registration, shareholders decisions, licenses, manufactory equipment, market activity, financial reports. Publishing this data on the open data portal allows users to receive access by API. For the publication of open data W3C has certified dictionary Data Catalog Vocabulary (DCAT), designed to facilitate interoperability between published data catalogs (http://www.w3.org/ns/dcat #) DCAT. Publishing data by DCAT dictionary improve the search of data for software agents and use this data for multiple topics. This technology can allow create distributed data catalogs and implement the federation for search system.
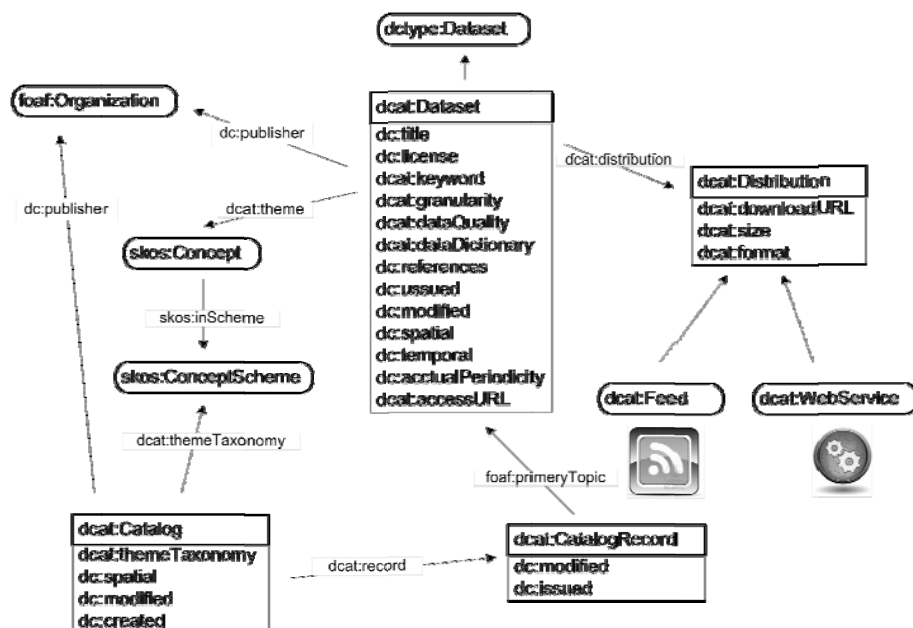
Fig. 1. Data Catalog Vocabulary
Source: [www4].

Vocabulary DCAT (Figure 1) include some terms from other vocabularies: Dublin Core (DC) (http://dublincore.org/documents/dcmi-terms/), and FOAF, SKOS (http://xmlns.com/ foaf/0.1/). New terms of vocabulary DCAT is the class Dataset (dcat: Dataset). This class include the records (class dcat:Record). The Datasets are described by classificatory in the terms vocabulary SKOS. The published open data give users free access to data without license. Access to the data is described by the class dcat: Disrtibution. Access can be provided through a subscription (dcat: Feed) or by a software interface (dcat: WebService).

A number of countries are active in the publication of open data: United States (http://data.gov), United Kingdom (http://data.gov.uk), European Union (http://lod2.eu). In January, 2013 the Government of Moscow presented the open data portal (http://data.mos.ru/). The preliminary stage of open data publication is creation of system for unique identification any base object in URI format. The UK Government, the United States performed a grate work to create standard identifiers for base entities such as schools and roads, public bodies and their functions, etc. This allow to any government agencies publish data about this objects at the federal level and at the level of cities, states, provinces, countries, etc.

The inter-agency and inter-layer information exchange

Publication of government data in open format cannot solve all problems in public sector information exchange. More important task is organizes the interoperability of government systems. One of the important areas of inter-agency and inter-layer interaction is the development of data models that are available to all interested participants. Creation and usage of standard data model will align the conceptual schema for data, including the reference data (e.g. uniform codes, identifiers, taxonomies, registers, geospatial data, licenses, etc.). Agreement on the data models will be an important step in the interoperability of information systems. Initiative for metadata management can help reduce the number of conflicts in semantic interoperability.

European Union initiative developed the theoretical models of the government data publication by standard namespace. This solution is presented as three models that describe the organization of information assets storage in repository, their metadata, and software for data access and processing (Figure 2). Interoperability of inter-agency interaction in case of ADMS is replaced by network of repositories that store information assets.
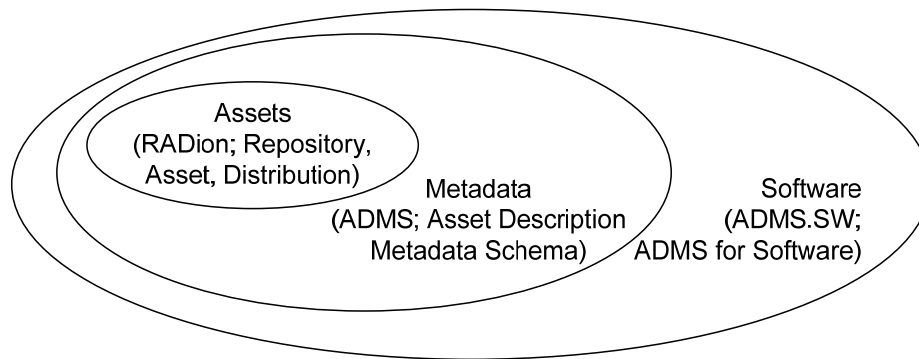
Fig. 2. The three-level models of ADMS
Source: Created by the author on base [www1].

For cross-agency connection is necessary to implement two types of models:
1. Organizational model that describes all the members of the community and their interactions.
2. The data model of the domain.

First group of models realized by RADion (Figure 3) and ADMS models. RADion describes the repository parameters that stores assets (Repository), own information assets (Assets) and distribution (Distribution).

The role of users is to manage the licenses (License: RADion), which allows for reading, editing, publication of assets. The implementation of e-Government services and information for administration involves different types of information assets: the base registries, domains, transactions, flow of documents, archival data. The management of information needs know all transaction of information asset. ADMS can provide this type of data about any asset publish in repository.
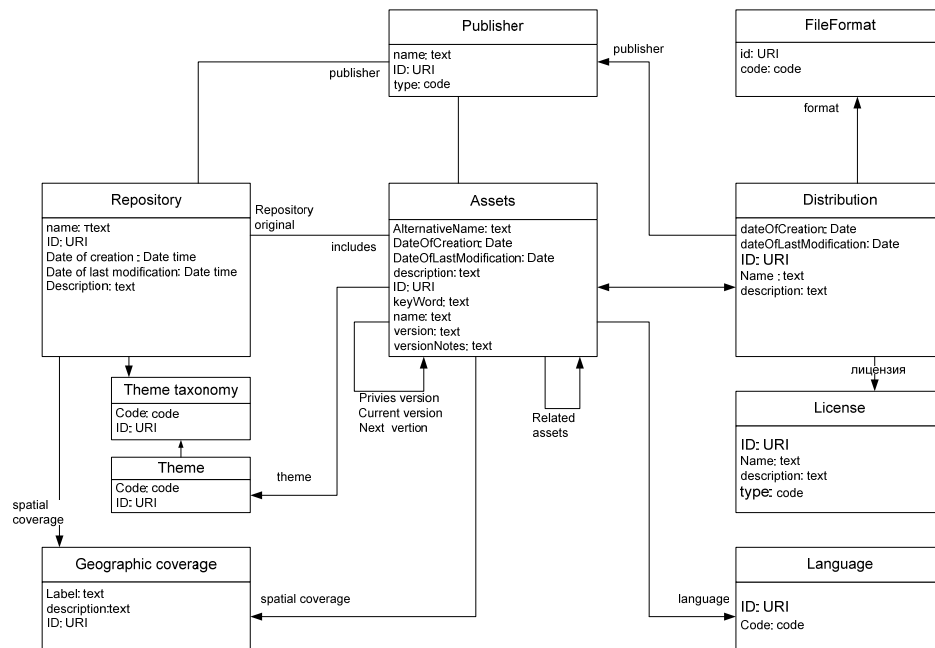
Fig. 3. RADion model for storage and distribution of information assets
Source: [www1].

Semantic of assets realized by the metadata model ADMS, where any information asset connected with detailed description: "The level of interaction", "Documentation", states the type of the asset, the period of time the relevance of asset performance technology and other positions.
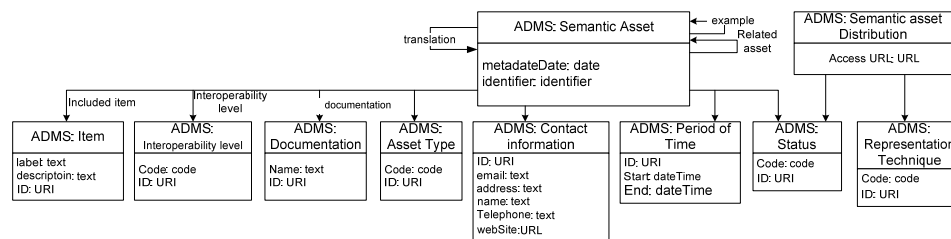
Fig. 4. Metadata description of information assets
Source: [www1].

The dictionaries of ADMS are published by SKOS specification. Now in SKOS format published six controlled vocabularies as components of the ADMS:

- the type of information asset, for example domain "model", "scheme", "taxonomy",
- the level of interoperability, for example "The legal interoperability", "organizational interoperability", "semantic interoperability" and "technical interoperability",
- license type: for example "attribution" BY, or "no derivative work" ND,
- type of publisher: for example "Company" and "public authority",
- format of presentation: for example "UML", "XML Schema", "Schematron", "OWL", etc.,
- status: for example "Completed", and "work in progress".

The technical aspects of interaction and the sharing the components and applications developed the third model: ADMS SW (ADMS SoftWare), which describes the technical parameters of information assets. Description of components made using the product classification Trove, project SourceForge.net. This system is used for the classification in software development projects. This model is attempt to create environment and technological infrastructure for providing information for the software development and distribution. Project experience with open source license shows that this approach allows for a high rate of development and regular modification of software. The development of a component work more efficiently in a format where any participant can take part in the development or revision of the components than the licensing of development. Enthusiasts and followers of the projects give a lot of time open libraries that allow the development of this area with greater efficiency than amply funded projects.

The dictionary for publishing open data DCAT, focused on providing access to citizens and businesses, while models in the ADMS were created for the interoperability of government systems, which is most important in the execution of administrative processes that are interagency by nature.

A set of RADion, ADMS, ADMS SW models are more focused on data integration, while the task of DCAT is the description of open data.

The ISA program along with a number of previous EU initiatives are aimed at increasing democratization of the society by improving the transparency of authorities and participation of citizens, on the one hand, and at creating a framework for implementation of pan-European electronic services and provision of information support for decision making, on the other.

Information or semantic interoperability closely related with data integration. The type of integration that are used in the corporate sector (ETL, Federation for RBD, SOA) [Gior11] do not always meet the needs of government, as the corporate sector is providing more opportunities to implement a rigid (strong) integration model. Such methods can be fruitfully used for e-services, but they will be of no use in the field of public administration information support.

If there is a good solution created for the integration type by a semantic web, it will be the universal solution. This method of integration has several advantages: It can be used to integrate all types of information assets, both structured and unstructured, while the majority of the methods used in the corporate sector are focused on the structured data integration.

Another positive aspect is that any user can determine the composition of the required data themselves. The data layer and data structure are accessible to the user, not hidden, unlike when they use the web service integration. In SOA, the user can receive the ready service and get a certain data set. Service parameters often not enough to get the needed dataset, so they have to turn to service providers. This generates a large number of services that turn into a hairball [ScLy10, p. 337].

It may be not that easy to create a complete picture using the semantic web as a method of data integration, which is provided by tight integration methods (normalization, integrity), but this is an opportunity to provide informational support to public administration officers, which will adhere to the "it is better to be approximately right, than precisely wrong" principle of management accounting of the corporate sector.

In this case the interoperability as a smooth interaction of information systems belonging to different departments is replaced by interaction with the repository, in which each member of the interagency processes publishes its information assets.

Implementation of electronic public services and the provision of administrative officers with information involve different types of information assets: Data of core registers, domain registers, transactions, document flow (interactions) and archival data. The sequence of transfer of individual assets to the repository is a matter of public information governance. ADMS makes it possible for departments to publish and register these assets properly.

Information sharing environment: data integration
of educational structures

New vocabularies are already being used in some areas: for example Eurostat liked statistical data [www8], the common information sharing environment for maritime domain [www9]. We have made some steps toward to create an environment of data exchange in education sector.

Education is the one main government services for many participants and categories of players of economic system. One of the problems of Education is to map the customer's expectations of a potential employer, company and the performance of educational institutions, on one side and the comparability of curricula in terms of structures, programmes and actual teaching for higher education institutions of the Bologna Process [www7], on other side.

The interaction of individual actors of Education need to create an environment to perform main steps: development, data integration, coordination, and the common concepts that meet the agreements of all categories of participants.

The aims of system interaction in the education sector to implement approach an expanding organization when information systems of all categories of participants are used to interact with government agencies, businesses, universities, alumni, to expand the scope of a single organization for the information and knowledge exchange. Such cooperation will help to raise the responsiveness of the educational environment and to coordinate the goals and activity of different organizations.
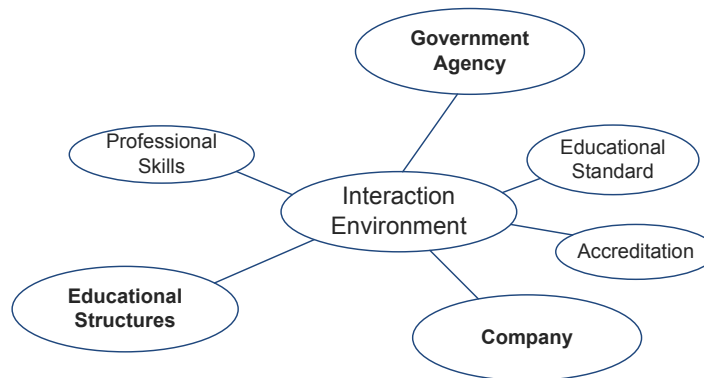
Fig. 5. Main classes of data in Education
Source: Created by the author.

Communication environment in the sector of education suggests the presence of such modules as:

1. Curriculum design for manage set of disciplines.
2. Syllabus engine in form of learning management system.
3. Competency management system as employers need and evaluation in terms of competences.
4. Competency development framework for different area, like [PMI07].

Now at the Economics Faculty of Moscow State University created the first two modules in the traditional relational model [www10], [www11]. We are working on the transition of these modules in the technology of semantic web. At the same time we are developing environment for permanent contacts on the basis of information technology with employer associations and government agencies.

One of the highlights of educational exchange data environment is the preparation of comparable syllabus of individual disciplines, the principle of what for some area will be worked out within the framework of the project Active Teaching Methods implemented by Economics Faculty of Moscow State University and University of Economics in Katowice.

Conclusion

Semantic web model are replacing an object-oriented paradigm as a method flexible sharing of information between participants. The relational technologies are suited for the data exchange within a controlled environment. In case of unknown number of participants, a variety of data and systems are needed are very simple methods of integration suitable for all participants. These technologies provide the semantic web, as approach is based on simple data organization scheme, universal for many domains. Using these schemes any participant can make information resources accessible to different users, automatically integrate into the global information space. These technologies are widely used to create multi-lingual online encyclopedia, social networks, intelligent search, creating the information space within the user community.

The new technologies for data exchange suppose two phases implementation in practice. The first phase is gain experience in the sector of open data. This area involves the development and adoption a set of technology standards. W3C with the European Union demonstrate progress in this direction, one example of which is the family of models ADMS.

The next phase involves the use of semantic web technologies for data integration within the community. The participants' interaction in this case is based on a data model of the domain. This model of information exchange makes it possible to build a semantically consistent expression by any operators.

One of the main subjects' areas for development the domain model is Education, which requires the environment for information exchange between companies, universities and government agencies. Creation the environment is a field for inter-university projects, with core in the universities as a place with the focused specialists, technology, stable relationships with other participants.

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SPECYFIKACJE SIECI SEMANTYCZNEJ DLA ROZPROSZONEGO PRZECHOWYWANIA DANYCH ADMINISTRACJI PUBLICZNEJ

Streszczenie

Efektywne wykorzystanie zasobów informacyjnych sektora publicznego może wpłynąć na wzrost jakości realizowanych usług i wykonywania powierzonych funkcji publicznych. Ponowne użycie zasobów informacyjnych sektora publicznego polega na wykorzystaniu organizacyjnych standardów przechowywania ich infrastrukturalnych rozwiązań w celu zapewniania dostępu użytkownikom końcowym do aktywów i systemów informatycznych.

Obecnie większość z tych witryn, aplikacji, baz danych nie jest dostępna w formie możliwej do zwyczajnego, zrozumiałego odczytania. Federalne i regionalne władze w Rosji samodzielnie określają wykorzystywane aplikacje, technologie informacyjne do ich tworzenia. Prowadzi to do tego, że modele danych aplikacji są z góry określane przez bizneslogikę funkcji automatyzujących. Jest to szczególnie istotny problem na poziomie regionalnym, ponieważ w każdym regionie organy władzy wykonują identyczne funkcje, ale z powodu różnic struktur organizacyjnych, przydziału obowiązków regionalne rozwiązania technologiczne nie są zintegrowane z innym poziomem w hierarchii. W artykule omówiono format przechowywania państwowych danych na poziomie federalnym i regionalnym.

Praktyczne zastosowanie omówionych standardów przedstawiono na przykładzie sektora edukacji. Wymiana informacji w tym sektorze ma kluczowe znaczenie przy określaniu współdziałania (interoperacyjności) pomiędzy pracodawcami, instytucjami edukacyjnymi i agencjami rządowymi. Wiodąca rola w tworzeniu środowiska dla wymiany informacji sektora edukacji powinna być przynależna uczelniom, gdzie znajdują się eksperci przedmiotowych dziedzin, technologie, istnieją silne powiązania z innymi członkami wspólnoty edukacyjnej.

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University of Economics in Katowice

SOCIAL RECRUITING – THE USE OF SOCIAL NETWORKS IN THE RECRUITING PROCESS

> *If content is king, then conversion is queen.*
>
> John Munsell, CEO of Bizzuka

Introduction

At the times of highly dynamic changes inside an organisation as well as in its surroundings, it is necessary to have the right human resources policy in place. Through candidate selection, staff development, motivation and provision of support to employees to help them enhance such skills as creativity, open-mindedness and flexibility, an organisation is able to work effectively and achieve its objectives.

Nowadays the traditional method of recruitment has been revolutionised by the influence of the Internet. A fast-growing number of users, convenience offered by social networking services and an increasing awareness of advantages that may be gained by using social media tools contribute to an abrupt growth of companies which communicate via such services on a regular basis. This also concerns their staff recruitment processes. Social networking, including sites like Facebook, MySpace, Twitter etc., is beginning to transform candidate recruiting. It is opening new doors for employers and job seekers to connect in a way not possible before.

A social recruiting strategy needs to be part of the company's overall goals and objectives to deliver a true return on investment (ROI). It must complement its other recruiting programs. The main focus of the article is to present and analyse the possibilities offered by social media to support the recruiting process. The research is based on LinkedIn.

Essence of the Recruitment Process

The basic tool which is expected to lead to the target vision of human resources in an organisation is a human resources strategy. This is a model, long-term concept outlining the types and methods of staff-related activities to be carried out. The activities undertaken within the HR function affect the way in which a company sources its staff, develops and motivates them and, ultimately, terminates employment. The staff management structure is presented in Figure 1.
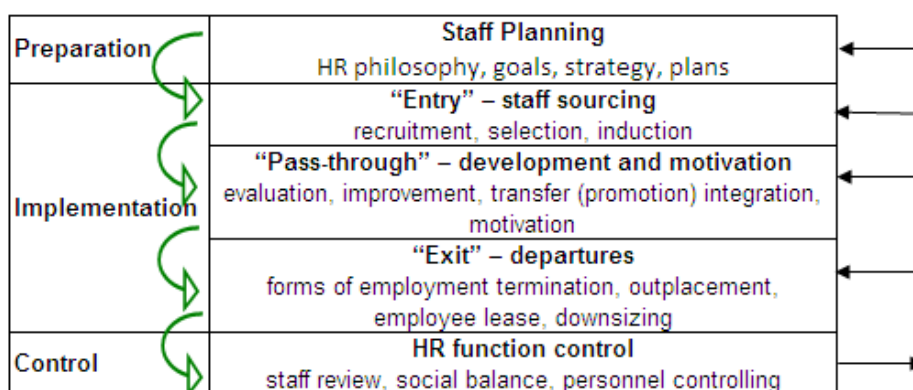
Fig. 1. Human Resources Management – stages and components
Source: [LiKo00].

The process of ensuring staff for an organisation and placing them on appropriate positions is called staff sourcing. The aim of staff sourcing is to hire the right number of people with required qualifications and at the right time so that the organisation can operate continuously and effectively. Successful sourcing is determined by endogenous factors (needs identification, job descriptions, qualification standards, job profiles) and exogenous factors (market opportunities to meet the needs) [Bien06].

Staff sourcing comprises three key stages: recruitment, selection and induction. Figure 2 presents the stages and the flow of a staff sourcing process.

The aim of recruitment is to collect a pool of candidates from whom selection can be made and with whom vacancies can be filled. Two issues are important here – sources and forms of recruitment. Sources of candidates may be external (in particular, a labour market) and internal ones. Recruitment involves finding prospective employees by placing job advertisements in media, e.g. in the press,
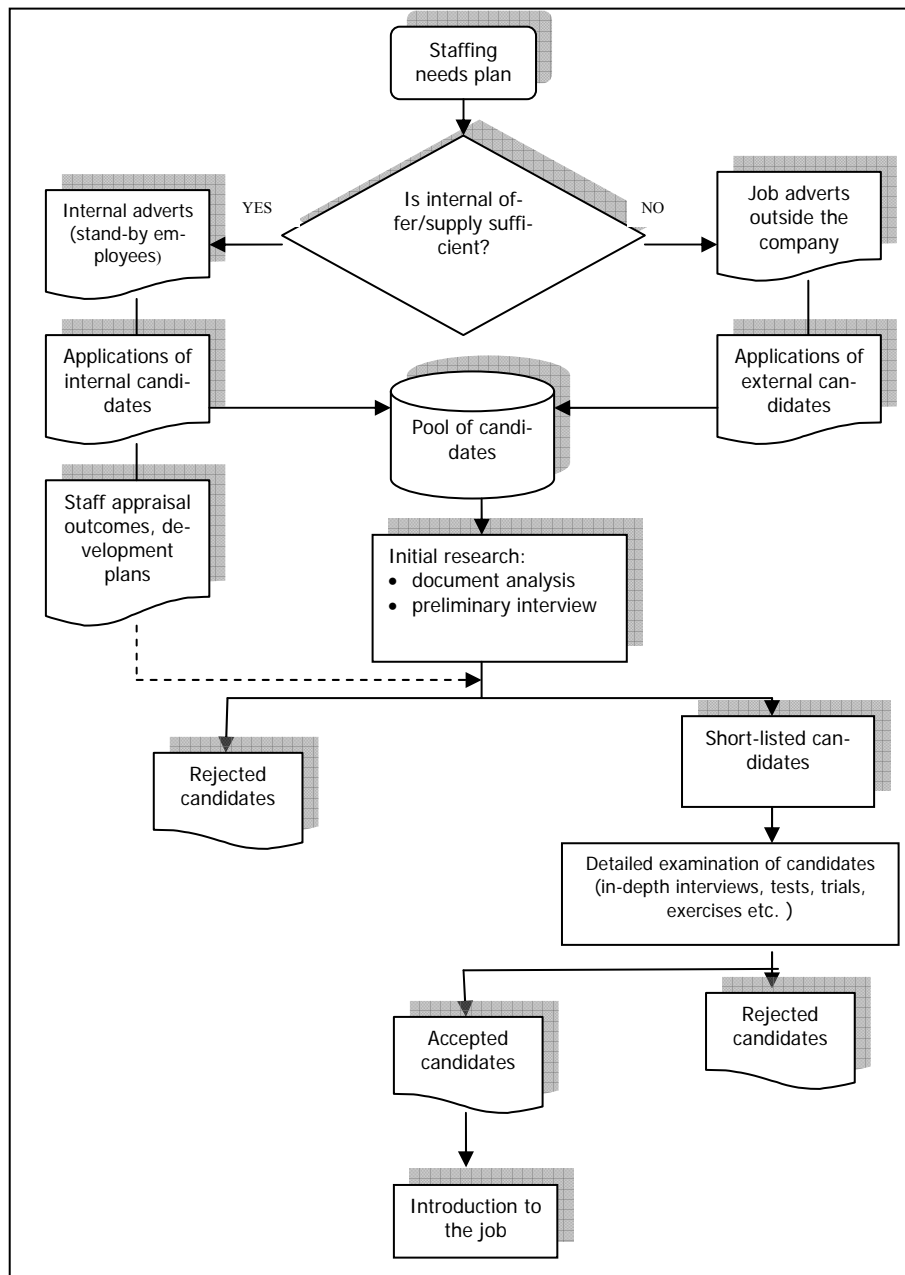
Fig. 2. Staff sourcing process
Source: [LiKo00].

Fig. 3. A selected job offer description
Source: Based on own sources.

Fig. 4. Information about current job offers received by e-mail
Source: Based on own sources.

on the Internet – creation of profiles by recruiters in social networking services, contacts with schools, recruitment agencies, participation in job fairs, use of HR consultancy and selection services, i.e. so-called head-hunters, etc. In such activities, it is vital to ensure that an employer's expectations and specific job conditions are communicated reliably (Figure 3). Such an approach may also be regarded as pre-selection (self-selection) of candidates for jobs.

At the times of e-commerce and an increasing role of social media, numerous companies decide to use recruiters to carry out staff sourcing for them. Such decisions are motivated by the following reasons:

- convenience of social networking services,
- increasing awareness of advantages which may be gained through social media tools,
- a possibility to update job offers depending on vacancies available (Figure 4),
- access to potential employees – the data shows that 75% of internet users have their own profiles in at least one social networking service which they regularly visit and update their personal information,
- job instability and related difficulties in predicting the need to look for new employment,
- easy tracking of attractive job offers, by following up on recruiters' profiles.

These reasons are also confirmed by the statistics. Figure 5, for instance, shows the selected statistics on LinkedIn.

LinkedIn has exceeded the barrier of 200 million users. The service is used by citizens of over 200 countries all over the world and it is available in 19 language versions. The biggest group of LinkedIn users are Americans (74 million). Currently, the popularity of this service is growing most rapidly in such countries as Turkey, Columbia and Indonesia. The fastest increase in the number of mobile users, however, has been reported in China, Brazil and Portugal. Every day almost 175,000 new users are added to the LinkedIn base, which makes over 5 million a month. The industry with the biggest representation there is broadly understood IT (4 million users). It is followed by financial services experts and scientific staff [www10].
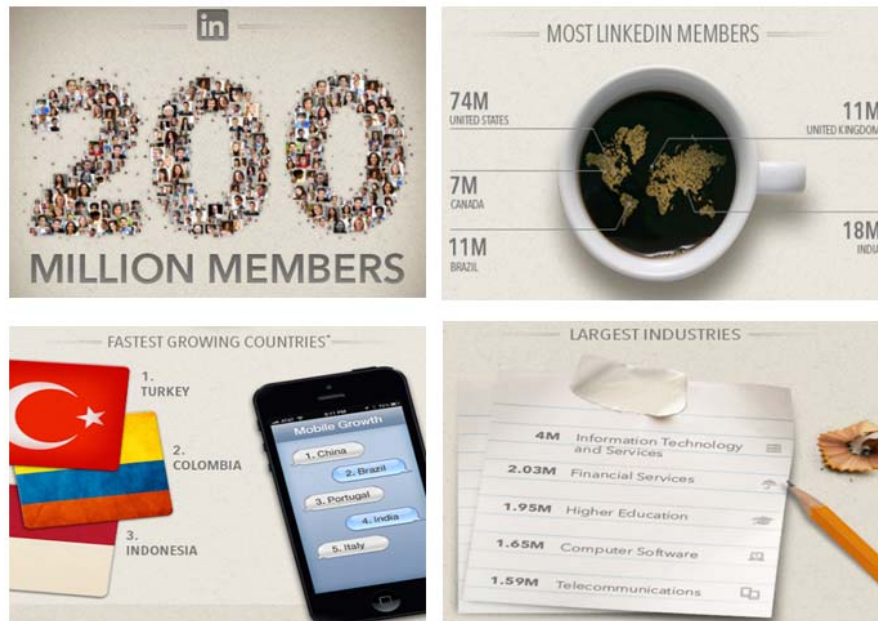
Fig. 5. Information about LinkedIn members
Source: [www10].

E-Recruiting and Social Media Recruiting

Recruitment is a process of finding and attracting capable applicants for employment. E-recruiting is the use of internet technology to attract candidates and aid the recruitment process. This usually means using one's own company website, a third-party job site or job board, a CV database, social media or search engine marketing. Social Media recruiting (social recruiting) is the part of e-recruiting.

The growth of social media makes recruiters change their perceptions of methods and practical ways of looking for new candidates for jobs. Traditional CVs sent by snail mail, faxed or attached to emails are now giving ground to social media recruiting. Social networks offer a powerful tool for recruiters to reach a pool of qualified candidates that they might not otherwise be able to reach. Instead of merely searching for passive candidates via search engine, it uses blogs, RSS, tagging, social networking, multimedia and community interaction.

Internet users are quick and eager to take advantage of social networking services because [www2]:

– media presence may help them to find jobs – in some professions a virtual dossier may turn out to be a prerequisite to prove their track record and skills,

– contacts given in social networking services may help them to acquire valuable knowledge (e.g. by sharing experiences), get the answers to their questions or assistance in looking for solutions to their problems,

– these services are a precious source of knowledge about potential employers when preparing to job interviews (fan pages, micro-blogs, topic-related forums),

– information found online helps them to create their own image of an organisation's business culture, etc.

Figure 6 presents activities conducted by employees in social networking services.
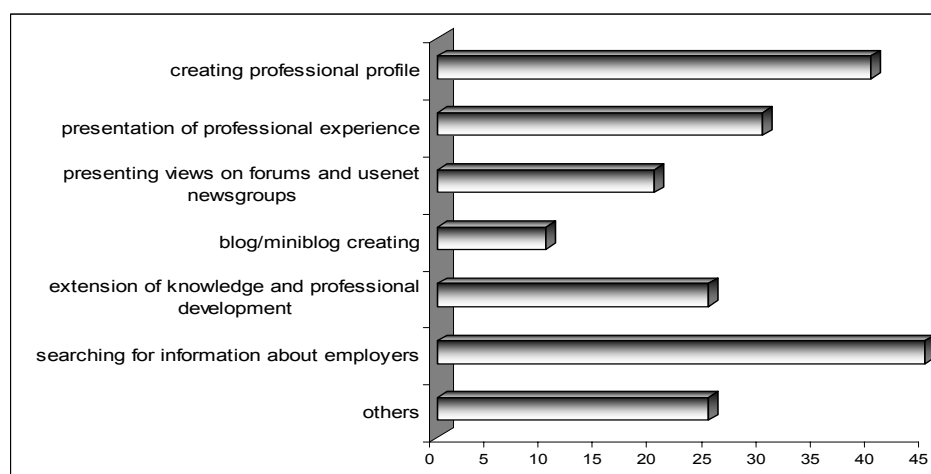
Fig. 6. Employees' activities in social networking
Source: [www3].

An interesting solution is the creation of groups which gather experts from various industries and countries, e.g. "Jobs in Poland –JOBS.PL". This is a networking group for posting job vacancies moderated by JOBS.PL. It encourages networking between job seekers, employers and recruiters. Poles and expats interested in Polish career opportunities are invited. The Group features as an RSS feed in News, jobs posted on the www.jobs.pl job portal. Any person or group that abuses the JOBS.PL LinkedIn group may not be admitted and may be re-

moved. The language of the group is both English and Polish with a preference, if possible, for English so all can understand and follow discussions. The group is managed in strict accordance with the rules established by LinkedIn as well as additional Linked: Group rules for the benefit of the Members as a whole [www11].

Social recruiting focuses on creating and involving communities formed by people who are interested in specific employers and use networks for recruitment purposes [www5]. The examples of such activities may include dedicated corporate applications placed on various platforms or social career networking sites [www11], which offer multi-step tests, games and training in order to select the best candidates. The most common form, however, is having a career profile in selected social networking services, such as Facebook, LinkedIn, Goldenline or Twitter.

Social media provide an attractive environment for employees, who have an opportunity to present themselves, and employers, who look for best candidates to recruit for specialist roles, revise and complete data on candidates who have submitted their CVs. The research findings show that 40% of employers check their potential candidates in social networking services [www2]. User profiles on business sites such as LinkedIn, GoldenLine or Profeo, may be treated as, better or worse, virtual resumes, the overriding aim of which is to draw a prospective employer's attention to a given person. In addition, SM help candidates to better prepare to job interviews they are going to attend. Corporate fan pages and micro-blogs run by companies' representatives help candidates to collect and review information about would-be employers.

Employees and candidates are the supply side of the labour market. According to the research, social media are mostly used by professionals (29%), the unemployed (27%) and line workers (22%) [www3]. They can easily follow what is going on in the labour market, by watching or 'liking' specific companies, getting access to current job openings, without the need to send any CVs. Such behavior tends to be perceived as a lack of loyalty towards their current employers. This is confirmed by the research findings, which show that as many as 62% of respondents continue to look for jobs although only part of them are not active on the labour market.

Planned participation in social media provides an opportunity to present one's competences. When creating a professional profile, a candidate should try to present all his or her professional experience gained so far and a list of responsibilities they have dealt with, so that it can catch the eye of an employer looking for a candidate to fill a specific vacant position. It is advisable to include

completed training sessions or currently performed projects. One may also place there scanned copies or descriptions of certificates which confirm the acquired competences and skills. Figure 7 shows a view of a LinkedIn profile.
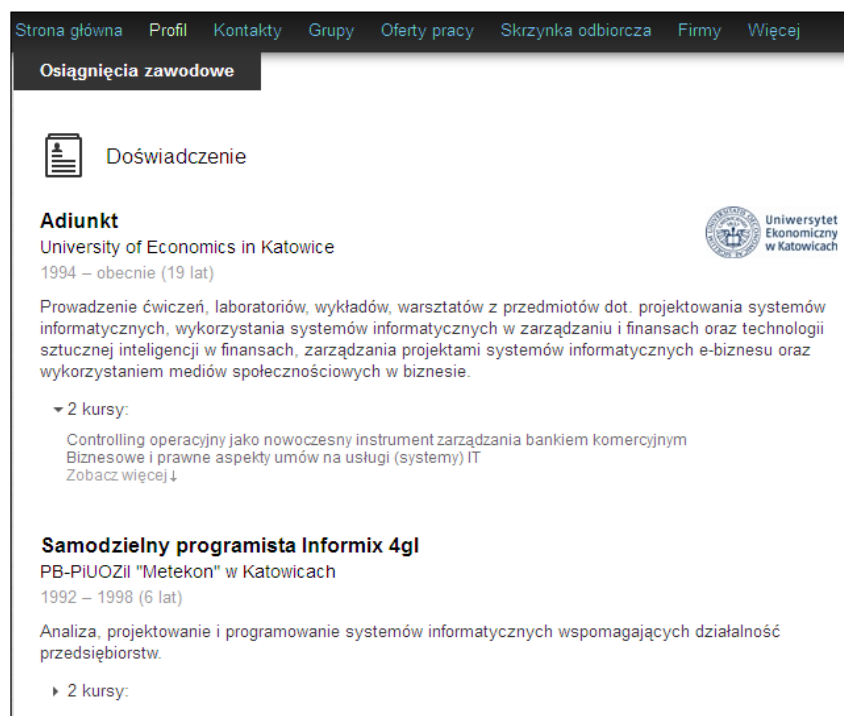
Fig. 7. View of a personalised profile in LinkedIn
Source: Based on own sources.

Social Recruiting may be conducted by means of [www5]:
– personalised job offers which act as advertisements displayed only to people who meet specific criteria (Figure 8),
– advanced candidate search engine,
– selective mailing,
– topic-based groups.
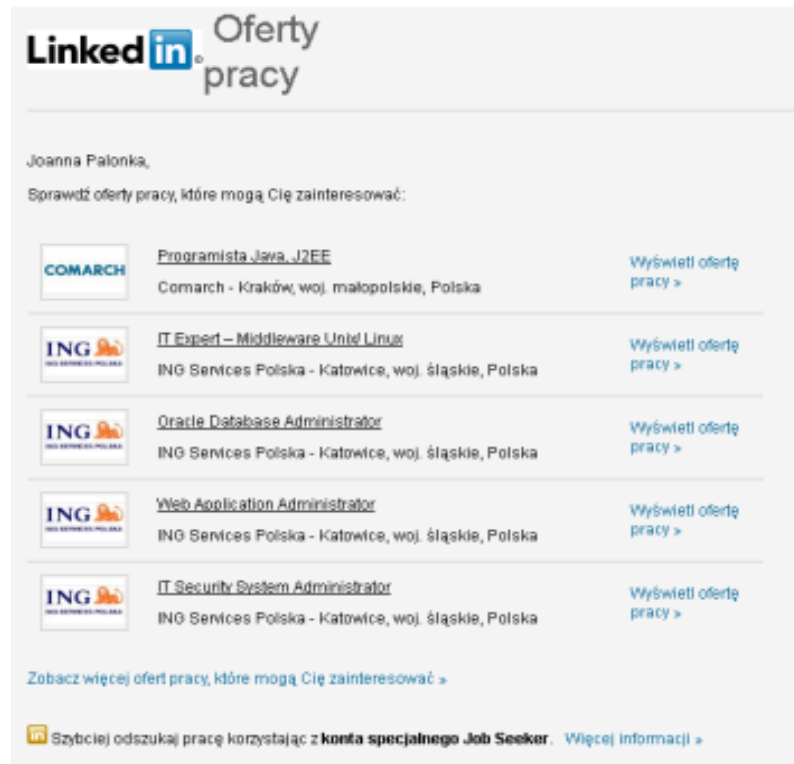
Fig. 8. Job offers for registered users
Source: Based on own sources.

An effective use of social websites in recruitment requires a coherent strategy to be devised and a set of success rate measurements to be identified. To that end, the following steps need to be taken [www8]:

1. Find out what a company wants to achieve by using social media. Does it want to raise awareness of the employer's brand, increase the number of potential candidates visiting its corporate career site or change the medium user's status from a candidate to a present employee?

2. Identify groups of potential candidates. What candidates would a company like to attract: professionals or students and graduates? Does it want to create a community of future candidates or just to find the people to appoint to specific positions as quickly as possible?

3. Direct potential candidates to one key source of information about a company. Employers tend to have career profiles on many sites which, on one hand, allows them to reach a bigger group of potential recipients but, on the other hand, may lead to confusion and a lower ROI. It is important to

have a special career website which could display information about the company, their business culture, currently available job offers and enable communication with candidates. Links to this websites should be placed in all the media and vice versa – it should be possible to go to the other tools immediately.

4. Involve people responsible for recruitment in social media. It would make their message more credible and a candidate could get an exact answer to his or her question.

The role of social media as a source of knowledge about candidates in the recruiting process is growing quickly. Also internet users' awareness of the importance of content given on social networking sites or any other 'traces' left by them on the web should grow at a similar rate. Job seekers need to take a good care of their online images, paying special attention to the content they place there as it may be seen by potential employers. This content may either help or prevent them from finding jobs.

Traditional Recruiting vs. Social Recruiting

A number of reasons may be given to explain why recruiters are eager to shift from traditional recruitment methods to social recruiting. These reasons include, e.g. [www7]:

1. An opportunity to get to know a candidate better – a traditional CV is usually limited to mere facts presented under specific headings. Recruiters, however, prefer to get to know a real person by watching videos, reading posts on blogs, following links and comments placed by the candidate.

2. More room for a candidate's creativity – a traditional CV or a letter of application do not allow a candidate to fully present his or her creativity. A network offers such an opportunity. Applicants may, for instance, build their own websites which may act as their business cards, record videos or create their CVs in Pinterest.

3. A three-dimensional picture of a candidate – in traditional recruitment a recruiter's perception of a candidate, having read his or her CV, often fails to fit their real image. A big number of valuable candidates happen to be rejected due to e.g. poorly structured CVs, and people who are requested to attend job interviews should not have been invited. A CV may look interesting but in reality a candidate may be unable to

talk about any previous professional experience or may have problems in social interactions. An opportunity to see the candidate's actions online allows recruiters to see a complete picture of a candidate as a person and his or her way of communicating with others.

4. Highly valued knowledge of social media – nowadays an increasing number of career choices require online presence. Marketers, journalists, graphic designers, IT and HR specialists, because of their professions, have to know how to move smoothly in the world of online communities. Recruiters assume that anyone capable of handling technology innovations should also be able to do well at work.

Social media should not be used as a replacement for traditional recruitment strategy, but rather as an extension and enhancement. A company has to recognize the potential for social recruiting.

Social Recruiting Benefits

Social media are becoming an important tool in recruitment of future employees for companies. They offer an easy and simple access to appropriate people at a low cost. Using social media recruiting requires time and effort, but it's an investment in long-term benefits for the company. The most important benefits are [Orac12], [www6]:

–   wider access and geographical spread – anyone from anywhere can apply for an advertised job; social media allow for immediate real-time interaction and 24x7 job search activity,

–   increased job visibility – with hundreds of millions of people on Faceook, Twitter or LindkedIn, using social networking platforms for recruiting will ensure that job offers will be seen and read by a larger number of qualified candidates,

–   better candidate quality – individuals who frequently use social media tend to be "early adopters" of innovations and also tend to be more tech-savvy; these kinds of candidates are more loyal fans that can become loyal employees,

–   finding hard-to-reach candidates – social media offer the ability to reach out to passive or hard-to-find candidates that likely couldn't be reached using other sources,

–   better ROI – posting and sharing job openings through social media is more likely to deliver results than a single description on a job board,

so using social media in recruiting results in better ROI than that of traditional recruiting as the benefits far exceed its cost,

– competitive advantage – using social networks gives recruiters a competitive advantage over other talent competitors who aren't using social media recruiting.

Summary

E-recruiting offers recruiters powerful and cost-effective ways to recruit staff for an organisation. It is the use of internet technology to attract and source candidates and aid the recruitment process. Now many organisations are establishing a presence beyond their homepages and are utilising social networking sites to recruit talent.

Today social media are visited not just to look for information, entertainment or acquaintances but also to look for jobs. In 2011, 80% of employers used social media and social networking services for recruitment purposes. The most effective social networking site was LindkedIn (94.5%). In comparison, Facebook was used by 24.2% and Twitter by 15.9% of respondents [www4].

For example, LinkedIn helps to find and to engage the best passive talent. It is flat out the best sourcing/networking/recruiting tool period [www9]. LinkedIn Recruiter allows users to:

1. Expand reach – with the most powerful search available on LinkedIn, expand searches beyond personal connections to access the entire LinkedIn network. Master even the toughest searches with powerful filters that help zero in on ideal candidates immediately.

2. Contact anyone – contact candidates through InMail® – LinkedIn's trusted messaging environment. Work more efficiently with InMail message templates and one to many InMails. Get higher response rates than cold calling and email.

3. Manage own pipeline – build, track and manage talent which we want to hire now or in the future with folders, reminders and smart to do lists. Synchronize team activities with shared projects, searches, profiles, and candidate notes.

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SOCIAL RECRUITING – WYKORZYSTANIE MEDIÓW SPOŁECZNOŚCIOWYCH W PROCESIE REKRUTACJI PRACOWNIKÓW

Streszczenie

W warunkach dużej dynamiki zmian w otoczeniu i wewnątrz organizacji konieczne jest właściwe prowadzenie polityki personalnej. Dobór, rozwój kadr, motywowanie i wykształcenie w pracownikach takich cech, jak kreatywność, otwartość i elastyczność, pozwalają organizacji sprawnie funkcjonować i osiągać zamierzone cele.

Dynamicznie rosnąca liczba użytkowników, wygoda korzystania z portali społecznościowych i coraz większa świadomość korzyści, jakie firma może uzyskać, stosując narzędzia social media, przyczyniają się do poprawy regularnej komunikacji za ich pośrednictwem. Dotyczy to także działań w zakresie rekrutacji pracowników. Media społecznościowe, takie jak Facebook, MySpace, Twittter, LinkedIn itd., zmieniają dzisiaj sposób rekrutowania pracowników i otwierają przed rekruterami zupełnie nowe możliwości.

Strategia rekrutacji z wykorzystaniem mediów społecznościowych powinna być elementem ogólnej strategii firmy. Musi być także zgodna z innymi działaniami rekrutacyjnymi. Celem artykułu jest analiza możliwości wykorzystania mediów społecznościowych do wspomagania procesu rekrutacji pracowników. Badania przeprowadzono na podstawie serwisu LinkedIn.

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CREATIVITY AS THE FOUNDATION OF CONTEXTUAL APPROACH FOR ENTERPRISE ARCHITECTURE DESIGN

Introduction

Organizational research is now characterized by widening boundaries, a multiparadigmatic profile, and methodological inventiveness. Choice of research methods relies not only on research aims and epistemological stance, but also on organizational, historical, political, evidential and personal factors, which are not problems to be solved, but factors to be included in practical research design. The article aims to present that context and creativity are important for corporate architecture development and that creativity development is supported by including context in the enterprise architecture (EA) model. The first part of the article covers explanation of what creativity and context mean for organizational development. The second part includes discussion on creativity in corporate architecture modelling by example of Zachman Framework (ZF).

Literature survey on context

Contextualizing methods choice for research and development has some implications. It is difficult to sustain a model of research as neutral observer. Even the selection of an underpinning paradigm is a politically inspired act, not merely an intellectually informed choice, as this can involve an implicit alignment with particular stakeholders' interest, overlooking or marginalizing issues that may be even more important to others [BuBr09]. The user's information needs are not satisfied by a single ideal set of documented requirements, but also by the analyses of the context of information searching and computing. Context is an all-encompassing term. In practice, context must be defined in relation to a purpose.

The context of use denotes the run-time situation that describes the current conditions of information system use. The target defines a situation of use by the designers during the development process of the system. Context is defined by Rusell-Rose and Tate as where you are, who you are with, and what resources are nearby [RuRT13]. Generally, context is perceived as a user-oriented phenomenon that is focused more on users' immediate surroundings than on their inner state. The framework for context consists of five key elements:

- any goals, tasks, actions or activities associated with what the user is doing,
- space, location, and time,
- user's physiological conditions, mental state and preferences,
- user's role, status, and relationships with other individuals,
- environmental factors including temperature, light, humidity and the information and material resources accessed by the user [RuRT13].

For Robinson et al. context means any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction between a user and an application, including the users and applications themselves [RoVW05]. Context plays an important role in reasoning domains, such as decision making, understanding, interpretation, diagnosis. These activities rely heavily on a background or experience that is generally not made explicit, but gives an enriched dimension to the reasoning and the reasoning knowledge. Context acts more on the relationships between the items in focus than on the items themselves [BrBr08]. A context is always relative to another context. Context has an infinite dimension and cannot be described completely.

Contextual information can be objective or subjective. Objective contextual information is based on an agreed-upon standard, by which the context value (such as GPS signals) is measured. By contrast, subjective contextual information requires reasoning, on either the part of the searcher or the system to gain value. Such information include mood, experience, information literacy, or domain knowledge [RuRT13]. Contextual information may be individual or group-based. The utilizing of contextual information aims at improving performance or ease of use for individual information technology (IT) users. Contextual information can be meaningful or incidental. Meaningful context can be defined by contextual information that directly affects how a task is performed and the task results are interpreted. Incidental context is contextual information as a part of a situation, but does not affect how a task will be carried out. Contextual information may also be extrinsic or intrinsic. Intrinsic contextual information concerns document language or type, but extrinsic contextual information concerns popularity of docu-

ments. The effects of contextual information may be visible or invisible. Visibility is the degree to which a system captures, uses and communicates contextual information to the users. Hiding the use of contextual information can reduce the cognitive load on users, making the decision processes simpler and quicker. For Holtzblatt et al., context means getting as close to the real work as possible by going to the users wherever they work and interviewing them while they are doing it [HBWW05]. The context of use can incorporate any real world aspect of interest, such as the user, the software-hardware environment, the physical and ambient environment, the socio-organizational environment. Therefore, lately the context awareness has received acceptance by information system developers, The context-aware applications refer to the ability of computing devices to detect, sense, interpret and respond to aspects of a user's local environment and the computing devices themselves [SeJa04]. Context-aware user interface development means tailoring and optimizing of the interface according to the context in which it is used. The use of a consumer's or user's context improves the information system experience and is offering more customized content, so it may remove the need to manually provide additional information [Ask012]. The evolution of the use of context has been developed in the following stages:

– access to the information straight forwarded on smartphones with the user's permission – primarily for location,
– layering in intelligence, to enable the organizations to know if a customer is in their store, or in a competitor's store,
– breaking from personal computer contexts and the merging of the information and physical worlds to deliver an entirely new innovative services,
– embracing motion as a control mechanism, for instance, phones can be controlled with motion today [Ask012].

Nowadays, the context-aware pervasive applications include context-aware mobile services, context-aware devices, appliances, smart things, the integration of context-aware computing with software agents and the Web, the use of context awareness for addressing, and communication between people, devices and software agents, context-aware controlled sensor networks and security frameworks [Loke07]. Context awareness enables the system to take action automatically, reducing the burden of excessive user involvement and providing proactive intelligent assistance.

Mintzberg has recognized that managing is a practice learnt through experience, and rooted in context. Particularly, the tacit knowledge is hidden in organizational context [Mint09]. The tacit knowledge is not easily accessible and is hidden beyond the practice of the job, through apprenticeship, mentorship and di-

rect experience, which as all form the context. Flexible security models are developed and the security levels can be increased or decreased not just based on the identities of people, but on the situation which they are currently in. Context-based security supports the reconfiguration of the security infrastructure according to the situation of use [Loke07]. Context is therefore the knowledge that supports the reliable derivation of meaning in an environment [RoVW05].

The influence of context on creativity

The influence of context can be seen as adjustment for privacy, trust and security in the sense that context information determines how much information could be revealed and to what degree the entities will be trusted. The influence of context shows the need for defining the interfaces, for instance in the domain of pervasive computing. Context contributes to the meaning that people assign to communication. The same data exchanged can mean something completely different in two different contexts. Information about the context, in which human beings' interactions take place can reveal sensitive information about the parties interacting, about their preferences, their goals, and the relations among them [RoVW05]. Creativity is an important consideration for context-aware systems, because an individual's context contains a large amount of personal information. The creative activities always involve change, new ideas, innovation and a certain discomfort of lack of stability. Generally, a certain amount of motivation is needed to make people operate actively. The contextual motivation is perceived as problematic because of consequences and side effects that are unexpected for someone outside the system and often too complex to be foreseen [Appe11]. Creativity is associated with a certain disregard for rules and structures. Creative practitioners are strategic thinkers, planning and making choices and evaluating and positioning themselves and their work according to a range of external and internal parameters. Creativity by Amabile is defined as a function of three components, i.e. expertise, creative-thinking skills and motivation [Amab83]. Organizational creativity can be stimulated, if the business unit is managed in such a way that employees are encouraged to generate and implement ideas for the overall good of the organization. The business organization managing the creativity should tolerate diversity, complexity and contradiction [BiCu10]. They benefit from a combination of different types of thinking and the creativity is embedded in a cultural context of the organizations. Human creativity may be classified into three categories known as the abstract (scientific), concrete (engineered) and art

creativities [Wang11]. According to Goguen [Gogu96] there are two dominant theoretical perspectives within human-computer interaction: the cognitive (cognitive science and experimental psychology) and the postcognitive (sociology and anthropology). Cognitive approaches to task analysis focus on aspects of user performance and their experiences. Postcognitive, or ecological approaches underscore the importance of context in evaluating human praxis. Postcognitive approaches focus on meaningful interaction from careful consideration of the environmental, sociocultural and historical contexts in which an activity occurs.

Context and creativity in enterprise architecture modelling

Creativity can be understood as a confluence of three factors: a domain that consists of a set of rules and practices; an individual who makes a novel variation in the contents of the domain and a field that consists of experts who decide which novel variation is worth further implementation. Creativity is a process to find a solution that is both novel and useful. However, problem solving often deals with issues for a certain goal with unknown paths and different scenarios' opportunities. There are five stages in a creative process, i.e. preparation, incubation, insight, evaluation and elaboration [Wang11]. The EA modelling process demands such a creative approach and provides a holistic expression of the enterprise's strategies and their impact on business functions and processes, taking into account the modern IT solutions. The EA methods help the firm to establish technical guidelines of how the service delivery function needs to operate to deliver cost-effective, flexible and reliable business services. The EA approach is to ensure the comprehensive understanding of the current state of IT in a business organization, the desired state, or the interrelationships of processes, people and technology affected by IT projects. Eventually, the organizations will have a bigger consistency of business processes and information across business units. The EA identifies opportunities for integration and reuse of IT resources and prevents the development of inconsistent processes and information. By understanding an organization's data architecture, there is a possibility to develop a standard data dictionary and metadata standard to minimize data inconsistency. Finally, the EA modelling ensures traceability between business processes, data, user roles, applications and IT infrastructure. Therefore, the EA involves additional domains such as business architecture, process architecture, data architecture, software application architecture and infrastructure architecture. The EA is a creative application of scientific principles to develop enterprise and its information systems. Cogni-

tive foundations of creativity are analyzed on fields such as the space of creativity, the approaches to creativity, the relationships of creation and problem solving, and the attributes of creative researchers. The cognitive process of creation is visible in the Zachman Framework (ZF), which provides a semiformal explanation of human creativity on different levels of business organization. The ZF provides a basic structure for organizing business architecture through dimensions such as data, function, network, people, time and motivation [Zach10]. Zachman describes the ontology for the creation of EA through negotiations among several actors. Each of the actor is working in his/her individual context. The ZF presents various views and aspects of the enterprise architecture in a highly structured and clear-cut form. It differentiates between the levels: Scope (contextual, planner view), Enterprise Model (conceptual, owner view), System Model (logical, designer view), Technology Model (physical, builder model), Detailed Representation (out-of-context, subcontractor), and Functioning Enterprise (user view). Each of these views is presented as a row in the matrix (see Table 1). The lower the row, the greater the degree of detail of the level represented. The model works with six aspects of the enterprise architecture: Data (what?), Function (how?), Network (where?), People (who?), Time (when?), motivation (why?). Each view (i.e. column) interrogates the architecture from a particular perspective. Taken together, all the views create a complete picture of the enterprise.

Table 1

The Zachman Enterprise Architecture Framework

Perspectives	DATA What?	FUNCTION How?	NETWORK Where?	PEOPLE Who?	TIME When?	MOTIVATION Why?
1. SCOPE Planner contextual	Business Things	Business Processes	Locations	Business Units	Events/ Cycles	Business Goals & Strategies
2. ENTERPRISE MODEL Owner conceptual	Semantic Model	Business Process Model	Business Logistics	Work Flow Model	Master Schedule	Business Plan
3. SYSTEM MODEL Designer logical	Logical Data Model	Application Architecture	Distributed System	Human Interface	Processing Structure	Business Rules
4. TECHNOLOGY CONSTRAINED MODEL Builder physical	Physical Data Model	System Design	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
5. DETAILED REPRESENTATIONS Subcontractor out-of-context	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification
6. FUNCTIONING ENTERPRISE User	Data	Function	Network	Organization	Schedule	Strategy

Source of the Zachman Framework: [Mino08].

Although Zachman assumes that the first level considerations are strictly contextual and on this level the local environment approach is important, and the fifth level considerations must be strictly out-of-context to provide an objective look at the information system, each of the levels of Zachman Framework reveals a certain context and requires a separate contextualized approach and consideration in the aspect of the actor on that level.

For the design of a particular product, usability, design, manufacturing costs and recyclability are among the fundamental objectives [EiWL10]. However, if the decision was made with respect to the whole range of products, at least some of these would become instrumental, thereby expanding the decision context. In this context, profit, market share, business strategy, growth and liquidity could serve as fundamental objectives. In Zachman Framework, the lower levels objectives and answers the questions included in columns are in a narrow context in comparison with upper levels objectives and questions that are considered in a broader organizational context. From the users' point of view, business planners' or business owners' objectives (last column in Table 1) are instrumental when making decision on whether to hold, sell or accumulate resources in the company. The ZF architecture model development requires two different approaches to creativity: analytic and synthetic. An analytic creativity can be defined on one hand as a topdown (i.e. from the 1st to the 6th level in Table 1) creation process to discover a novel solution to a given problem by reducing it to the subproblem level where new or existing solutions may be found. On the other hand, as bottom-up (i.e. from the 6th to the 1st level in Table 1) creation process, the synthetic creativity can be developed to discover a novel solution to a given problem by inducing it to a superproblem (upper level problem) where new or existing solutions may be proposed. The combination of the two approaches is also permitted.

Conclusion

Rational decision making on corporate architecture development requires a clear understanding of the underlying objectives. Comprehension of objectives helps improve recognizing better alternatives and attractive decision opportunities. Attempting to gain clarity with respect to ZF persons' objectives can be intellectually demanding (see roles specification in Table 1). However, there are a number of indicators that can be focused on i.e. shortcomings in the status quo, comparison of architecture development alternatives, different strategic goals, external guidelines, and the objectives of other people outside the enterprise. Funda-

mental objectives have to be distinguished from means objectives. Only objectives that are fundamental in the given decision context should be considered for an evaluation of the alternatives. Corporate architecture goals do not simply exist, instead, they have to be developed and modelled by a thorough thinking. The key issues are the sources a decision maker can draw on in a specific decision context.

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KREATYWNOŚĆ JAKO PODSTAWA PODEJŚCIA KONTEKSTUALNEGO DO PROJEKTOWANIA ARCHITEKTURY KORPORACYJNEJ

Streszczenie

Celem artykułu jest przedstawienie tezy, że analiza kontekstu oraz kreatywność projektantów są ważnymi czynnikami rozwoju architektury korporacyjnej. Przyjęto, że rozwój kreatywności może być doskonalony przez uwzględnienie kontekstu w modelowaniu architektury przedsiębiorstwa. Pierwsza część artykułu zawiera wyjaśnienie kreatywności i kontekstu w naukach o zarządzaniu i w praktyce rozwoju organizacji. Druga część obejmuje dyskusję na temat kreatywności w modelowaniu architektury korporacyjnej na przykładzie modelu siatki Zachmana.

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SPECIFIC ANALYTICAL PERSPECTIVES IN THE MODELLING OF WORKFLOW SYSTEMS

Introduction

Workflow IT systems are becoming increasingly popular IT tools within the layer of enterprise application software. The interest in the systems of this type results from the evolution and popularity of the process-based approach to enterprise management and the evolution of the enterprise resource planning method with its IT support tools – ERP systems. From the 1970's enterprises have been using MRP/ERP systems, which initially supported manufacturing material requirements planning, then planning the demands on equipment, staff and finally, the enterprise finances. It can be stated that presently the operating processes, within which the materials, products, goods or money are processed, are supported by appropriate functionalities of ERP systems. It is high time to develop the support tools concerning processes which are not directly related to the means of production, but with the processes of immaterial workflow, information and decision flow. This area includes workflow systems discussed in this paper.

The workflow processes are the most complex and unstructured ones. Their complexity results from the fact that practically all employees of an enterprise participate in their implementation. Lack of structure results from the character of information and decision-making tasks. The examples of workflow processes include: project planning and control, preparation of sectional and consolidated budgets, processes of issuing operating decisions, for instance, approval of costs, commercial conditions, processes of periodic employees' appraisal or, finally, processes carried out within team work, for example, preparation of offers or contracts. To assure effective implementation of the workflow system in an enterprise, a thorough business analysis and organisation, and very often reorganisation of processes, must be performed first. The theory of analyses and design of informa-

tion systems (IS) provide many analytical methodologies and tools, however, according to the experience of authors, there are perspectives which are very significant for the workflow systems, but which are not sufficiently taken into consideration. The paper indicates the perspectives of organisational structure, localisation structure, enterprise rules and concepts as the elements essential for the complete model of the workflow processes. The aim of this paper is to show the meaning of these perspectives and pointing out author's analytical tools needed for building of workflow system's model. The first part of the work discusses the basic concepts concerning workflow and presents the assumptions of an independent methodology of analysis dedicated to this type of systems. This methodology includes the above-mentioned additional and specific analytical perspectives. Further part provides a more detailed description of the said perspectives and suggests analytical tools which may be used in their description. The last part of the paper presents the practical use of the discussed perspectives and tools. Scenario of the example was based on the assumptions of the analytical project in which the author participated; also the proposed methodology was used. Identification data of the organisation was changed for the purposes of this paper. The proposed modelling perspectives of workflow systems form the basis of a complete analytical methodology codenamed SPARD. The methodology will be discussed in further author's works.

1.   Basic concepts concerning workflow systems

The idea of workflow systems goes back to philosophical and linguistic considerations from the 1960's [ĆWIK06]. Current research within this field is focused on the modelling and designing of IT tools supporting the work and information flow in organisations. Presently many academic and business institutions work on the subject of workflow systems. A few organisations for standardisation were established with regard to the variety of theoretical and practical approaches. Workflow Management Coalition (WfMC) is the best known among them. WfMC unifies the concepts and establishes standards concerning workflow systems. The publication of a dictionary of concepts and terminology regarding workflow [WFMC99] is a significant achievement of this organisation. The glossary created by WfMC is one of the main sources of terminology on which the scientific and technical works are based. For the purposes of this paper the translation of such concepts as workflow, workflow system and definition of the workflow process were presented.

This paper does not include the definition of a business process, because it does not differ from the generally accepted definition. One of the examples of difficulty in translation can be the basic concept, i.e. "workflow", which does not have a direct Polish translation. The Polish version of the definition concerning the concept of workflow (mainly translated into Polish as "przepływ pracy"), taken from the glossary of WfMC and given by Z. Martyniaka [MART00] is as follows: "The automation of business process, in whole or in part, during which the documents, information and tasks are transferred from one participant to others for the purposes of implementation of an action pursuant to the set of formalised rules". This term is the source of the definition of workflow system usually translated as "system przepływu pracy". The definition reads as follows: "The workflow system is a system which, on the basis of a software, allows for creating definitions of processes and managing the implementation of instances of processes launched on one or many workflow engines which can interpret definitions of processes, communicate with the participants of the workflow and, where it is necessary, it can trigger other applications" [ĆWIK06, MART00]. The ability to manage the business process implemented in the organisation in accordance with the previously defined, prepared or configured definition of process is a very significant and characteristic element of the workflow IT system. It was also noted that, in accordance with the general concept of workflow, it refers to the "transportation" of documents, information or tasks between the participants of the process, i.e. the organisational units or particular persons who belong to the organisational structure.

Following the explanation of the workflow system, the definition of the workflow process was quoted: "(…) it is a form of business process presentation allowing for automated processing such as modelling or implementing a process by a workflow management system" [RENK12]. The definition of the process consists of a network of activities and relations between them, criteria for initiating and completing the process and information on particular activities such as performers of the activity or applications and data related to the activities.

2. General assumptions of the proposed methodology of workflow processes analysis

The analytical methodology proposed by the author derives a bit from all the most important approaches to IS analysis and design. The main analytical perspectives of the methodology are consistent with the structural approach. Ac-

cording to it, the complete analysis of information system requires the description of **data** processed in it and **processes** within which this processing takes place [YOUR89]. However, it was pointed out that the processes would be described in more complete, business terms, not just in purely informative terms (which constitutea difference in comparison to the structural approach). The additional perspective used in the proposed methodology are activities. To increase the accuracy of the workflow model, the methodology proposesa description of each activity specified in the process model on the lowest level, i.e. the scenario of its realization. As it was stated in the introduction, the process and data model, scenarios of activities or states do not exhaust the subject with respect to the workflow system. In this case the perspectives should be broaden and some of them modified.

The workflow system is a specific type of information system in which the information, documents and tasks are transferred between the participants in accordance with the set of formalised rules. The economic organisation consists of participants who are divided into organisational units and work in the functional reporting system – within the organisational structure. It constitutes the frame which indicates which organisational unit or position has the duty and authority to collect information, perform the task or process the document. That perspective was called the organisational structure.

Modern business organisations have a very wide territorial scope of activity which very often has impact on multi-department, regional or global structures. Often the companies create joint holding groups which may use common IT tools. This context is also significant for the workflow system where the dedication of tasks must include the geographical region where a particular organisational unit or position is located. Such an analytical perspective was called a localisation structure.

The set of formalised rules of task, document and information flow is a very significant element of workflow. It is the key control element for this type of systems. The business rules are taken into account in majority of approaches to IS analysis and design. However, in other categories of systems, the modelling of rules is focused on the presentation of the algorithm for calculating certain variables and, to a much lesser extent, on the presentation of control in processes. The second aspect is the key aspect in the workflow system and must include the conditions of navigation within the organisational and localisation structure.

Another analytical perspective proposed in the methodology is the enterprise concepts structure. The conceptual aspect is taken into account in classical methodologies within the data model presenting objects, attributes and relations which the organisation wants to know about. However, this attribute level is not sufficient for the workflow, because it is not enough to indicate that the object attribute concerning the employee at the organisation is their position; it has to be described which competences are assigned to each position and what are the mutual relations between the positions (this is a reference to a particular organisational structure). The data model does not include the formal templates of documents, forms or other templates prepared in the organisation. The workflow system is a flow of data sets which physically has the form of formal documents consistent with the established and described templates. Description of these templates, as well as abbreviations and references used in them, are based on the concepts specifically defined in the life of an organisation – in this paper they were called enterprise concepts.

To model the workflow system completely, with taking into account the above-mentioned conclusions, the proposed methodology has to indicate the following four additional perspectives:

- – organisational structure,
- – localisation structure,
- – business rules,
- – enterprise concepts.

In further part of the paper the proposed methodology will be referred to as the abbreviation SPARD (from the first letters of the English names of the main perspectives). Particular analytical tools were chosen for the indicated set of perspectives; their full list is presented in Table 1.

Table 1

Perspectives and tools of SPARD methodology

Perspective	Tools
Organizational Structure	Org Chart (OC)
Localisation structure	Localisation Chart (LC) (on the basis of UML deployment diagram)
Processes	Business Process Diagram (BPD) (consistent with BPMN)
Activities	Use-case scenario
Business Rules	Pseudocode
Data and enterprise concepts structure	Data and concepts dictionary (DCD) Entity Relationship Diagram (ERD)

Source: Own elaboration.

The analytical tools used in SPARD methodology are derived from various approaches to the information systems analysis. The organisational structure diagram is not related to any IT approach; it is used in the management and economic methods. The notation of the deployment diagram constituting the component of UML [FOWL2003]. The BPMN used for process modelling is currently the most popular tool used in the process-based approach [DREJ11]. The use-cases in the object-oriented approach are the basic tool for the specification of requirements concerning the system [COCK00]. The scenario is a text tool, however it is properly formalised and unambiguous. The pseudocode, data dictionaries and Entity Relationship Diagram ERD are known and are used in the structural approach [YOUR89].

3.   Specific workflow perspectives and analytical tools

Perspective of the organisational structure perspective
– diagrams of organisational structures

Presently, the organisational structure modelling is not included in any of the main approaches to the analysis of information systems (the organisation – OMG, involved in the development of the object-oriented standards, works on the presentation of the organisational structure and its implementation in further versions of UML – www.omg.org [ŻELE12]). In the workflow systems the responsibility for assigned tasks and competences for their performance comes directly from the organisational structure. The org chart (OC) will be used for modelling this perspective. The org chart presents the division of the organisation into organisational units (business units) and positions with their reporting relations. Usually the organisational units consist of groups of employees. In case of individual employees there are positions. For the purposes of the workflow systems modelling the term of a role was proposed in place of a position. The role indicates the ability and authority to perform an activity, for example, project manager, warehouse operative, administrator. Figure 1 presents an illustrative diagram of the organisational structure.
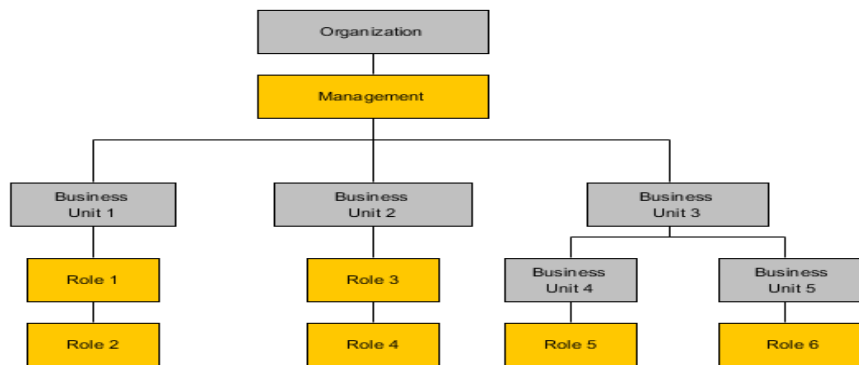
Fig. 1. Illustrative diagram of the organisational structure
Source: Own elaboration.

Perspective of the localisation structure – diagrams of the localisation structure

To illustrate the physical structure of the organisation the notation of the deployment diagram constituting the component of UML was proposed. The symbol of a node in SPARD methodology stands for a physical, geographically separate localisation within which the activity of the modelled organisation is conducted. To obtain a more complete picture, the organisational units operating in a particular localisation are described. The directional relations between nodes (localisations) can be marked, however, in majority of cases these relations are bidirectional. The additional element shown in the localisation chart is the system equipment of particular localisations. Figure 2 presents an illustrative diagram of the localisation structure.
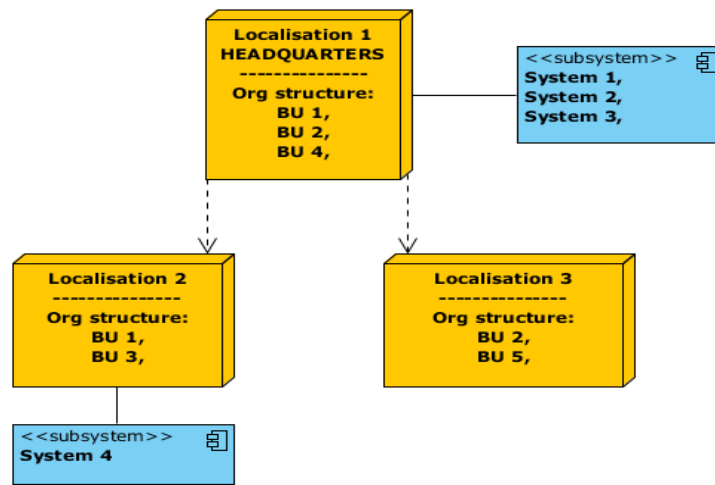
Fig. 2. Illustrative diagram of the localisation structure
Source: Own elaboration.

Perspective of business rules – pseudocode

With regard to the description of business rules, a very important task is to create an accurate, formal and algorithm representation. While creating a workflow model it has to be noted that the rule has to be encrypted in the code of an IT tool operating the workflow, particularly in the definition of the workflow process. The business rules in organisations are usually kept in form of regulations or instructions. During selection the tool for modelling the rules of the proposed SPARD methodology, the representation matching the requirements of the formal algorithm and comprehensibility of the business language was searched for. The pseudocode was chosen, otherwise known as the structural Polish language, a process specification method known from the structural approach (OCL, known from the object-oriented approach, was considered less accessible). On the one side the pseudocode is structural, i.e. it should include sentences with syntax which resembles the code of program instructions, i.e. the instruction and parameters of its triggering. On the other side it is the Polish language, because all the instructions and parameters will be included in the specification of the rule in the Polish language [YOUR89].

Three main rules of the pseudocode:
– the pseudocode instructions are verbs in the Polish language,
– the instruction parameters may only be the elements of data related to the described model, i.e. the ones included in the data and enterprise concepts dictionary,
– within the pseudocode there is the possibility to apply conditional functions describing the alternative action after fulfilment of appropriate conditions (for example if-then, case or do-while).

Example of the business rule specification with the use of pseudocode:

if *faktura_kwota_brutto >= 50 000*   **then** *akceptacja [Prezes_zarządu]*

                                                   else *akceptacja [Główny_księgowy]*

where (faktura_kwota_brutto – is described in the data and enterprise concepts dictionary, and Prezes_zarządu, Główny_księgowy – are the roles additionally described in the organisational structure).

Perspective of the enterprise concepts
– data and enterprise concepts dictionary

The data dictionary specified all data object elements used in the workflow processes. The data dictionary is a text tool, however, it is formalised. The data elements are taken from data objects in org charts, localisation charts, BPD, ERD and descriptions of business rules. The dictionary should also include definitions of enterprise concepts which are present in the specific communication language of the organisation.

The data dictionary includes three types of elements:
– elementary data – data which is not subject to further division,
– data packages – elementary data set,
– enterprise concepts.

All above-mentioned types of elements are described within the category of context, definition (for the packages), unit of measure and limit values (for elementary data). The naming convention shown above comes from the Yourdon Structured Method [YOUR89] (except for the enterprise concepts which were added by the author). An example of the data dictionary is presented in the next chapter.

4. Practical example of use of the specific workflow perspectives

General characteristic of the analysed organisation

The object of a sample scenario will be the company KPRM – Krakowskie Przedsiębiorstwo Robót Mostowych. This enterprises specialises in the construction of bridges and hydrotechnical structures. KPRM provides comprehensive investment services, starting from the design phase and ending with execution and operational supervision. The seat (headquarters) of the company is located in Cracow. The company is a multi-department organisation with three area branches. Each branch has its own resources and implementing measures. In the headquarters of the company a dozen building contracts are simultaneously carried out. The branches manage a few building contracts at the same time.

KPRM is preparing to implement the workflow system which will allow for the realisation of the new controlling policy of the company. The basic assumption of the new controlling policy is the possibility of an ongoing monitoring of the financial results of the company with details concerning individual contracts. Persons appointed by the Management Board are to be responsible for the results of particular contracts and results of organisational departments working to the benefit of the contracts. With regard to the above-mentioned assumption, majority of operation should have a several-stage authorisation. Presently, the basic information problem of KPRM is the flow and registration of expenditure documents, particularly external documents and those which are sent directly to the area branches of the company. The flow of documents in its current approach, based on the paper carriers, is very time-consuming, requires double amount of labour and generates many errors. As a result, the financial results are known only during the tax return period (20th day of the next month). The discussed example will provide only the analysis of the process of purchasing documents flow – a significant, but not the only process that needs to be optimised at KPRM to implement the new controlling policy effectively.

Cycle of the workflow process analysis concerning the purchasing operation
a.   Analysis of the organisational and localisation structure

The first stage was the analysis of the organisational structure as the frame of the workflow processes. The starting point was the "official", documented organisational structure. It was the basis for the system of organisational units, whereas the positions were mapped into roles significant for the workflow system. Creation of OC was not completed at the end of this stage and there were

situations during the process modelling when additional roles were found. Figure 3 presents the fragment of OC for the company KPRM. Next, the diagram of localisation structure was created (Figure 4).
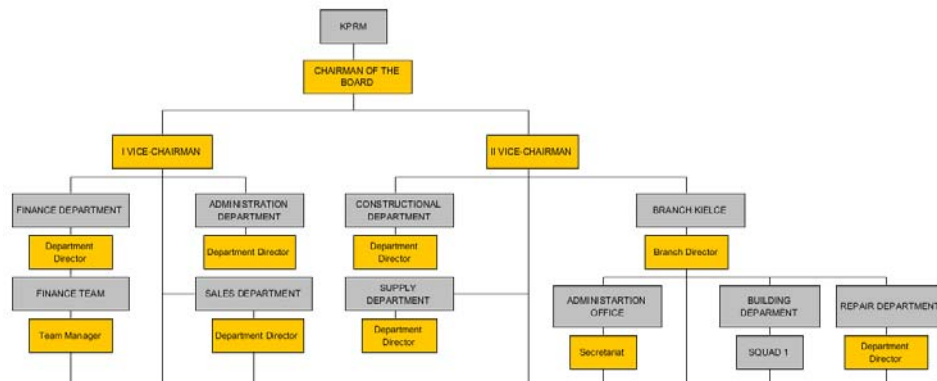
Fig. 3. Fragment of the organisational structure diagram of KPRM
Source: Own elaboration.
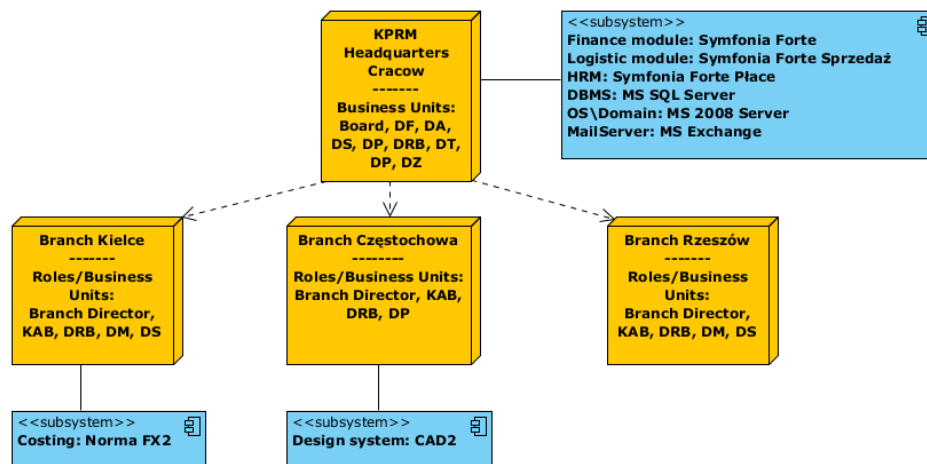
Fig. 4. Localisation structure diagram of KPRM
Source: Own elaboration.

The creation of the data and enterprise concepts dictionary was commenced already at this stage.

b.   Workflow process analysis concerning the purchasing operation

The next step was the analysis of purchasing operation process with regard to the roles and the sequence of activities. BPD was created. The model of processes can be changed and modified many times, because during the analysis of scenarios of particular activities or the business rules, the analysis team comes up with new "ideas" and adjustments to the described processes. Figure 5 presents the fragment of BPD for the workflow process concerning the purchasing operation.
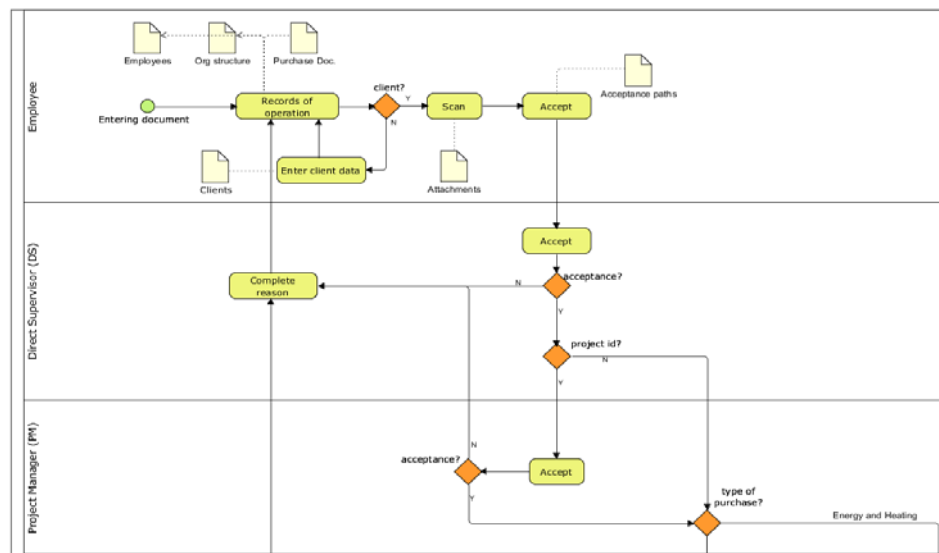
Fig. 5. Fragment of BPD concerning the purchasing operation workflow
Source: Own elaboration.

c.   Analysis of business rules

Together with the process model the business rules controlling its course were described. Simple rules were described directly on the diagram, just like in the case above. The more complex ones were described separately. In the last case the rules of pseudocode were applied. The rules for the analysed workflow process concerning the purchasing operation were collected in the table presenting the process path depending on the type of purchase (Table 2). With regard to the large size of the table, the rules of acceptance were shown only up to the

third level and only three types of operations were included; the source process handled nine types of acceptance levels and had five acceptance levels.

Table 2

Rules of acceptance paths depending on the type of purchase (fragment)

Acceptance levels	Level 0	Level I		Level II		Level III	
Types of operations	Role	When	Role	When	Role	When	Role
Primary and secondary materials	Employee	Always	Direct Supervisor (DS)	? Project id	Project Manager (PM)	Always	PD
Stationery	Employee	Always	DS	Always	Purchase department (PD)	dok_zak_kwota_brutto >2 000 PLN	Chairman
Energy and heating	Employee	Always	DS	? kontrakt	PM	dok_zak_kwota_brutto >2 000 PLN	I Vice-chairman

Source: Own elaboration.

d. Activities and data analysis

Further stage of the analysis was to divide the activities shown in the process model into steps which needs to be taken by the role or system. Due to the volume of the paper and described scenarios they will not be presented. Simultaneously with the description of scenarios of particular activities, the data and enterprise concepts dictionary was developed. Table 3 presents the fragment of the data and enterprise concepts dictionary.

Table 3

Fragment of the data and enterprise dictionary

Data/concept	Context	Definition	Limits	Unit of measure
dok_zak_data_sprzedaży	Sale date appearing on the document			Date (dd-mm-yy)
dok_zak_termin_płatności	Matuiry		0-365	Integer (4,0)
dokument_zakupu	External or internal document showing the operation of the purchase made by the KPRM	dok_zak_numer + symbol_klienta+ +dok_zak_data_sprzedaży +dok_zak_data_wpływu + numer_pracownika + symbol_działu + {dok_zak_opis_pozycji +dok_zak_kwota_netto+dok_zak_stawka+ numer_kontraktu}		
Project manager (PM)	An employee designated by the Board to oversee the contract. Responsibilities is describe in Attach xx.			

Source: Own elaboration.

The data and enterprise concepts dictionary does not exhaust the subject of the data model. Upon describing particular objects, the relations between them were modelled. ERD, due to the volume of this paper, will not be presented. The methodology itself and more detailed description of the case are the subject of the author's next paper.

Summary

The significance of such specific analytical perspectives of the workflow system as the organisational and localisation structure, enterprise rules and concepts, was proved practically. Basically throughout the entire period of modelling, the analysis team was referring to diagrams or specifications of these perspectives. It can be stated that the organisational and localisation structure constitutes some kind ofa frame and a mechanism for testing the completeness of the model. The model, created in accordance with SPARD methodology, may be the starting point for collecting requirements concerning a new IT tool supporting the workflow, as well as for the commencement of the simulation process analyses, description of ISO procedures or developing the expenditure and controlling policy of the company.

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SPECYFICZNE PERSPEKTYWY ANALITYCZNE W MODELOWANIU SYSTEMÓW WORKFLOW

Streszczenie

Systemy informatyczne typu workflow stają się coraz popularniejszymi narzędziami IT warstwy oprogramowania aplikacyjnego przedsiębiorstw. Aby zapewnić skuteczność wdrożenia systemu workflow w przedsiębiorstwie, powinna go poprzedzać gruntowna analiza biznesowa i uporządkowanie oraz niejednokrotnie reorganizacja procesów. Teoria analiz i projektowania systemów informacyjnych dostarcza wielu metodyk i narzędzi analitycznych, jednak istnieją perspektywy ważne dla systemów workflow, które nie są w nich wystarczająco uwzględniane. W artykule wskazano na perspektywy struktury organizacyjnej, struktury lokalizacyjnej, reguł i pojęć firmowych jako elementy konieczne do pełnego modelu procesów workflow. Celem jest wskazanie roli tych perspektyw oraz narzędzi analitycznych potrzebnych do zbudowania kompletnego modelu systemu work-flow. Ostatnia część artykułu pokazuje praktyczne zastosowanie wskazanych narzędzi w rzeczywistym przypadku analizy przedwdrożeniowej.

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MOTIVATION FOR STUDENTS: GAMIFICATION IN E-LEARNING

Introduction

Using games in education is not a new idea. Most people who learn out of their own, unforced, incentive take part in many types of traditional games and video games. It is also hard to imagine an internet user, that never took part in a simple game of solitaire. For many years, self-standing games have been successfully used in schools and universities as training aids. The mechanism of gamification is actually something else. The most popular definition states that gamification is:

- "the use of game design elements in a non-game context" [Dete11],
- "the integration of user-centered game design elements into non-game contexts" [Norm90].

From these definitions one can come to a conclusion that every learning process can be modified in order to use the mechanisms that are available in games. The main goal to utilize this mechanism is to raise motivation in people who are learning. The designed process of gamification must take the user into consideration, and not the university, for example, that wants to implement that mechanism. The process of gamification in e-Learning in the instance of universities can take place in such places as:

- training aid courses, such as e-Learning courses; so that gaming aspects may be used,
- he university e-Learning platform,
- both.

The purpose of this article is to present an innovative mechanism of gamification implemented on the platform of social learning. In the first part of the article was characterized the most common and easiest to implement mechanisms that occur in the case of courses and e-Learning platforms. The second

part of this article describes objectives of WeLearning platform, the third part is devoted to a presentation of created gamification mechanisms for e-Learning courses, users and the whole platform.

1. The mechanisms of gamification

The most popular ideas that can be easily used on a low-budget (creating a different game is a challenge and it usually takes up thousands of game designers' work hours, graphic designers' work hours, and game testers' work hours) in the instance of e-Learning courses are [Raym11]:

   a. **Defining partial goals and learning effects** – courses, especially academic courses, usually contain hundreds of pages of information for the student to study through. In most instances, in order to check the student's progress, a test/exam is taken after the completion of the module(s). In complex games, the gamer has the option to choose different missions, from the easiest training missions to the most difficult task (of course the challenges should not be impossible to complete as to avoid the user getting put off by the game). After completing every task, the student should get a debriefing with information about his achievements, progress and an option to a more challenging level based on the knowledge the user gained up until this point. It is not easy to design such a course, because the topics often times are not strongly associated with one another as part of a subject.

   b. **Ensuring debriefing information** – the student should obtain an articulate piece of information regarding every completed task/project. A simple "test result: 70%" does not suffice, nor does a plain correct answer sheet. Instead, next to every single question there should be an explanation as to why an answer is incorrect, or correct. Another useful information is the location of the user in the course. In games, the user always knows where he/she is (for example: location on a map) and always has access to help information. In e-Learning systems, the users get lost often, they don't know what to do, how to talk, or even how to ask for help should minor technical difficulties occur.

   c. **Taking note of student progress** – the gamer always knows how advanced the mission is he/she is playing, or how many tasks he/she has to complete before he/she can go onto the next level. There usually are a few

progress bars on display. This is not obvious in e-Learning courses. The courses are designed with the help of interior tools that some of the most popular e-Learning platforms such as Moodle, or Blackboard do not have. The courses are designed with the help of e.g. Adobe Captivate that often times have progress bars. However, it is displayed within one module, and not the entire course. This problem can be resolved quite easily by displaying a user progress box (a form of reward for the student) after every single completed module/subject during his/her progress throughout the entire course.

d. **Defining a range of awards** – every person within the course as well as within the entire e-Learning system, should have sufficient information regarding the awards system explaining what has to be done to earn an award and within what timeframe and/or stage of the tasks at hand an award can be earned. Awards may be given out according to various requirements: after an x amount of pages are completed, after completing a certain amount of tasks, or alternatively, awards may be given out at random for every user at different stages. Awards may be temporary, meaning that they are merely displayed after the successful completion of a task and they do not add up to the total score, or they may be linked to the final mark.

e. **Utilizing other good designer's practice in creating games** [Kapp12] – every game consists of an interesting short description that encourages people to pick it up and play it, whereas courses, more often than not, possess a boring syllabus. The visual page in games is extraordinarily well built; an aspect that academic courses completely omit. Of course, what counts the most is the content of the material, but in the era of vast availability of various sorts of free repositories of graphics the task to ensure a game an attractive visual is not a difficult one and it is one that does not require high skill, or a long period of time to carry out. Every game is tested on users who bring the attention of the designers to the visual aspects, the arrangement of elements, and the navigation panel through their own suggestions. This rarely takes place in the process of launching e-Learning courses, or developing a new operating platform. People who will be using these platforms will spend a great amount of their time using these products.

Within an e-Learning platform of a university setting the following gaming elements can be additionally implemented:

1. **Avatar updates** [Raym11] – the skills and experience level of a gamer is most often visible by simply glancing upon his/her description and avatar. Players that complete additional missions can purchase additional inventory and upgrade the character they use in their game. After revealing the entire description of the user, one can take note of his/her best results, the amount of points earned, available inventory, and next missions that await completion. In academic e-Learning, these features do not exist. Every course is independent and the completion of one module even on a higher difficulty level does not affect achievements in others. Additionally, the learner does not have the ability to purchase additional inventory. Awards may come in different forms. Not all areas of the course have to be available to the learner from the start; besides point earning, awards may consist of the ability to use articles that normally come with a fee (but in this case they are made free of charge), participation in events that take place on campus, or even a chance to win a book published by the university. Every learner can have a visual symbol of their experience level next to their surname along with awards earned (badges, different icons, symbols, etc.).

2. **Utilizing social games** [SqJe03] – in social media, one may take note of the popularity of many varieties of games. It is surprising, because the games on social media websites are very simple and in contrast to other games available elsewhere, they are poorly developed and have poor graphics. The essence of their success lies in the possibility to play these games with friends and the ability to compare your results with theirs. In the classic e-Learning course, the learner has nothing but his own score to view. Only teachers have access to all the students simultaneously. This causes a drop in learning motivation among students. Some people do not care about how to properly present themselves, and in the moment of public display of their results, they care more about appearing good (scorewise) within their close group of friends and their teacher rather than contrasting their results with the group as a whole. If achieved results in various e-Learning courses were to be made visible for everyone to see, it would be hard to cover bad results in the next few courses.

In the description provided above it can be concluded that gamification can truly change the way people approach the course design and e-Learning plat-

forms on an in-depth level [Munt11]. When discussing gamification critically, one should not identify it merely with its exterior features that consist of points, badges, awards, and result charts. Adding these elements exclusively only trivializes problems and does not motivate people to learn. In the following sections other gamification mechanisms have been described as well as how they have been implemented in an innovative social learning platform that is being currently being developed – WeLearning.

2. The WeLearning platform

Tischner European University in Cracow is creating an innovative education model as a means to appease current student expectations and also to attune the university to socioeconomic changes in the following foundations:
 – social development,
 – the blended learning method,
 – open source philosophy.

As a part of this model, a diversified education offer that is displayed on the social learning platform came to be – it is called "WeLearning". The users of this platform are to create a community of active learners that participate in discussions, meetings and can create new articles on the platform. The goal of TEU is to make the philosophy of life-long learning among Poles more popular.

The designed system is intended to be an internet platform that will help to create and share knowledge, as well as to develop skills and a sense of community among like-minded individuals. This community is not intended to be made available exclusively for students, staff, and sympathizers of TEU, but from the very start it is intended to be open for everyone interested, regardless of age, level of education, or university affiliation. The only condition is a life-long hunger for knowledge and willingness to make new acquaintances with like-minded individuals. The interests of the users of the platform and their activities will be used as way to measure the job and education market. The university will then be able to plan its endeavors (for example: the opening of new courses of study, creating new specializations) to ensure the best qualifications for its graduates and to build an interesting additional offer (cultural events, trips, conferences with interesting people). The platform will use Web 2.0 tools in a unique way. They will be used in the process of creating, gathering, and verifying information and in the process this will create a community. They are not meant to be merely additions to the

classic e-Learning articles as seen on platforms of the likes of LCMS. The unique solution, which is not yet implemented in e-Learning systems in world renown and Polish universities alike is the motivational system that focuses on virtual currency. The name of the currency will go by the name of "talent", which will be used to "purchase" additional materials (schoolings, courses, etc.) and will be used in the grading of the knowledge and skills of the user. Talents will motivate the social media community to self-development, to comment on posted materials on the platform, and to be active creators of new materials.

3.   The mechanisms of gamification on WeLearning

The WeLearning platform consists of many modules in which mechanisms of gamification have been implemented, such as:
–   tasks that have to be completed by the user, or a group before new tasks are unlocked on the next level of the DL course,
–   progress bar (for example: page 2/30, 50% completed task), which allows the user to identify his/her location; it is implemented upon choosing a certificate,
–   the awarding of badges upon completion of new levels,
–   additional points (or better scoring privileges) for tasks carried out as part of a group that encourages users to do teamwork and meet new acquaintances,
–   user ranking (sorted by points, level of activity in different categories: most active in discussions, most written articles, etc.),
–   help for other users through trade of inventory, or points.

3.1. Talents – virtual currency
In order to implement the above mechanisms, it has been decided to create **talents,** a virtual currency, which is to be used by users of the platform. Talents can be earned through activity on the platform as well as **offline activity** (see Table 1). Every user can view their earned talents and use them by purchasing learning inventory. In the instance of earning talents for offline merits, the user must send an application to the administrator to receive talents. The mechanism of gamification has the goal of motivating the platform users even more.

Table 1

An exemplary amount of points allotted for Online platform activity

Type of activity	Amount of Talents	Granting
Adding Distance Learning course	30	After the publication of the course
Adding inphographics	10	After the publication of infographics
Adding e-book	1	After the publication of e-book
Running your own blog (lead = publish at least 5 per month)	20	Once at the end of the month
Adding links to valuable material on the Internet	3	After the designation as a valuable link by at least 10 people
Adding own Podcast	10	After the designation as a valuable link by at least 10 people
Adding educational movie (Youtube movie) made by someone else	1	After the designation as a valuable link by at least 10 people
Adding m-learning aplication	80	After publication of the application
Completion of the pre-prepared e-Learning course 5h	15	After passing the course, upon successful completion of the test
The monthly increase in the number of talents for a minimum of 10%	5	System calculates comparing the first and last day of the month
Bonus for the quality of the copyrights materials	0 to 5	The system calculates the average of the user ratings (1-10) which globally copyright material gathered 1-2 – 1 bonus talent 3-4 – 2 talents 5-6 – 3 talents 7-8 – 4 talents 9-10 – 5 talents No copyright material – no score

Source: The analysis of expectations and system features of the WeLearning Social Media Learning Platform.

Since the platform resembles a social media website, it should not be a surprise that awards are a feature for posting high quality materials. Articles generated by users is one of the foundations of social learning. Many studies point out that 90% of social media users are passive article consumers, 9% are moderate article publishers, and about 1% users provide 90% of the entire material [Niel06]. This is why such a large amount of points should be awarded for posting lengthy, articulate articles that are highly valued by other users.

Additionally, platform users have the ability to earn additional points for offline activity (see Table 2).

Table 2

An exemplary amount of points allotted for offline platform activity

Type of activity	Amount of Talents	Granting
Performing in real life a short training/workshop (up to 4h)	30	After the training
Training completed after completing the survey on professional development and participation in a conversation with a professional advisor	15	After the conversation
Participation in a short WSE event (panel, display, read, talk, chat, etc..) – up to 4 hours	15	After the event, based on the attendance list
Taking advantage of short real life learning opportunities (trainings, workshops) – up to 4 hours	20	After the event, based on the attendance list
Taking advantage of long real life learning opportunities (trainings, workshops) – up to 8 hours	40	After the event, based on the attendance list

Source: The analysis of expectations and system features of the WeLearning Social Media Learning Platform.

The administrator that allots additional talents to a particular user writes in information regarding the offline activity that merited the user additional talents in order to avoid confusion. The charts presented above are exemplary and may be modified throughout the evolution and development of the platform. Allotting talents for offline activity has the aim to motivate platform users to participate in events organized by the university, to get them to better acquaint them with its offers, and to encourage users to interact within the platform community.

3.2. Cotillion badges

Platform users with a certain amount of talents can unlock new levels of difficulty (see Table 3). For every unlocked level a user gains a virtual badge known as a **cotillion.** The platform contains different types of badges, which differ from one another visually. Every user of the platform can identify the experience level of a user by looking at cotillions. It is worth mentioning, that cotillions are not related to the current amount of talents, but are calculated on the basis of historical data. For example, a user was very active, earned and accumulated 500 talents on his/her account and is on the 5th level, but decided to buy entry tickets to workshops for which he/she paid 300 talents, which subsequently resulted in his/her current balance to equate to 200 talents – he/she still remains on the 5th level. It can be said that talents define the current balance of a user, and cotillions reflect historical data.

Table 3

Exemplary experience levels of users

Level	Amount of "Talents"
0	0-25
1	26-50
2	51-99
3	100-199
4	200-299
5	300+

Source: The analysis of expectations and system features of the WeLearning Social Media Learning Platform.

Virtual currency cannot be purchased by real currency, because that would be immoral. Paid for materials and participation in different events may be paid for with real money, or talents. Users will have two options to choose from, for example, participation in an e-Learning course with a specialist as a lecturer for the price of 200 talents, or alternatively, 100 PLN. The option of purchasing talents could lead to a situation where users that have the necessary monetary funds would be able to do anything from the start, without putting in the required effort into their studies in order to become experts in a given field.

3.3. Statuses

After earning a certain amount of talents in a given sphere of activity, WeLearning participants should have the ability to earn additional prizes in the form of **statuses,** or titles. Here are some exemplary names of statuses:

- – commentator (a person with the largest amount of valuable comments),
- – expert (a person that posted the most highly valued articles on a specific subject such as e-Learning, or administration),
- – traveler (a person that posted the most highly valued galleries and published many posts on the traveler's blog),
- – organizer (a person that organized a large amount of real events for platform users),
- – and many others.

One user can be an owner of many statuses.

3.4. Feedback

One of the foundations of gamification mechanisms is easy to understand information that should be immediate and provided in a clear, simple way. Every platform user has access to articulate information regarding talents earned by him/her, or by other users (see Table 4). Information regarding talents, cotillions, and statuses is viewable on the user's profile.

Table 4

An Exemplary list of earned talents on the WeLearning platform by the user

Date	Type of activity	Amount of Talents
10.12.2012	Adding Infographics	1
10.11.2012	Adding valuable commentary	2

Source: The analysis of expectations and system features of the WeLearning Social Media Learning Platform.

Information regarding talents contains the merited activity, the amount of points awarded, and the date. The implementation of this mechanism ensures full transparency and eliminates suspicion of foul play.

3.5. Additional rewards

The most active users of the platform will have access to additional prizes in the form of paid for materials, course discounts, workshops, and post-graduate certification courses organized by the university and other universities as part of a collaborative effort between universities. In future development of the platform, promotional offers by outside companies can be implemented into the system. Companies interested in advertising their products/services, or wishing to consult their strategies with consumers can have access to the system (and use crowdsourcing – a process in which an organization outsources tasks traditionally carried out by workers to an unidentified, usually broad group of people, instead of a chosen small group of experts). Exemplary prizes may be made available to users of the platform by outside firms in the form of [Lipi13]:

– discount offers for courses and workshops organized by platform associated firms,
– material prizes, such as products of a particular company,
– financial prizes; awarded for providing the best idea in the process of a social problem resolving activity put forth by a company,
– internships/apprenticeships.

Implementing outsider prizes should raise the level of motivation in platform users, especially if the prizes are particularly attractive and adequate to the effort required in order to win them. Points earned for academic performance on the platform and commercial activity should be separated, possibly by creating two different ranking systems, or designing them in two different colors in a chart that displays earned talents as a way to differentiate between the two sources.

Summary

The proposed mechanisms of gamification are innovations for higher education in Poland. Only after the full launch of the platform will it be known if the designed functionality that are found in business and marketing will turn out to be equally effective in higher education. One of the possible dangers is the lack of engagement/participation on behalf of the people using the system, particularly in the instance of a prize/award shortage. Paradoxically, such prize/award systems are proven to be ineffective for people with a high sense of inner motivation [Nich12]. That is why the proposed mechanisms should serve as an exterior source of motivation for people whose inner motivation is lacking. The moment award systems and rankings will be launched, users could feel largely controlled. Another

negative possibility may be the chance of implementing an unhealthy environment of rivalry that would result in a decreased willingness in users to help others and users to be less keen on engaging in collaborative group work. However, it appears that this is an interesting experiment in Poland that will provide us with answers to the effectivenss of utilizing gamification in higher education.

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MECHANIZM GRYWALIZACJI NA PLATFORMIE E-LEARNINGOWEJ SPOSOBEM NA WZROST MOTYWACJI STUDENTÓW

Streszczenie

W ostatnich latach wiele firm wykorzystuje w działaniach marketingowych mechanizmy grywalizacji. Również w edukacji wiele procesów związanych z nauczaniem może być tak zmodyfikowanych, aby wykorzystywać mechanizmy dostępne w grach. Głównym celem tych działań jest spowodowanie wzrostu zaangażowania osób uczących się. W artykule przedstawiono projekt innowacyjnej platformy kształcenia społecznościowego na poziomie szkolnictwa wyższego, uwzględniającej mechanizmy grywalizacji. Omówiono szczegółowo system motywacyjny oparty na wirtualnej walucie nazwanej Talentami i jego możliwy wpływ na zachowania użytkowników platformy.

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PROSUMPTION AWARENESS AMONG YOUNG CONSUMERS

Introduction

Advances in information and communication technologies (ICTs) are among the key drivers of social, economic and technological changes. These changes are embedded in and determined by the information society, i.e. one which depends for its emergence and its growth on access to information and the ability to exploit it [Ziem13b], [Info10, p. 471], [Kisi08].

Today's consumers, being part of the information society, tend to be very fluent in searching and managing information for a specific purpose. Using ICTs, they share opinions and participate in a number of activities initiated by businesses. Many consumers are unaware that the true motivation underlying contests or interactive games run by business companies is to stimulate them into action and then use them to a company's own ends. By getting involved into such activities, consumers become prosumers without knowing it [Ziem11], [Ziem13a], [InCo13], [XBT08], [ZBD08], [Gune10], [HOdJ11].

The objective of this paper is presenting results of research revolving around phenomenon of prosumption among young consumers. Our research was aimed at exploring prosumer awareness, particularly among youth consumers who are keen users of ICTs. The authors sought to demonstrate the extent to which consumers are aware of becoming prosumers through their involvement in different sorts of programs organized and supported by business companies.

The paper continues as follows. The theoretical section presents the role of consumers in business enterprises and explains how they, using ICTs, become prosumers. The empirical section is devoted to the findings of a direct survey focusing on prosumer awareness. Last section of the paper contains conclusions.

The outcomes of our survey can be useful for businesses intending to get consumers involved in the process of innovation. They reflect consumers' inter-

est and desire to take part in a rich variety of prosumption initiatives. The findings also indicate which interactions between businesses and consumers the latter are most willing to support.

1.   Theoretical background – *consumer* vs. *prosumer*

More and more studies will distinguish the notions of *consumers* and *e-consumers*, where the former are an individual who purchase goods in traditional ways in order to meet their own needs or the needs of their household [Szop12, p. 46], while the latter satisfy their consumer needs by buying goods and services via the Internet [JaWo11, p. 10]. The Internet plays a central role in the emergence of a virtual world of consumption [DaJa10, p. 42]. Its explosive growth has altered the relationships between businesses and consumers. Modern consumers are no longer seen merely as the end users of a product. To an increasing degree, they have become partners to business companies, whether traditional or virtual ones. They want to co-author products that are launched to the market. At the same time, they are uncompromising judges of product quality as well as of the manufacturer. More and more often they take advantage of the Internet to share opinions with other consumers [DaJa10, p. 55].

Through their personal involvement and their proficiency with ICTs, consumers have become more and more aware of the way they use goods and services, thus turning into co-creators – prosumers [ZBD08], [Merc12], [InCo13]. Over the years, the degree of prosumers' involvement has varied, and so has the scope and importance of their role. Originally, the prosumer was identified with someone making goods for his own personal use [Toff97]. In that sense, prosumers would simply consume what they themselves produced. As technology progressed, the prosumer took over some of the business companies' roles and some of the processes typically found in business enterprises. Finally, prosumers got engaged in the production process by contributing to product design and re-configuration [Ziem11]. As a result, they were able to obtain a final product that fulfilled their expectations perfectly.

The contemporary understanding of the term *prosumer* has been largely influenced by ICTs. In practice, the term applies to those consumers who meet at least two of the three following characteristics [ZaPr08]:
  – they seek the advice and opinion of the Internet community and usually consult it when planning a purchase,

– they publish product descriptions or make inquiries about products in the Internet,
– they take part in promotional events, partnering in the creation of products, advertising slogans or campaigns.

The rapid expansion of Web 2.0 technology and the increasing role of modern-day prosumers brings attention to how ICTs have made it easy for us to become prosumers. Web 2.0 represents a technology that enables users to actively engage in social networking. It provides them with an unprecedented degree of control over the contents of Web resources [Coll10], [HaBa09]. They can make evaluations, comments, share thoughts and experiences and build different types of social relations. It is hardly imaginable these days that an Internet user would have never had exposure to other users' opinions. A growing number of Web users are sharing their thoughts and experiences with others through forums, blogs, feedback/comments pages, etc. [Siud12]. Further, business companies are attempting to exploit the potential of the Web – notably its popularity with young people – e.g. by launching promotional programs and events designed to engage consumers in corporate plans and activities.

The authors feels that today prosumption corresponds to companies' competitive struggle whereby consumers are involved in the process of knowledge exploration, innovation and value creation [Ziem11]. Prosumption makes it possible for consumers to engage in product or service development by contributing their knowledge and ideas as well as through collaboration with others [Arvi07]. Such consumers are called prosumers. Today's prosumers will use ICTs to satisfy their needs, to search and create information. Prosumers will gladly volunteer their involvement in joint product development, product improvement, idea generation and solution-finding processes [Radz11], [Garo11], [Bruns08]. Prosumers' activity should result in the making of products characterized by enhanced functionality and compliance with user expectations [LGG12]. Hence, two other closely related notions are frequently found in studies of prosumption: co-creation and co-design.

2. Research methodology

Issues outlined in the preceding chapters were addressed by a recent survey which the authors undertook in an effort to investigate prosumer awareness among contemporary consumers. To accomplish this, Web users were surveyed

for their familiarity with the notions of *prosumer*, *prosumption*, and *co-creation*, and its likely linkage with their declared use of ICTs, which are perceived as conducive to the growth of prosumption.

The paper focuses on addressing the following research questions:

1. Are consumers familiar with the notions of *prosumer*, *prosumption*, and *co-creation*?
2. What factors determine prosumer awareness?
3. Do consumers identify themselves, by admitting to involvement in specific activities, as prosumers?

Obtaining answers to these questions required efforts of cognitive and utilitarian nature. Literature search and extensive reading of both domestic and international writings were followed by mind mapping and the application of critical thinking methods. These were supported with the use of a questionnaire-based direct survey. In processing the findings, statistical analysis and data analysis techniques incorporating pivot tables were employed.

The questionnaire-based direct survey was performed in March and April 2013 and involved a sample of 575 persons, including 346 women and 229 men. The survey was run on a group of consumers, a majority of whom were Generation Y[*] youth, since those are now considered the largest and most active faction of Web users [Laza12]. Generation Y people are known to approach ICTs as an unalienable part of their lives and as tools used for work as well as for entertainment. They are happy to buy goods and services delivered via the Internet. They will also often exchange comments with other Web users and consult the opinions of others before making purchase decisions [Eisn05], which has been confirmed by the authors' research findings.

The subsequent chapter presents research outcomes which depict prosumer awareness among Internet users and prosumer activities pursued by them.

Further in the paper the authors employs the term *prosumption* in analyzing, describing, and making references to the research outcomes. It should be remembered, however, that the term is to be treated as a portmanteau word and a mental leap. In fact, as the survey shows, prosumption is always accompanied by two synonymous terms: *prosumer* and *co-creation*.

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[*] A number of authors have categorized Internet users by demographic factors and characteristics. It is argued that generations will differ significantly in terms of attitude toward Internet access and the use of ICTs. It is generally agreed that Generation Y is made up of persons born between mid-1970s and mid-1990s. More on current generations can be found in [Gard06], [Fazl08], [TheR10].

3.   Research findings – prosumption awareness

The determinants of prosumption

In the survey, emphasis was placed on establishing how much Web users, many of them representatives of Generation Y, knew about prosumption, and whether they pursued any prosumer activities in the Internet.

The respondents were asked if they are familiar with any of the three notions: *prosumption*, *prosumer*, *co-creation*. It was found that only 14.4% of those surveyed knew at least one of these notions, while 85.6% were ignorant of all of them. Age was the key factor determining familiarity with the term *prosumption* (*prosumer*, *co-creation*). This correlation is shown in Figure 1.
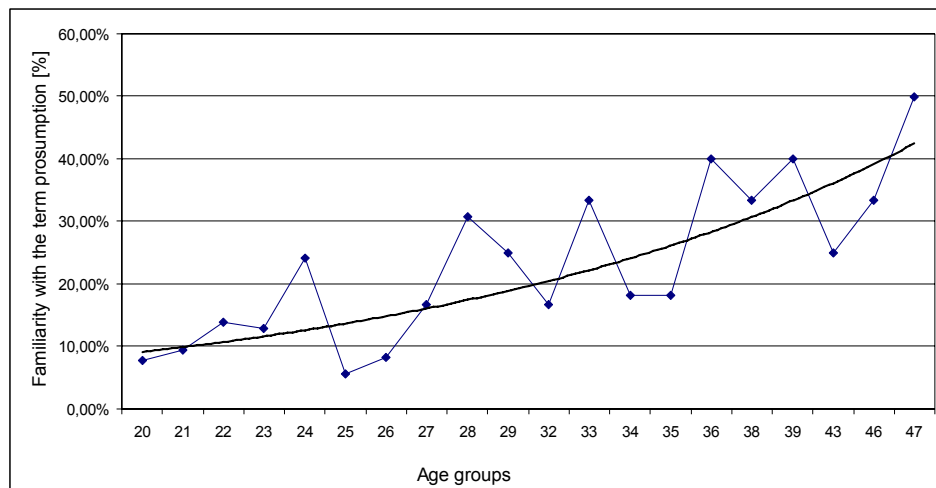
Fig. 1. The percentage of persons familiar with the term *prosumption* in respective
        age groups
Source: Author's own research.

In Figure 1, the traverse indicates the percentage of people in respective age groups (the horizontal axis) who declared familiarity with the term *prosumption* (the vertical axis). The trend, plotted as a solid line, shows the relationship between familiarity with prosumption and the respondents' age. It is easy to see that prosumer awareness increases with age.

Figure 2 illustrates how familiarity with the term *prosumption* correlates with gender.
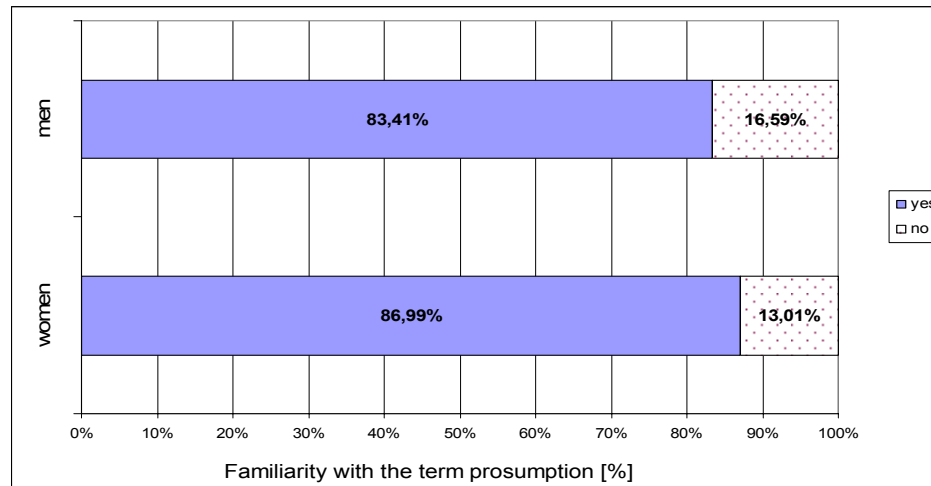
Fig. 2. The percentage of men and women familiar with the term *prosumption*
Source: Author's own research.

It turns out that slightly more men are familiar with the term. 16.59% of men and only 13.01% of women declared familiarity with *prosumption*. What the graph shows best is, nonetheless, that most respondents, both men and women, do not know the term at all.

Prosumer as a feedback provider

The research was centered on analyzing prosumption through the lens of opinions, comments, rankings and polls. This approach reflects a conviction that these represent important ways in which one can influence products and services. Comments posted in the Internet can be instrumental in making decisions on the extent and nature of modifications to all kinds of merchandise. More than that, they could inspire a manufacturer or service provider to introduce improvements and enhancements even in cases where no modifications were previously considered necessary. As a result, companies are able to respond promptly and effectively and to align their business with concepts that would be difficult to discover in any other way.

The truth is that, in contributing their opinions, consumers do not think in terms of their usability for business purposes. All they do is share their thoughts

and experiences with others, hoping to help them in that way – to reassure or alert them, or even to discredit certain products. What they do not often realize is that, by doing so, they help businesses at the same time [Baru10, p. 244].

The respondents were asked whether they:

1. Had ever come across evaluations of products or services provided through:
    – rankings or polls,
    – giving opinion or comments.
2. Had ever evaluated a product or service themselves through:
    – rankings or polls,
    – giving opinion or comments.

When answering the questions, the individuals surveyed could choose among five options: "definitely not" (never); "probably not"; "no answer"; "probably yes"; "definitely yes" (lots of times). The results are shown in Table 1.

Data included in the table clearly demonstrate that most people have come across user opinions and comments on products and services in the Internet. 62.1% of the respondents stated that they very often looked at opinions and comments, and 24.3% of them that they quite frequently did. These combine into a total of 86.4% of those who do look for opinions and comments in the Web and use them as tips before making their own purchase decisions.

Table 1

The distribution of the respondents' activities vis-à-vis rankings, polls, opinions and comments

Specification	Definitely not	Probably not	No answer	Probably yes	Definitely yes
Have you ever come cross product or service evaluations provided through:					
Rankings, polls	11 (1.9%)	47 (8.2%)	62 (10.8%)	192 (33.4%)	263 (45.7%)
Opinions, comments	8 (1.4%)	24 (4.2%)	46 (8.0%)	140 (24.3%)	357 (62.1%)
Have you ever evaluated a product or service through:					
Rankings, polls	92 (16%)	175 (30.4%)	85 (14.8%)	122 (21.2%)	101 (17.6%)
Opinions, comments	89 (15.5%)	178 (31%)	86 (15%)	116 (20.2%)	106 (18.4%)

Source: Author's own research.

At the same time, those affirming that they "very often" looked at Internet rankings and polls on products and services represented 45.7% of the survey sample, while those who "rather often" looked at such polls and rankings consti-

tuted 33.4%. Therefore, in aggregate the proportion of respondents who have come across product or service rankings and polls totals 79.1% of the sample.

The proportions are different when it comes to active involvement, i.e. providing feedback and making one's own opinions or product evaluations available to others in the Internet. Unlike with seeking the opinion of others, persons declaring a low level of activity make up the largest group of respondents. The group represents 30.4% in the case of rankings and polls, and 31% in the case of opinions and comments. At the same time, 38.8% of the sampled Web users declared that they had evaluated products and services through rankings and polls, and 38.6% of them – through opinions and comments. When asked, *Have you ever evaluated a product or service through rankings or polls, opinions or comments?*, these individuals replied with a "rather yes" or "definitely yes". In conjunction with the Gemius S.A. report on "Prosumers in the Polish Internet*"* (the original title: "Prosumenci w polskim Internecie"), this seems to be sufficient evidence that the group, representing nearly 39% of all Web users, can be identified with prosumers[*].

By way of summary to the discussion so far, it could be concluded that Web users often make use of other users' opinions and comments available in the Internet. However, they do not contribute such opinions and comments as often themselves.

Prosumer as a value creator

A prosumer is not just someone who reads and posts comments in the Internet. A prosumer is primarily a proactive consumer entering into a variety of interactions with businesses. Such interactions usually involve two kinds of activities:

1. Consumers' (Internet users') engagement in the process of improving and modernizing products that are already present in the market and are well known to consumers.
2. Consumers' engagement in the design and development of new products through sharing original ideas, innovative concepts, and non-stereotype solutions.

Consumers' involvement may take a number of diverse forms, ranging from games and contests to serious initiatives aimed at encouraging consumers to design new products or suggest improvements to existing ones.

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[*] For comparison's sake: the authors of the December 2007 Gemius S.A. report assert that prosumers account for 36% of Web users.

The authors inquired if:

1. They knew of any examples of consumers' (Web users') involvement in designing or improving products (services) through:
   – offering an original product/service design to a commercial manu-facturer,
   – suggesting improvements to a product/service.

2. They had ever personally designed, or suggested improvements to, a product or service through:
   – offering an original product/service design to a commercial manu-facturer,
   – suggesting improvements to a product/service.

The outcomes are given in Table 2.

Table 2

The distribution of the respondents' activities vis-à-vis product (service) design or improvement

Specification	Definitely not	Probably not	No answer	Probably yes	Definitely yes
Do you know of any examples of consumers' (Web users') involvement in designing or improving products (services) through:					
Offering an original product/service design to a manufacturer	89 (15.5%)	219 (38.1%)	158 (27.5%)	78 (13.6%)	31 (5.4%)
Suggesting improvements to a product/service	78 (13.6%)	200 (34.8%)	169 (29.4%)	94 (16.3%)	34 (5.9%)
Have you ever personally designed, or suggested improvements to, a product (service) through:					
Offering an original product/service design to a manufacturer	324 (56.3%)	198 (34.4%)	27 (4.7%)	18 (3.1%)	8 (1.4%)
Suggesting improvements to a product/service	313 (54.4%)	190 (33%)	38 (6.6%)	22 (3.8%)	12 (2.1%)

Source: Author's own research.

Data contained in Table 2 shows that 53.6% of the respondents do not know of any form of inviting consumers' contribution to product (service) design. 48.3% of them do not know of any initiatives where improvements to products (services) would be suggested by consumers. These groups selected "definitely not" or "probably not" when answering the questions on consumer activity.

On analyzing responses to the questions about opportunities for consumers to offer their original product designs to a manufacturer, the following can observed:

- 31 persons said "definitely yes" when asked whether they knew of any such opportunities,
- 78 people replied "probably yes" when asked if they had ever come across such initiatives.

This means that, in total, 19% of the respondents were aware of mechanisms whereby consumers' proprietary product designs could be submitted to business companies.

As for suggesting improvements to a product/service that is already available in the market:

- 94 persons answered "probably yes",
- 31 people replied "definitely yes".

This produces a total of 22.3% maintaining that they are aware of consumers' involvement in introducing improvements and modernizations to products or services.

The second portion of data presented in Table 2 concerns the respondents' own prosumer experience. For the sake of comparison, the largest group within the survey sample is made up of those who have never been engaged in prosumer activities by contributing product (service) designs (90.8% of all the people surveyed) or suggesting improvements to existing products (87.5% of those surveyed). All of these people marked the answers "definitely yes" or "probably yes" when replying to the relevant questions on prosumer activity. Only 26 out of a total of 575 respondents stated that they had offered their own product (service) design(s) to a business company; 8 of the 26 claimed that they had repeatedly done so.

It was not very different in the case of suggestions for improvements to products or services. 34 people declared prior involvement in such activities, but only 12 of those admitted to doing it often.

The findings discussed above demonstrate that most consumers are aware of prosumer activities taking place around them. However, few of them get personally involved in such initiatives.

There are many examples of consumers' suggestions for improvements in products and services. Specific examples are given in the paper: "Complementarity Web 2.0 and prosumption in the context of today's business support" [ZiEi13].

Discussion and conclusion

The sample consisted of tertiary students. The manner in which the survey sample was formed could be partly justified on pragmatic grounds: owing to that, most respondents (73.4%) were young individuals between 20 and 24 years of age, which is consistent with the objective of learning about those who use ICTs fluently and frequently. On the other hand, the selection implies that the findings may not be representative for the entire population. However, the sample obviously permits definite conclusions on contemporary youth.

Survey results discussed in the paper have drawn an outline of prosumption among contemporary ICT-proficient youth. The respondents demonstrate an awareness of prosumption-related and prosumption-driven programs run in the Web. Nevertheless, they do not often get personally and actively involved in such initiatives. This condition may be attributable to a relatively low level of companies' commitment to reaching a great number of consumers with relevant proposals. Consumers may be also discouraged by such factors as the not so friendly terms, a cumbersome registration process or complicated, confusing software applications.

Moderate interest in prosumer activities may be a consequence of consumers' attitude toward a majority of promotional events, which are usually seen as just another pushy form of advertising. Last but not least, the outcomes may be indicative of inferior popularity of the media through which business companies attempt to target consumers. It can be therefore assumed that these media will continue to evolve toward greater interactivity and openness to consumers.

The research outcomes presented in the paper delineate a large scope for innovative projects available to business organizations. They demonstrate, too, the extent of consumers' interest in certain types of activities and indicate the forms of interaction which consumers are the happiest to support with their creativity. They also highlight the challenges facing a business company which would like to stimulate consumers' activity toward increased involvement in modernizing, modifying and improving their products and services or toward designing new ones.

Acknowledgement

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ŚWIADOMOŚĆ PROSUMENCKA MŁODYCH KONSUMENTÓW

Streszczenie

Artykuł koncentruje się na zidentyfikowaniu poziomu świadomości młodych konsumentów dotyczącej prosumpcji oraz poziomu wykorzystania ICTs na potrzeby prosumpcji. Na wstępie scharakteryzowano prosumpcję oraz rolę, jaką w rozwoju prosumpcji odgrywają ICTs. W kolejnej części artykułu zaprezentowano wyniki badań przeprowadzonych wśród młodych konsumentów, których celem była odpowiedź na pytanie, czy młodzi konsumenci znają prosumpcję oraz czy uczestniczą w różnorodnych aktywnościach prosumenckich proponowanych im w Internecie przez przedsiębiorstwa. Wyniki badań podzielono na trzy części. Pierwsza dotyczy znajomości pojęcia „prosumpcja" wśród respondentów. Druga koncentruje się na analizie prosumpcji przez pryzmat tworzenia opinii i komentarzy oraz rankingów i głosowań. Trzecia prezentuje stopień zaangażowania konsumentów w doskonalenie i projektowanie produktów i usług. Wynikiem przeprowadzonych badań są konkluzje dotyczące chęci angażowania się młodych konsumentów w działania prosumenckie organizowane przez przedsiębiorstwa. Badanie zostało przeprowadzone na podstawie analizy literatury wspartej metodami krytycznego myślenia oraz badania bezpośredniego z wykorzystaniem ankiety.

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THE ROLE OF THE EDUCATIONAL SERVICES
IN THE INFORMATION SOCIETY
– THE EXAMPLE OF THE MUSIC INDUSTRY

Introduction

The industrial revolution improved the living standards of human but also showed its dark sides. One of them was the increase of unemployment caused by the displacement of people by machines. This phenomenon was described by numerous well-known economists as David Ricardo [Ric21] or Karl Marx [Mar09], [Gust12]. However technological development is associated with mankind progress, its dark sides highlighted most in the era of mass production. Especially after the financial crash in 1929, people started seeing the technological progress as a danger. By the time of the Great Depression human had used the technological progress to improve all products. Unfortunately the production of things with long life cycle led to decrease in sales. The lower sales meant the lower production and caused the increase of unemployment. To counteract this phenomenon the new technologies were used to manufacture the products with the shorter life cycle. It led to excessive production and waste of natural resources. That situation directed to objection of many economists and ecologists. Opposing the globalization and devastation of the environment some solutions are proposed. One of them is the idea of the degrowth [Lato09] which advocates for the downscaling of production and consumption [Wiki13].

The different view of the issue of technology influences on economy is presented in works of Jean-Baptiste Say. He noticed that although the inventions eliminated jobs in some trades, they also created them in other different ones. Furthermore the inventions created the new professions which hadn't existed [Gust12]. As for Arthur Cecil Pigou, he claimed that the inventions not only creat-

ed the possibility of production of new goods but also reduced their prices and increased the demand [Pig32], [Gust12]. Joseph Alois Schumpeter regarded the technological unemployment as a temporary phenomenon an unavoidable by-product of business cycles in capitalist development [Hag13]. The similar point of view is presented in the article by Erick Brynjolfsson and Andrew McAfee [BrMc12]. Although they show that contemporary machines are encroaching into areas that used to be the domain of people, they also notice that despite all described dark sides, innovations were inscribed in history of humanity and contributed to development of mankind [BrMc12]. This way of thinking led us to the era of the information society. In contemporary world inventions and new technologies not only create new jobs but also affect positively products life cycle.

The main aim of this article is to present the examples of business activities in information society which can prove the actuality of Say's, Pigou's and Schumpeter's tenets. Presented examples concern business activities related to educational services. They show how new technologies create new jobs in the area of educational services and how new jobs affect brand awareness and sale. The first section deals with mentality of information society members and value of education. The second section presents Yamaha Music Schools and Suzuki Schools as the examples of the educational services fostering human creativity and creating new jobs. The third section contains the similar examples of educational services in other branches. The drawn conclusion are presented in the last section.

Mentality of information society members – value of education

On one hand, the new technologies caused the increase of joblessness and the overproduction. On the other hand, they initiated the development of mankind. This development is related to the phenomena, named by J.A. Schumpeter as *creative destruction*. According to J.A. Schumpeter each new general purpose technology instigates a new business cycle. The animation of cycle starts after the new technology comes into general use. After reaching the maturity by the new technology, the cycle comes into the depression phase. After it another new technology appears and destroys the old institutional structure created by outgoing technology. The upcoming new technology creates its own institutional structure, which improves economic situation and develops the society [Gust12], [Hag12]. The problem with new general purpose technologies is that they always require new skills from humanity. Unfortunately our skills and institutions don't keep up with the rapid changes of technology [BrMc12]. It causes the problem

with unemployment. Therefore, the education has the principal meaning which will increase especially in the information society.

In today's world information is the main good. We are the information society. This kind of society requires its members to be well educated. Transforming information process requires an extensive knowledge. First of all, the members of information society have to use machines designed to work with information. Besides, they have to know how to process the information. Since the industrial revolution, the mankind has invented a lot of labor-saving appliances. Today preparing food, washing or cleaning are easier than before – even one hundred years ago. According to Maslow hierarchy of needs, reaching basic needs, people think about needs of higher order such as, needs of self-realization. For this reason the members of information society educate even after university graduation. In addition, living in information society when technology changes very fast we have to educate all the time to catch up with the changing environment.

Knowing the importance of being well educated the members of information society start their education in early childhood. Kindergartens are well prepared to work with children. The children are taught many useful things, e.g. existing in a group, presenting their skills, being independent. Education at this level has a big impact on further learning and furthermore on personality. On the field of children education we can also observe development of numerous business activities. The most popular are language schools and numerous sports courses. The children are also offered to attend art classes. Besides sculpturing, handcraft and painting there are a lot of activities educating in music.

E. Brynjolfsson and A. McAfee recommend the race with machines, not against them. To implement this strategy they advise fostering organizational innovation and investing in human capital. To reach this aim they acclaim investments in human education and skills to get most out of racing technology [BrMc12]. Despite all power and speed of today's computers, they show little creative abilities. So, in this area the humanity is ahead of the machines. The system of education should reinforce this natural human potential. Among many ways, fostering human creativity there are also those related to music education. Numerous studies support the statement that the music education helps to have better academic achievements. The music education improves auditory perception skills and might impact reading abilities [ATWL02]. It can also have positive impacts on maths skills. Although there are some researches adding some caveats to this notion [HoO'C13], the active involvement in music has the positive impact on intellectual development of children [SoRo09]. Especially if the

involvement in music is an enjoyable experience, it influences general attainment, team work, self-discipline, emotional sensitivity and creativity [Hall10].

The example of Yamaha Music Schools and Suzuki Schools

Among the business activities based on music education there are Suzuki Schools and Yamaha Music Schools. The roots of both methods are derived from Japan.

Shinichi Suzuki was the author of Suzuki method and philosophical system, described in the book "Nurtured by Love" [SuSu83]. They assume the music education of all children and not only talented ones. Learning to play any instrument is based on children's abilities of imitation. In the beginning the method was dedicated to playing the violin. After the Second World War it also included other instruments. Today there are many schools based on Suzuki method worldwide. The main aim of this method is the universal child's development and the sensivity to beauty. The early learning music influences many skills as language and maths. It also improves manual skills, coordination and memory. Furthermore, a child is taught concentration on the task, cooperation with other people and regular work to achieve targets [MuzZak13].

Yamaha schools are created correspondingly with Suzuki method. Although the popularity of both schools is similar (Figure 1), in Poland Yamaha Music School seems to be more popular than Suzuki School (Figure 2).
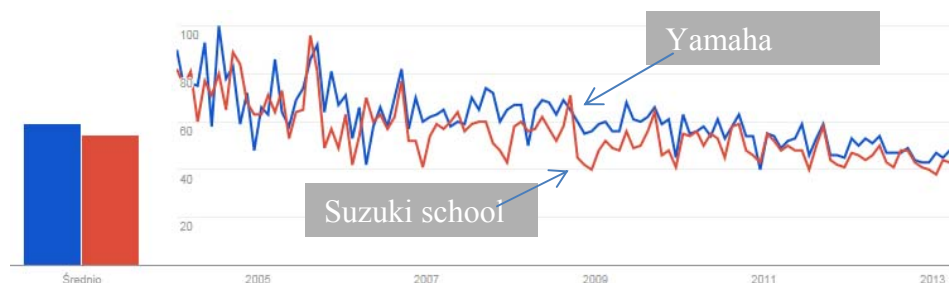

Fig. 1. The interest of Yamaha school and Suzuki school in world
Source: [www1].

It is confirmed by a higher number of Yamaha schools functioning in Poland (Yamaha: 127 [Yam13], Suzuki: 12 [Cums13]) and the Google Trends (Figure 2).
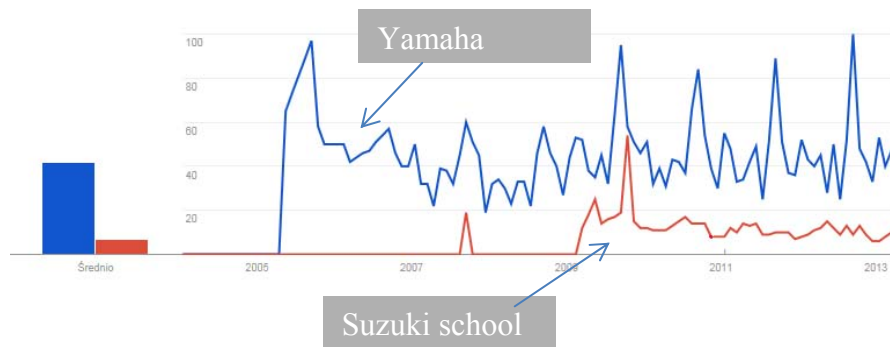
Fig. 2. The interest of Yamaha school and Suzuki school in Poland by Google Trends
Source: [www1].

Trade mark of Yamaha is also well known as a producer of motorcycles, marine products and snowmobiles. It is also well known as a manufacturer of musical instruments including pianos, guitars, string instruments, drums and wind instruments. It manufactures also audio-visual products and music production tools. Yamaha Music Schools function as a part of Yamaha Corporation. They are a good example how activity in educational branch increases brand awareness. Yamaha Music Schools are opened worldwide (Figure 3).

Fig. 3. The extent of Yamaha schools
Source: [www2].

According to data from Google Trends, we can suppose that in each country Yamaha school life cycle is different (Figure 4).
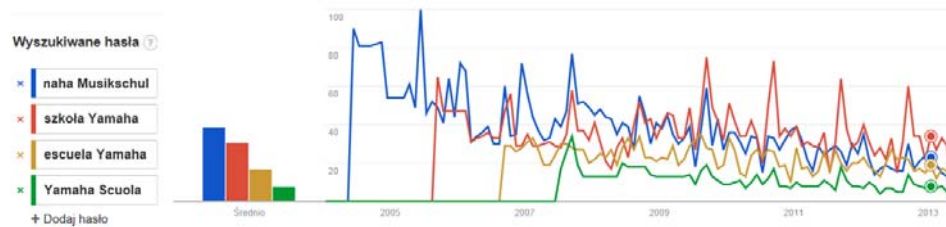
Fig. 4. The interest of Yamaha school in different languages (German, Polish, Spanish, Italian)
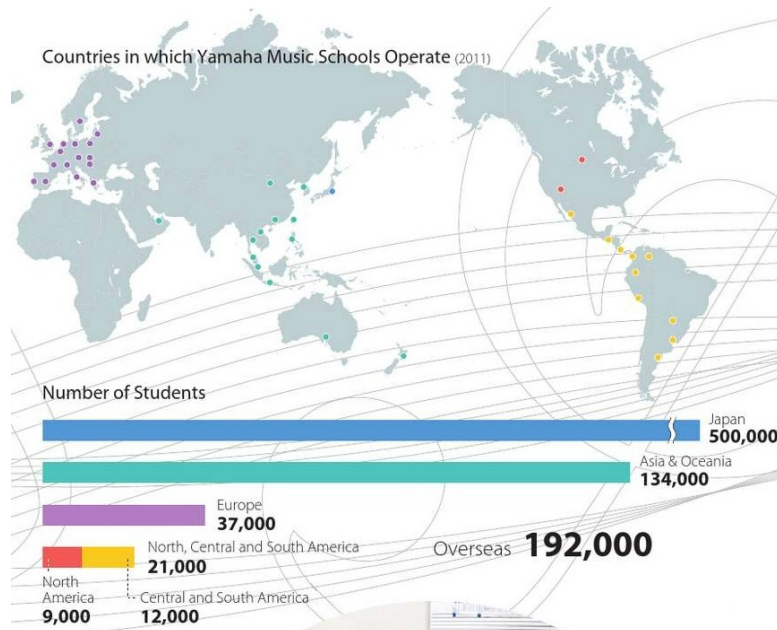
Source: [www1].

The schools are designed first of all for pre-school children but also for older children, teenagers and adults. The main foreign market entry strategy is franchising [Dul09]. It provides each school with the access to standardized educational materials, organizational and marketing system. Every few years Yamaha schools exchange instruments and make the sale to their pupils of previous ones at competitive prices.

Among all Yamaha products, the electronic instruments have the main role for this article. In Poland for Yamaha Music Schools the keyboards play the special role. They are even more popular than the guitars (Figure 5 and 6). Playing the keyboard is like playing the piano. The children learn reading music notes but thanks to many keyboard functions playing is easier. It is also more spectacular because of keyboard's accompaniments and voices systems.

Fig. 5. The interest of Yamaha keyboards and guitars in Poland by Google Trends

Source: [www1].

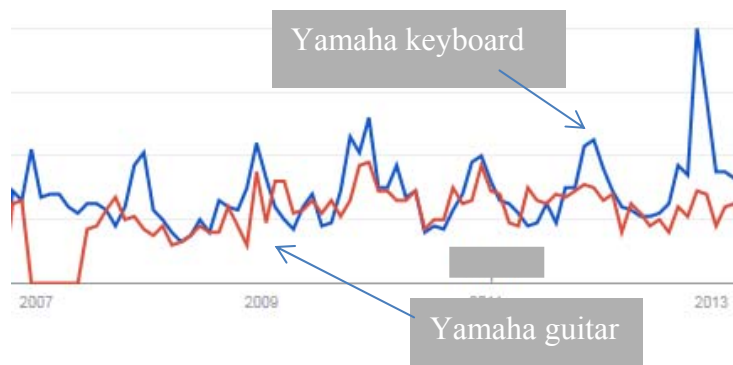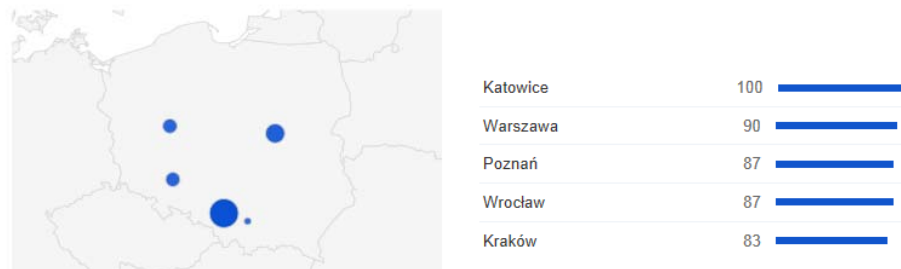| Katowice | 100 |
Warszawa	90
Poznań	87
Wrocław	87
Kraków	83

Fig. 6. The regional interest of Yamaha keyboards and guitars in Poland by Google Trends

Source: [www1].

The method of education

Music education of pre-school children bases on a special method. During the lessons the parents accompany the children and they participate in the process of education. Yamaha education method assumes studying in a group. During each lesson children learn a new song. The main theme of each song is also the main theme of art activities of children. During the lessons the children listen to music, paint, draw or stick. They have special books They also use the music instruments such as rattles, tambourine or drums. At home children listen to songs from lessons recorded on CD. The music education of older children and teenagers also concerns teaching in the groups. The pupils can choose among a few instruments such as the keyboard, the guitar or the saxophone. However the most popular instrument is the keyboard. There are a few reasons of it. First of all after infant educating programs children are pupils who are four years old. Playing the keyboard at this age is easier than playing the guitar or saxophone. Besides playing the keyboard is more spectacular thanks the many functions of the instrument. During the lesson pupils learn reading tunes written with the notes. Usually the main music theme is based on pop music which is an additional motivation for pupils to play. Besides reading the notes, pupils learn accompaniment and improvisation [Yama13].

The music education in Poland

The activities such as Yamaha and Suzuki music schools fill a gap in Polish society. In Poland after the Second World War the system of music state schools was created. Only the most talented children can educate in those kind of schools and the level of education is very high. In this way many children can't learn playing any instrument. With time the disproportion between the children educated in music state schools and the children not educated in them has become enormous. It also has resulted the decrease of music education of all Polish society [BGMS10]. The situation changed with the emergence of initiatives as Yamaha and Suzuki music schools. The music education has become more available.

The prices of music instruments, especially the electronic ones also became more available. The lower prices of the keyboards comparing to acoustic pianos caused easy and common access to these kind of music instruments. As A.C Pigout noted, new technologies increased the access to products and caused decrease of their prices [Gust12]. Additionally the members of society have felt the need of music education of their children. They regard it as an investment in the human potential and the creativity so required in today's world. This attitude of society has given new jobs for music teachers and those who organize these kind of music schools. It also stimulates the sale of music instruments for schools and pupils. This way the tenets of Say and Schumpeter about job creating by inventions seems to be still actual.

The examples of educational services in other branches

The other example of educational services is the activity of producer of Statistica software. It is the software package for statistical and analysis, released by StatSoft. The activity of StatSoft is addressed to academic. The university staff and the students can use Statistica under license Site Licence free. It is renewed annually. Having the access to this software package the university staff teaches using Statistica. There are also numerous competitions based on Statistica [PolSl13]. Hereby this statistical tool is popularized. Probably present students will also use the Statistica package in their future work. In this way the new potential customers are created. Popularizing Statistica, StatSoft also organize the training centers with numerous courses. There are also various online guides, manuals and articles.

Similar activities are noticed by Cisco, the enterprise related to teleinformatics equipment and services. To popularize its trademark various trainings on the field of network are offered. The main recipients of those trainings are the high school pupils and the students. On the web sites the training videos and expert advice are placed.

Conclusion

Although the technological development improved the living standard of human, it was also seen as a danger. This danger was named technological unemployment. As it is known, the technological unemployment is taken from the insufficient education of society. It is shaped when the technology overtakes common knowledge and skills of society members. To counteract this phenomenon it is necessary to intensify the society education. It often happens that the main role in this intensification is led by enterprises. They organize schools, often with the special method of training. To popularize the software they offer the special licenses. These licenses are dedicated to the academic staff, who in turn, promotes the software among students. After graduation the recent students will probably use this software in their jobs.

These activities of enterprises not only promote the trademark but also generate the new jobs. The examples of Yamaha school and Suzuki school show this phenomena. Yamaha and Suzuki methods of teaching provide the new jobs for music teachers worldwide. Furthermore, appearance of these methods and schools reviled in our society the need of different education of our children. This need is related to the race with the machines on the job market. The winning of humanity in this race is possible only if we are ahead. Despite the fact the computers are encroaching into areas that used to be the domain of people, they don't possess some skills. One of them is creativity, which we can develop introducing the arts to education.

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ROLA USŁUG EDUKACYJNYCH W SPOŁECZEŃSTWIE INFORMACYJNYM – PRZYKŁAD BRANŻY MUZYCZNEJ

Streszczenie

Postęp technologiczny od zawsze polepszał standardy życia ludzkiego, a także pokazywał swoje ciemne strony. Jedną z nich był wzrost bezrobocia wynikający z zastępowania człowieka przez maszyny. Negatywny wpływ postępu technologicznego był podkreślany przez licznych ekonomistów. Inne spojrzenie na tę problematykę prezentowali Jean-Baptiste Say, Arthur Cecil Pigou i Joseph Alois Schumpeter. W swoich pracach udowodnili oni, iż bezrobocie wynikające z postępu technologicznego jest zjawiskiem tymczasowym. Postęp technologiczny, choć eliminuje miejsca pracy w jednych branżach, kreuje je w innych. Co więcej, tworzy zawody, które dotąd nie istniały. Dodatkowo zmniejsza ceny dóbr i zwiększa popyt na nie.

Głównym celem artykułu jest przedstawienie przykładów biznesowej działalności, które potwierdzają prawdziwość tez Saya, Pigou i Schumpetera. Prezentowane przykłady dotyczą biznesowej działalności związanej z usługami edukacyjnymi. Pokazują one, jak nowe technologie wpływają na tworzenie nowych miejsc pracy, a te z kolei na świadomość marki i sprzedaż produktu. Ponieważ przykłady biznesowej działalności dotyczą usług edukacyjnych, więc w artykule opisano mentalność członków społeczeństwa informacyjnego i szczególną wartość edukacji w takim społeczeństwie. Jako główne ilustracje wspomnianych usług w branży muzycznej przedstawiono przykłady szkół muzycznych Yamaha i ośrodków muzycznych kształcących metodą Suzuki.

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APPLICATION OF THE SOFTWARE AGENTS SOCIETY IN THE KNOWLEDGE MANAGEMENT SYSTEM LIFE CYCLE

Introduction

Modern organizations, looking for new ways to improve their competitiveness, are focused on the application of innovative solutions that can improve the efficiency and effectiveness occurring in these activities. As a result the IT solutions market for ERP class systems, focused on improving the efficiency of operations and business in the field of decision effectiveness, is constantly evolving. These systems are used to assist in the processing of data and information sharing, as indicated by the literature, can be considered in terms of knowledge management (KM) systems. The result is that the modern knowledge-based organizations must be on one hand used with systems oriented on primary processes such as sales, generating profits, and on the other hand they are aware that competitive advantage requires the use of solutions that support knowledge management in an organization. As a result, modern organizations, aware of the significance of the application of organizational knowledge, require exploration of modern information systems in order to support the different stages of the life cycle of a knowledge management system and perfecting the execution of the processes occurring in them. Software agents can be such a solution; and in the context of multi-agent solutions – software agents communities.

The aim of this article is to present the concept of software agents community and its impact on the areas of knowledge-based organizations on the basis of the life cycle of a knowledge management system.

The scientific purpose of this article is to present the possible influence of software agent technology on knowledge management system's life cycle. These research methods include the literature review in this field. In author's opinion, using software agents as a part of information systems organization increases

their functionality, usability and gives an opportunity to enhance them with se-
mantic knowledge representation standards like OWL.

Author's previous studies tend to indicate the possible use of community
software agents as part of a supportive and perfecting business processes in or-
ganizations [StZy2010]. This paper will address the aspects of modeling such
solutions as elements enabling support for modern knowledge-based organiza-
tions in the field of their business processes. In the first part of this article the is-
sues of software agents will be presented, then their predisposition characteris-
tics for use in the field of knowledge management organization will also be
presented. Finally, the aspects of the use of software agents on the basis of the
life cycle of a knowledge management system will be shown.

1. The use of software agents in the area of supporting the business processes in an organization

Modern approaches to the theory of organization and management devel-
opment are focused on the processing approach, associated with the flattening of
the organizational structure and related to the rejection of the classical functional
structures of the task forces, created cross-organizationally, which are estab-
lished for specific tasks [ZaZy2013]. The organization is treated as a set of pro-
cesses that permeate each other, are reproducible and clearly defined. Process
approach towards activities taking place in organizations may also result from
their consideration in a systemic perspective. This approach aims to increase the
competitiveness of the organization in a dynamic environment, by reducing
costs, improving service quality and improve its operations with clearly defined
stages of the process, the possibility of monitoring and elimination of potential
"bottlenecks". The process approach supports effective implementation of the
objectives adopted by the organization. Competitiveness requires them to not on-
ly improve the efficiency of the business processes, but requires consideration in
the context of knowledge management processes. Knowledge management is
defined as the process of identifying, capturing, and organizing and dissemina-
tion an organization's intellectual assets which are important to its long term per-
formance [SD2006].

Modern organizations, which must compete in a changing environment, re-
quire the systems to support both of these trends. However, this is an extremely
difficult task. On one hand, systems targeted at business processes operate on da-
ta and are related to the current activities of the organization in obtaining rele-

vant results such as sales. Knowledge management systems, which are created there, are not built for achieving the basic processes, but as part of the employees support and to provide knowledge on these existing processes. The result is that the IT solutions built at the junction of two streams require further exploration of the methodological aspect of the construction and the impact on the organization itself and its effectiveness. Agent based solutions can be considered as an aid to both approaches.

According to the definition of an autonomous agent, it is a system situated inside and is a part of the ambient environment and is capable to analyze and affect it in time, strive to set goals and to simulate the impact of changes in the environment [LAI2004]. Such solutions, using different mechanisms of artificial intelligence, can assist human activities or replace him. Software agent groups allow to consider them as multi-agent systems. The development of the concept of software agents allowed to define the concept of a multi-agent system, which can be regarded as an organized community of individual units, where agents play specific roles and interact with other agents. The scope and the subject of research conducted so far indicated that the current development of agent technology research is focused on the design of open, mobile systems with broad functionality and high dynamic range. As a result, the use of agents generates new features of the system, which include focus on knowledge, self-organization and distributed decision making [IvBu2013]. In the literature, such arrangements are referred to as organization agents [FM2007]. In this case organization agents are treated as a united group of agents to achieve specific goals. They form a social entity, with defined structure, resources and authorities. They are created for the implementation of emerging goals and may also be referred to as electronic institutions/gent institutions [CLR2008]. One of the trends is the concept of agent society, which typology proposed in the context of their use as an item of information systems supporting knowledge-based organizations is presented in this paper [Zy2013b].

The development of the multi-agent systems concept makes the static architecture of multi-agent systems in a hierarchical architecture become insufficient mainly in the context of the construction of self-organizing solutions (for network architecture, market), where mobile agents become members of the community in a dynamic way. Artificial community of software agents can be regarded as a set of agents who act on each other using certain rules and standards. Alike in human societies such artificial community members must have permission to coexist in this environment and for the completion of their objectives in

the presence of other units. The purpose of using standards in such systems is to manage the rules for participation in the community and to provide mechanisms for the achievement of desired behavior [DJ2009]. As a result, agent-based solutions should, on one hand, be used with defined standards of their structure (e.g. the use of multi-agent platforms defining the norms and principles of the system's operations), and on the other for the co-operation with the user they should use the mechanisms that allow them to semantically interpret the stimuli received from the environment. Depending on their use as part of an information system organization, they should operate on the knowledge contained therein concerning the standards and principles of the organization. The result is that the communities of software agents, considered in the context of their use as part of a knowledge management system, should:

- support the different stages of the life cycle of a knowledge management system,
- not only automate tasks carried out during the implementation of the organization's business processes, but also to apply the knowledge within the organization for their improvement and support,
- use a common conceptual base processable by the mechanisms of semantic processing of knowledge,
- be associated, by semantic descriptions of resources, in organization's information systems, as well as a part of the organization's knowledge portals that can be supported by agents or constitute a centralized knowledge bases for them,
- use currently applied multi-agent environment construction standards, which helps in their design and creation, and be supported by the modeling methodology aimed at defining their relation structure, but taking on aspect of the knowledge of the system in terms of knowledge within the organization.

In order the software could be considered agent oriented solution, it must have certain characteristics. From the point of view of software agents features such as proactivity, autonomy, mobility, openness, personification, and personality are undertaken in the literature [SS2007]. From the point of view of the application of software agents in the area of supporting organizations we can distinguish:

1. **The ability to learn and interact with the environment** – the process of collecting, processing and sharing the knowledge and information requires the cooperation of the participating stakeholders. Developed agent

communication standards support processes of semantic representation along with inference on the basis of their content.

2. **The ability to adapt to new conditions and effects in real time** – the distribution of knowledge requires the involvement of stakeholders and analysis of the environment in which the agent is located. Software agents have characteristics which allow them to take real-time actions based on the changes of the codified knowledge and resources to respond to user needs in real time.

3. **The ability to adapt to their tasks** – the use of semantic knowledge representation method allows for interpretation of the purpose and determining whether the knowledge is sufficient to perform the agent's tasks. In the absence of adequate knowledge the agent is able to communicate with the environment in order to acquire it.

4. **The ability to store codified partial knowledge concerning given problem** – the use of agents and methods of semantic representation of knowledge allow mobile agents to perform tasks with only a selected portion of the codified knowledge related to the task that it performs. The result is that such units do not need to have direct access to the knowledge management system and can work remotely in terms of ubiquitous communication.

2. The use of software agents in knowledge-based organizations on the background of the life cycle of knowledge management system

It can be stated, based on the above characteristics, that the knowledge-based organizations use intellectual capital to manufacture products, provide services, but also consciously manage intellectual capital and are capable of learning. In other words, knowledge-based organizations are those that adjust their offer and the way they work to the knowledge resulting from the reflection on the current course of action and consciously manage knowledge resources, which are the organization's part and which show signs of co-operation. General architecture of the analyzed systems can be seen in [GBA2004], [AlChu2004], [XiZhXu2006] as a three-tier architecture. The first tier is the interface layer, which can be seen as user interface to enable user's access to information or knowledge represented in system, gather information/knowledge from them and

help users in better understanding of the information and knowledge. The second tier is business/knowledge tier. It is responsible for generating knowledge, sharing it among users, giving access to the codified knowledge and supporting its creation. The third tier is infrastructure services which can be represented by structured resources or data representation mechanism. In previous publication [ZyKo2013] authors reviewed different implementations of software agents as part of KM system and proposed a general concept of knowledge management system supported by software agent society in the area of knowledge evaluation.

From the point of view of knowledge management processes we can distinguish the following stages of the process, defined as the life cycle of a knowledge management system:

1. **Knowledge generation** – the use of software agents in this area can concern their communication with users or systems. In the first case, the use of interface agents allows, during direct contact with the user, to gather knowledge on the subject and on the actions that he takes. If such a solution is a part of the organization's knowledge portal, it allows to collect knowledge such as the needs of potential customers, their expectations and information needs. In the case of linking software agents with the organization's information systems, software agents can be part of the automation process of knowledge discovery in the data. If the organization is equipped in a knowledge portal, software agents can support its operation, treating it as a repository of knowledge within the organization and allowing it to describe the organization's information resources based on the developed concept map. Such metadata, defined using description languages ontology, can be interpreted by software agents and used in the performance of their activities.

2. **Knowledge evaluation** – the use of the organization's knowledge portal gives the software agents the ability of analysis to support awareness and use of processes in organizations. In this case, codified knowledge stored in the portal, through the mechanisms of agent's artificial intelligence, can be assessed and used in the organization's business processes. Audit knowledge is a key element of knowledge management. Thanks to the analysis of the knowledge base the software agents can support the operation of the organization to generate new knowledge about it and support the decision-making processes. This requires ontology description languages such as OWL, allowing the agents' inference. An example of the use of software agents in this process has been shown in [ZyKo2013].

3. **Knowledge sharing/dissemination** – it is currently the most common use of software agents by organizations. Currently created solutions, that have their own knowledge base, enable direct communication with the end user. Although anthropomorphism is indicated as a key element of the impact of human agents, it depends on the knowledge that an agent has whether the agent software will be considered as a useful tool. In the case where such entity is linked by organization's information systems, the use of descriptive semantic knowledge contained in them allows agents to draw conclusions based on the defined rules and knowledge from e.g. a BI system and for the interaction and business processes course. An example of applying semantics in the BI system's resources description area can be found in this work.

4. **Knowledge leveraging** – although this phase is seen in the literature with regard to the knowledge management system users, here you can also search for items related to the use of software agents. Main feature of software agents is their ability to communicate. In the case of communication between agents it is necessary to determine how to interpret the generated transmission between these units. The use of semantic description of knowledge gives program agents and their creators a conceptual basis which allows defining the interpretation/meaning mechanisms of the specified knowledge. Using semantic knowledge description methods results in the improvement of human-computer communication and the communication within the system.

5. **Knowledge discovery** – from the point of view of the use of software agents in knowledge-based organizations, knowledge discovery process may concern two aspects. The first is related to the creation of agents' community, which must support such an organization. For the purpose of the creation of such solutions adequate preparatory measures for diagnosis of knowledge and its sources are required, along with knowledge codification process, which will be used by software agents. In this case there is a problem of encapsulating the knowledge of the agent, and inability of its updating and development. The use of the knowledge portal in this area allows for agent's integration on the knowledge representation layer level, so that software agents can exploit new resources of codified knowledge placed on the site by users and the agents themselves.

Conclusion

Presented issues indicate that the undertaken problems are an innovative approach to knowledge management processes in knowledge-based organizations using the concept of community of software agents. Especially in the era of the semantic Internet development and the currently under construction Web 4.0 concepts, which essential aspect is the use of agent technologies for processing of knowledge on the Internet. Thanks to the community of agents and ubiquitous communication it will be possible to easily integrate distributed devices within business processes where a man is involved, a dynamic specification of business processes with their participation and the codification of such processes within the concept of composite software, and ultimately to obtain a competitive advantage in the knowledge-based organization, thanks to the possibility to obtain new knowledge about the processes and the participating entities. The use of semantic solutions in this process will assist in the representation of acquired knowledge and its processing by information technology and by the man himself. This way of codifying the knowledge about the dynamic business processes and entities participating in them makes it is possible to use the agents' community also for the purpose of managing of acquired knowledge.

Acknowledgement

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WYKORZYSTANIE SPOŁECZNOŚCI AGENTÓW PROGRAMOWYCH
W CYKLU ŻYCIA SYSTEMU ZARZĄDZANIA WIEDZĄ

Streszczenie

Nowoczesne organizacje, poszukując nowych dróg poprawy swojej konkurencyjności,
są ukierunkowane na zastosowanie innowacyjnych rozwiązań informatycznych, które mogą
poprawiać efektywność oraz skuteczność zachodzących w nich działań. W efekcie rynek
rozwiązań informatycznych w obszarze systemów klasy ERP zorientowany na poprawę
efektywności działań oraz Business Intelligence w obszarze skuteczności decyzji stale
się rozwija. Systemy te stosowane dla wspomagania przetwarzania, udostępniania danych
i informacji, jak wskazuje literatura, mogą być rozpatrywane w kategoriach systemów
wspierających przetwarzanie wiedzy w organizacji. Powoduje to, iż nowoczesne
organizacje oparte na wiedzy muszą wykorzystywać z jednej strony systemy
ukierunkowane na procesy podstawowe, np. sprzedaż, generując zyski, a z drugiej mają
świadomość, iż przewaga konkurencyjna wymaga stosowania rozwiązań wspierających
zarządzanie wiedzą w organizacji. W efekcie nowoczesne organizacje, zdając sobie sprawę
z istotności zastosowania wiedzy organizacyjnej, wymagają poszukiwania nowoczesnych
systemów informatycznych, które wspierałyby różne etapy cyklu życia systemu
zarządzania wiedzą oraz doskonalące realizację procesów w nich zachodzących. Takimi

rozwiązaniami mogą być agenty programowe, a w kontekście rozwiązań wieloagentowych – społeczności agentów programowych.

Celem niniejszego artykułu jest przedstawienie koncepcji społeczności agentów programowych oraz obszarów ich oddziaływania w organizacjach opartych na wiedzy na tle cyklu życia systemu zarządzania wiedzą. Dotychczasowe badania autora skłaniają do wskazania możliwego zastosowania społeczności agentów programowych jako elementu wspierającego i doskonalącego procesy biznesowe w organizacjach. W niniejszym artykule zostaną poruszone aspekty modelowania takich rozwiązań jako elementu pozwalającego wspierać nowoczesne organizacje oparte na wiedzy w zakresie realizowanych przez nie procesów biznesowych. W pierwszej części zaprezentowano zagadnienia dotyczące agentów programowych, dalej przedstawiono ich cechy predestynujące je do zastosowania w obszarze zarządzania wiedzą organizacji. Na koniec ukazano aspekty stosowalności agentów programowych na tle cyklu życia systemu zarządzania wiedzą.