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INFORMATION SYSTEMS IN MANAGEMENT

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THE USE OF IT TOOLS FOR THE SIMULATION OF ECONOMIC PROCESSES

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This research paper presents an attempt to assess available IT tools supporting process management, namely Aris, Adonis, iGrafx and IBM BPM. It was indicated that the basic functionality of these tools is similar, but while using the same tools for modeling more complex cases there are substantial differences in the capabilities of description and simulation of economic processes.

Keywords: processes simulation, IT tools for processes modelling, Aris, iGrafx, Adonis, IBM BPM

1. Introduction

Development of IT tools used for modeling of economic processes has been already going on for many years. Especially at the turn of 80s and 90s of the 20th century, a number of applications was created, of which improved versions are used and developed currently. The classics of these tools include:

1) ABC FlowCharter – created at the end of 80s. of the previous century in the Roykore company, which was taken over by Micrografx, which was once again taken over by iGrafx [1, 2] as a part of Corel corporation.
2) MsVisio – you can also model with it processes in the eEPC notations (extended Event-driven Process Chain) and with the downloaded overlay or latest version of MsVisio 2013 you can do it also in the BPMN notation

(Business Process Modeling Notation, now it is referred to as Business Process Model and Notation) [3].

3) ARIS (Architecture of Integrated Information Systems; German: *Architektur Integrierter Informationssyteme*) concept developed by Professor August Wilhelm Scheer from the University of Saarbruecken. ARIS TOOLSET was developed by IDS-Scheer company, which has been taken over by Software AG [4]. Currently, the latest version is Aris 9.0.
4) Adonis of the BOC company [5] – you can model and simulate processes in the BPMN notation as well as on the basis of BPMS notation (Business Process Management Systems) developed by the Institute of Business Informatics in Vienna. The latest version is Adonis 5.0 and free version of Adonis CE 2.0 (Community Edition).
5) IBM BPM (Business Process Manager) - a product created in 2011 as a result of the merger of WebSphere Process Server (WPS) that was developed by IBM since 2005 and purchased in 2010 Lombardi TeamWorks product (subsequently renamed WebSphere Lombardi Edition WLE). It enables the modeling of processes by using the BPMN notation. It also enables the simulation and implementation of modeled processes without additional third-party products [6].

In addition to the tools discussed above a lot of applications for modeling and simulation of business processes can be found on the Internet e.g.:

1) Business Navigator [7].
2) Certus Process Modeler [8].
3) BizAgi [9].
4) Lucidchart – application available as Google Cloud solution which is free of charge for persons having a Gmail account.
5) Simul8 [10].
6) Process simulate [11].
7) Enterprise dynamics [12].
8) ShowFlow Simulation Software [13].

You can find more of such applications, some of which were assessed in the report of Gartner Inc [14].

The purpose of this article is a comparative analysis of four leading applications: Aris, Adonis, IBM BPM and iGrafx in the field of the business processes simulations. Comparative test of simulation capabilities of chosen IT tools is based on sample linear process model, composed of 4 workstations, that process products in series of 10. Results achieved by analysed applications concerns the processing time. A comparison of these results with each other and their processing time observed by team of students performing the experiment shows significant differences. Deviations are caused by both the parameters definitions capabilities and simulation algorithms built in each application.

Analysis presented in the article reveals limitations of simulations performed by each IT tool. Due to the limitations of allowed article volume, the test of simulation capabilities is limited to time parameters that includes waiting time, preparation time, transport time etc. Similarly these problems are reflected in process costs, as resources cost depends on use time (both human resources and assets).
Apart from conclusions on processing time simulation, short characteristic of 4 applications used in test is also presented. It contains:

1) Availability - free trial and test versions, conditions of academic alliance programs.
2) Easy of use of user interface.

These aspects have major impact on the choice of tools for the analysis in this article, therefore, they are included in ending part.

2. Related Works

In the literature many articles on process simulation in IT tools topic can be found. Most of them present simulation capabilities in one chosen application [15, 16, 17]. They are commonly based on the particular case, for example a single workstation [18] or a few of them [19]. However, there not many articles comparing capabilities of more IT tools, like a Visual SimNet and Taylor II applications [20]. The strength of this article is also simulation of very simple process and inspiring analysis of the literature [21, 22].

3. Basic functionality in the area of processes simulation

All four analyzed applications are comparable in terms of basic features in the area of processes simulation. The main parameters controlling the simulation are:

1) Times assigned to activities in the process.
2) Costs assigned to these activities directly or resulting from the use of resources allocated to the implementation of specific activities.
3) Logical gates (operators).
4) The probabilities controlling the course of the process in the situation of forking process paths.

These parameters allows you to perform a simple simulation of the process. However, the question arises whether more advanced capabilities to simulate the process are included in these tools. Such test, designed on the basis of experiments conducted in the classroom with students, will be described and conducted on the selected four applications: Aris, Adonis, iGrafx and IBM BPM.

4. Test structure

The task, which verifies how the analyzed applications deal with the problems of processes simulation under conditions of the variability of the parameters controlling this simulation, is based on a very simple model of the manufacturing process [21. p. 111]. The experiment, carried out with the participation of students, used the model of four manufacturing cells located in series. In each cell, one person manually performed some physical activity, and the second one was supposed to note down the durations of these activities. Each station transferred the effect of their work to the subsequent one. Characterized manufacturing process is shown in Figure 1 where there are consecutive activities, placed in subsequent lanes. In the figure, we can see dialog boxes where the parameters of activities durations and normal distribution, which is applied here, are entered.

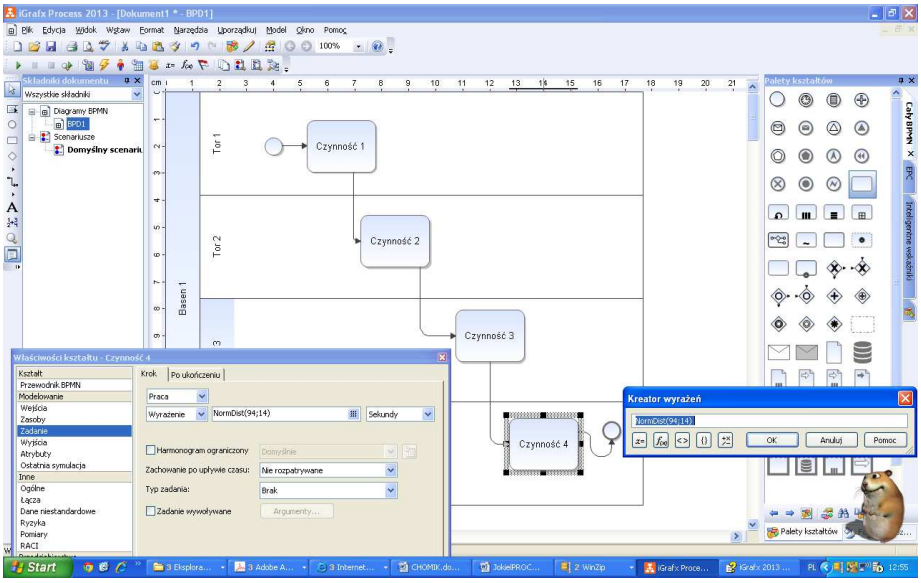

Figure 1. Manufacturing process modeled in BPMN notation in iGrafx 2013

The task was to estimate the production time of a series of 10 finished products in this system. Contrary to all appearances, the estimation of the total time for the passage of 10 process instances is not a simple task. First of all, the outcome is affected by fluctuations in the times of performing actions concerning the subsequent manufactured products by the processing stations. Despite the fact that all stations perform the same range of activities, the duration of this processing is different. Not only between the processing stations, but also within the same working posts as to successive products. The observed fluctuations in performing manual actions at the successive processing stations are presented in Table 1.

Table 1. The results of operations duration measurements for individual processing stations in the examined group of students

Products	The processing time of consecutive products at appropriate stations in minutes			
	Station 1	Station 2	Station 3	Station 4
1	01:58	01:42	01:26	01:27
2	01:38	01:40	01:25	01:31
3	01:49	02:04	01:16	01:42
4	01:27	01:49	01:21	01:37
5	01:42	01:51	01:21	01:43
6	01:23	01:45	01:19	01:25
7	01:32	01:39	01:10	01:43
8	01:30	01:52	01:02	01:50
9	01:22	01:33	01:35	01:42
10	01:48	01:31	01:07	01:35

By subjecting these data to statistical processing, we can calculate the following indicators for these activities (rounded to the nearest second):

1) The arithmetic average is 1 minute 34 seconds.
2) The median is 1 minute 35 seconds.
3) The mode is 1 minute 42 seconds (this result occurs 4 times in the study population).
4) The variance is 1 minute 7 seconds.
5) The standard deviation is 14 seconds.

The model treatment of the process execution at the average gives 13 x 94 seconds = 20.37 min. However, this value rather cannot be expected

The whole process of manufacturing a series of 10 products through the above described manufacturing process handled by the students was 23 minutes and 43 seconds (not considering the quality level goods manufactured at that time, i.e. without adding the time needed for correction of errors made in processed products by the work stations to this result).

The described process will now be simulated using four analyzed IT applications. First of all, we should determine the duration of each activity. As can be seen from the actual data, it varies between the values of: 1: 02 and 2: 04.

The advantage of positive deviations (observations of times exceeding the average) does not significantly differ from the sum of negative deviations (observations operation times shorter than the average). It amounts to 12 seconds (below the standard error). In this situation, it is usually assumed that for the estimated time of operations execution, one can adopt symmetric probability distribution. But the usual practice is that the normal distribution is adopted because of the convenience of use resulting from, for example, well-prepared and easily accessible tables of this distribution [23]. Unfortunately, such minor rounding or smoothing of small differences can have a significant impact in the

case of processes simulated in series, especially large series. This is a typical situation, in which the butterfly effect may occur [24].
It is also worth noting that, although small, yet the regularity is observed also in this case, consisting in that the probability of completing the operation X_i within a time shorter than the average $\overline{X}$ is smaller than the probability of completing this operation over a period longer than the average, which is denoted by the formula [22, p. 375]:

$$P(X_i < \overline{X}) < P(X_i > \overline{X}) \quad (1)$$

This is proven by the aforementioned predominance of positive deviations from the sum of negative deviations by 12 seconds.

5. Test results and tools assessment

Thus, the following data were adopted for the needs of simulation:
1) The duration of operations has been assumed at the level of the arithmetic mean, in particular owing to the fact that its value deviated from the determined median only a little within the surveyed population (1 minute 34 seconds).
2) Normal distribution was used for the probability estimation of deviations for the average value.
3) The value of the standard error was adopted at the level of 14 seconds.

These data were introduced as parameters of tasks in process models created in the analyzed applications. It is shown in Table 2.

Table 2. Results of simulation in the studied IT tools (normal distribution)

No.	Application	The applied notation	The result of the passage of one process instance	Simulation result of a series of 10 pieces in minutes.	Range of results achieved by 10 series of 10 products in minutes.
1	Aris Simulation 6.0	eEPC	6:03	21:40	21:40
2	Adonis 4.0	BPMS	6:16	No result	No result
3	iGrafx 2013	BPMN	6:10	22:14	from 20: 57 (simulation No. 10) to 23: 40 (simulation No. 7)
4	IBM BPM	BPMN	6:53	22:35	from 21: 19 (simulation No. 1) to 23: 14 (simulation No. 4)

Aris simulations were conducted in Aris 6.0 and Aris 7.1 due to the access to these versions of licenses. The current version of Aris 9.0 is not available free of charge. Unfortunately, it was not possible to carry out 10 series of 10 products in a single course of the simulation. Therefore, 10 subsequent simulations of the same model were conducted one by one, but the results achieved in each of these 10 simulations were the same 21:40.

In the case of Adonis, in the standard version, it is not possible to assign probability distributions to the attributes of a task. One of them is the execution time. It can be expected that in column 4 of the above table, the result of 13 x 94 sec should appear, namely 20 min and 37 sec. However, the results generated by Adonis 4.0 are 1: 02: 40 – one hour two minutes and 40 sec. This means that application did not take into account the possibility of parallel processing of successive products by work stations. At first, only 10 products were processed at the Processing Station 1 for 15 minutes and 40 sec and then the same thing happened at three subsequent stations. It is possible to modify Adonis, so as to handle more sophisticated simulations, but the BOC company does this at the individual request of a customer, for an additional fee.

iGrafx 2013 has a very friendly and intuitive user interface and a wide range of simulation capabilities.

In the IBM BPM program, 10 simulations with identical parameters have been carried out. The average execution time of 10 process instances was 22 minutes and 35 sec (the scope from 21 minutes 19 sec to 23 minutes 14 sec). Within the additional parameters of applications available in this tool, it has been established that each station is assigned one unique person, and the time interval, at which a new process instance is executed, was set to a constant value of 1 minute. This resulted in visible in the simulation results quickly increasing waiting time for the process instance at the first station and variable waiting times for subsequent stations, resulting from the variable (dependent on the normal distribution) execution time at the preceding stations.

The results obtained by the three tools (Aris, iGrafx, IBM BPM) differ from one another. The shortest simulation time for the production of a series of 10 products was reached by iGrafx with the time of 20 minutes and 57 sec per series. Also, with the use of this software the longest simulation time, which is 23 minutes and 40 seconds, was reached. This means that iGrafx generates the greatest deviations of simulated values. The reasons for these differences can be explained by calculating algorithms and the number of decimal places used for the calculation in different tools. However, the difference (though not radical) is visible between the results generated by machines and the time achieved by the team of students. Maximum production time of a series of 10 products generated in iGrafx only came closer to the time achieved by the students actually performing this simulation, i.e. to 23 minutes and 43 sec. One may draw conclusion that in the case

of people, greater deviations of activities completion should be expected than in the case of idealized simulation model.

In this situation, a simulation with the use of asymmetric probability distribution was carried out, the modified triangular distribution was used to reproduce the situation in accordance with the formula 2, which describes this phenomenon. Figure 2 shows an example of such asymmetric distribution.

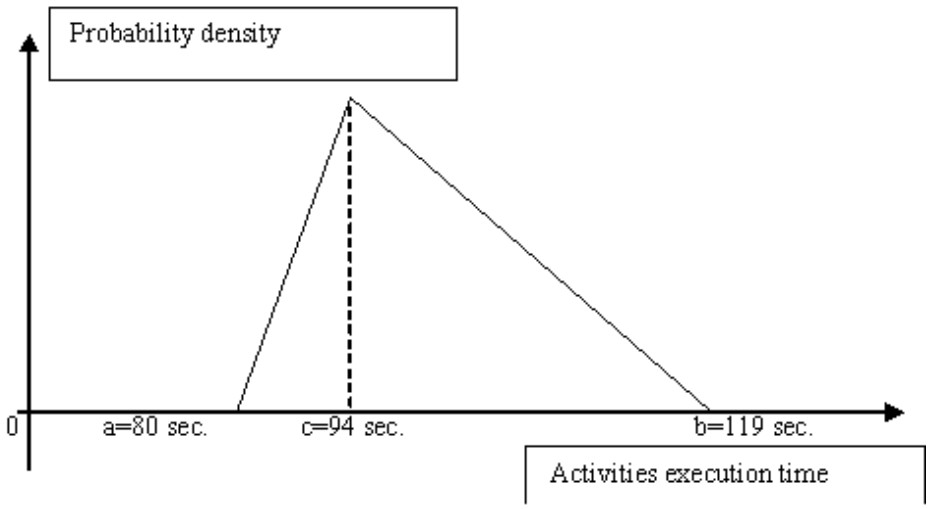

Figure 2. Triangular distribution attributing higher probability to longer execution times of activities

Only two applications, Aris and iGrafx, support the triangular distribution. The IBM BPM does not provide for the use of asymmetric probability distributions.
When using a triangular distribution with the following parameters:

1) a – minimum processing time by any processing station within the simulation of the production of a series of 10 products = 80 sec. (1 min 20 sec.).
2) b – maximum processing time for any station within the simulation of the production of a series of 10 products = 119 sec. (1 min 59 sec), which is longer than any of the simulations presented above.
3) c = 94 seconds (1 min. 34 sec) – the average mean was adopted here instead of the usual modal value.

results were obtained, which are shown in Table 3.

Table 3. Results of simulation in the studied IT tools (triangular distribution)

No.	Application	The result of the passage of one process instance	Simulation result of a series of 10 pieces in minutes	Range of results achieved by 10 series of 10 products in minutes
	1	2	3	4
1	Aris Simulation 6.0	6:15	22:06	22:06
2	iGrafx 2013	6:20	21:56	from 21: 22 (simulation No. 1) to 22: 52 (simulation No. 9)

The use of the triangular distribution also did not result in significant differences in the simulation results. Further, even the longest times achieved in this simulation (22 minutes 52 sec) do not come up to the time achieved by the team of students (23 minutes 43 sec). Interestingly, this maximum time is shorter even than maximum simulation time with the use of normal distribution with the following parameters (E=1 min 34 sec; sigma = 14 sec) that was 23 minutes 40 sec. This observation is worth further analysis, but at the present moment it can be only commented on with underestimation of the protein factor, as expressed by some engineers, i.e. the human factor in the form of performers of these activities.

6. Conclusion

Finally, it is worth presenting a summary comparison of the discussed applications in terms of economic processes simulation, which is shown in Table 4.

Table 4. Synthetic comparison of the described IT applications

Application	Advanced simulations	Availability for the test	User interface
Aris	Broad possibilities in licensed versions	Aris Express - only to paint process maps	There are difficulties in defining and positioning of objects parameters
Adonis	Limited simulation in the standard version	Adonis CE 2.0 -the possibility to simulate the modeled processes	Unintuitive arrangement of menu components (animation, assigning contractors in dialog screens)
iGrafx	Broad possibilities	Full trial functionality for 30 days	Easy and intuitive operation
IBM BPM	Vast possibilities, however, some limitations are present (the use of asymmetric probability distributions	There is a temporary access to the test system though irregular (such possibilities should be tracked on the website)	Intuitive handling but its mastering takes more time than in the case of iGrafx

For the purposes of more sophisticated simulations, we recommend iGrafx, Aris and IBM BPM; as these programs have extensive simulation capabilities. In the case of IBM BPM; it should only be remembered that there is no possibility to characterize the parameters by means of asymmetric probability distributions. In the case of Adonis the main problem is the need to define the parameters "rigidly", i.e. the duration and the costs assigned to activities may be defined as one value.

Conclusions from performed test includes results comparison between the several applications, as well as the juxtaposition of simulation results with experiment performed by students. Time values in 10 products simulation series in presented manufacturing process were shorter than values achieved by the human team. It can be easily explained by the unexpected occurrence of performer deconcentration, wariness caused by monotony, fluctuations of media read times by workstations, etc. factors during the simulation performed by the students team. These phenomenon were hard to reflect in process models for simulations, so the IT tools have not taken it into account. Therefore it shows the problem of including in process simulations phenomenon with undefined probability of occurrence.

The second observation is the diversity of the same process (with the same time parameters values) in different applications. It may be caused by different calculation accuracy (number of decimal places) in algorithms.

However, the surprising observation comes from results of simulation using triangular distribution which takes into account a greater probability of achieving longer execution times. iGrafx applications

shows smaller execution time of 10 products series in a process in both, the simulation of one 10 products series and the longest time of series in 10 series of 10 products simulation. These simulations results are surprising due to intuitive feeling, that longer execution times should occur when using triangular distribution. However it is statistical regularity, about greater probability of observing longer execution times. To identify significant statistical difference there should be much more than 10 series.

In all applications, it is possible to create a process map in the BPMN notation. In some of them it is also possible to create them in the eEPC notation (Aris, iGrafx 2013). In terms of availability iGrafx 2013 should be distinguished for the possibility to test the full versions of the software for 30 days. On the contrary, tools such as Adonis and Aris Express are always available in the community version. The functionality of Adonis Community Edition 2.0 definitely exceeds the functionality of Aris Express, because it is possible to perform both the simulation along with animation and the analysis of process paths, use and resource loads. IBM BPM is available temporarily and irregularly only for the prepared training activities. Then, it is possible to log in on the website [25] and use the tool in the test mode.

By contrast, iGrafx should be distinguished above all in terms of the ease of use, i.e. intuitive user interface. Familiarity with similar applications causes that the user is able to master the program in a very short time. IBM BPM has more difficult and less intuitive interface. Aris supports a lot of simulation parameters, but by mastering this application is difficult, more difficult than, for example. iGrafx. In the case of Adonis is surprising location of certain functions, eg. the animation of process simulation is on the menu in the area of modelling, not in simulation.

However, depending on user requirements, sometimes a greater emphasis can be placed on quick and easy processes modeling, application usage time, or possibility to carry out rough process analyses rather than on the possibility to make sophisticated simulations. Tools presented in this paper can be variously assessed in terms of these purposes. Therefore, this paper may contribute to more accurate selection of a given application supporting process management tailored to individual needs of the user.

Another aspect that is worth mentioning is the ability to implement the processes in organizations. In this respect, the most interesting solution is the IBM BPM, which is a motor itself, where the modeled processes are the backbone of the workflow. Thus, users work directly on the previously modeled in this environment process-related models without the need for other systems/applications. Other programs operate on different principles. The models, which are created in them, can be transferred to another environment, which usually is the ERP system (*Enterprise Resource Planning*), namely SAP, Oracle, BAAN, etc. The XML language is most commonly used for this purpose, into which process models from these tools are translated, and then they are transferred from XML to ERP.

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APPLICATIONS OF INTERNET IN EXPORT BY SME

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Development of information technologies and increasing communication possibilities are currently some of the most important factors of civilization's development. Access to information and availability of new technologies influence the economy in great degree and significantly change the way enterprises behave. Application of Internet and modern IT technologies as tools provides small and medium enterprises with easier access to new markets and increases availability of potential customers, along with simplification of export. This paper describes ways in which SME can apply Internet and modern information and communication technologies in export. Special attention was given to social media.

Keywords: Internet, small and medium enterprise, SME, export

1. Introduction

Economy and economic activities are increasingly influenced by access to information and information technologies. Permanent and unstopping development of Internet tools and technologies, along with growing application of the Internet, gives the enterprises numerous chances and possibilities. Taking advantage of them is largely necessary for development of modern companies. Internet can be nowadays used in virtually all areas of company activity. Moreover, the Internet lacks bureaucratic limitations, geographical barriers and time issues, due to low access costs, ease of access, egalitarianism and interactivity. This resulted in the Internet becoming a source of competitive advantage for companies that can access it and take advantage of its applications. Implementation of modern technologies allows

companies to gain competitive advantage and use market opportunities better and in full. Technological development seems to have greater speed that it was expected – it is now possible to access international market immediately and to improve efficiency of activities of small and medium enterprises on local markets [1].

Internet grants numerous advantages that negate some drawbacks small and medium enterprises suffer, giving them more even ground in competition with larger companies. Application of Internet and modern IT technologies as tools provides small and medium enterprises with easier access to new markets and increases availability of potential customers, along with simplification of export.

This paper describes ways in which SME can apply Internet and modern information and communication technologies in export. Special attention was given to social media.

2. Internet and trade

Since the commercial application of Internet began, analysts predicted its significant influence on trade [5]. A lot attention was given to potential advantages for export-based companies (both B2B and B2C), due to partial reduction of traditional export barriers (mainly in the area of information regarding potential market and customers). A great reduction in role of middlemen was expected as well, along with shortening of delivery chains [6], but this prognosis did not come true in some sectors (especially in the multimedia industry: a lot of middlemen came to be, offering books, music and movies).

Application of Internet and associated communication and information technologies allows for reduction of communication cost, shortening product and services delivery time, makes digital delivery of important information possible, lowers transport and distribution costs, and improves integration and cooperation between business and trade partners. Internet becomes a global trade platform; along with its development, new and more efficient information exchange system become widespread, along with new possibilities of goods and services trade. Enterprises use Internet as tool that allows for: learning customers' opinions, communication with news services, providing required information to national administration, managing and tracking packages and investment management [2]. Enterprises use other Internet tools as well: reports regarding current economic situation of a given market or area, lists of providers, lists of agent, list of administration offices or market research tools [4].

Development of the Internet, availability of telecommunication connections and computer technology caused significant increase of online transactions.

Internet influences a transaction in three stages [3]:

- First – when customer looks up product and price information,
- Second – when an order is placed,
- Third – when the order is delivered.

Internet simplifies both processing market information and the selling process itself. Aforementioned stages are part of so-called e-commerce – transactions that take place in Internet. E-commerce development influences international trade, for example by such Internet-based B2B solutions as Alibaba [7] or Globalsources [8]. This kind of Internet sites are convenient platforms that make trade exchanges between local and international companies possible. E-commerce, being a new channel for transactions on a very different scale than those encountered before, influences international trade by optimizing the costs, efficiency and value of the transactions. E-commerce noticeably influences several areas: product prices, product supply, revenues of companies, and trade flows between countries [9].

Application of Internet in daily activities of an enterprise both influences and is influenced by other market participants (both other companies and clients). The more the Internet is accepted as a communication and transaction channel on a given market, the more enterprises decide to use it in order to retain their competitive advantage. The fact that the Internet is used by dominant company in a given branch will cause other companies in the same branch to adapt it more quickly. Enterprises should consider not only the Internet influence on their activities, but also changes that are results of its application by other market participants. Analysis of those changes can be performed by Porter five forces model. Internet influences all forces this model is concerned with [10]:

- Threat from new players on the market – Internet lowers entry barriers and makes creation of new enterprises possible. Creation of a new company requires lesser investments (e.g. creation of an online shop is far less expensive than founding a traditional shop).
- Threat from new substitutes – Internet shortens the life-cycle of a product, along with encouragement of innovative solutions in customer service.
- Customer bargaining power – greater access to information about products significantly increases customer bargaining power. The ability to compare offers and prices coming from different manufacturers and to look up substitutes is very easy to achieve. This forces the enterprises to make more careful marketing decisions.
- Suppliers bargaining power – Internet information flow makes the suppliers far better informed about the real situation in their area of operations, which in turn improves their bargaining power.

- Threat from current competition – it is easy to look up company information in the Internet, including its activities and past actions. This has increased the value of transparency and fairness as factors in company success. The customer ability to compare products, resulting in easy switch to competing product, has increased greatly as well.

It is a widespread opinion that the Internet simplifies the actions that improve SME competitive advantage and makes their international expansion possible. ICT grant numerous advantages. This paper, due to its limited size, will present only several main possibilities that social media – one of the most crucial components of the Internet - grant to SME in both improvement of internal workings of a company and in development of export.

3. Social media in enterprises

Social media is a concept that is far more than just consumer phenomena. Nowadays, social media are often used for internal communication, along with staying in touch with both other companies and public administration. Social media grow in their importance and coverage. They quickly evolve from a hub of personal, private social activity into a platform for establishing professional contacts, performing business activity, and making deals. Organizations increasingly relay on process of distributed problem solving, using knowledge and skill of clients and external experts in order to work out innovative solutions to problems they are facing. According to research conducted by McKinsey Institute [11], about 60% of work time of average white-collar worker is taken by research, reading e-mails and replying to them, and cooperation with team members. According to aforementioned research, applying social media as tools in those activities may lead to 25% increase in work efficiency. Social media are used to create task-based, specialized teams (often in form of so-called virtual teams), formed from employees form different departments (or different organization altogether). The advantages from applying the social media as tools in organization are numerous, among others: faster and more intensive information and knowledge flow inside the organization, shorter products development cycle, and faster reaction to signals coming from the market and from the competitors. Various types of social media that can be used by both consumers and by enterprises are shown in Table 1.

Table 1. Applications of social media for use both by enterprises and consumers

Technology	Possible application
Media and file sharing	Upload, share and comment on photos, videos, and audio
Social networks	Keep connected through personal and business profiles
Social gaming	Connect with friends and strangers to play games
Blogs/microblogs	Publish and discuss opinions and experiences
Crowd sourcing	Harness collective knowledge and generate collectively derived answers
Ratings and reviews	Evaluate and rate products, services, and experiences; share opinions
Shared workspaces	Co-create content; coordinate joint projects and tasks
Social commerce	Purchasing in groups, on social platforms, and sharing opinions
Discussion forums	Discuss topics in open communities; rapidly access expertise
Wikis	Search, create and adapt articles; rapidly access stored knowledge

Source: based on M. Chui, J. Manyika, J. Bughin and others, *The social economy: unlocking value and productivity through social technologies*, McKinsey Global Institute, 2012, p. 4

The most intensive use of social media is seen among enterprises that share certain characteristics [12]:

- Large part of enterprises employees are white-collar workers,
- Brand recognition and consumer opinions are considered important for the enterprises,
- The enterprises consider reputation, credibility, and consumer trust important assets
- The products are distributed online,
- The products share certain similarities, for example: they are experimental (e.g. new software applications) or inspirational (e.g. energy drinks).

The research conducted by McKinsey Institute identified 10 different ways of using social media in the process of creating new value in the company [13]. Social technologies can be used towards general improvement of internal workings of the enterprise or in specific stages on the added value creation chain (see Table 2).

Table 2. Ten ways social technologies can add value in organizational functions within and across enterprises

<table>
<tr><th colspan="2">Organizational functions</th><th colspan="2">Across entire enterprise</th></tr>
<tr><td rowspan="2">Product development</td><td>Derive customer insight</td><td rowspan="8">Enterprise-wide levers

(Social as organizational technology)</td><td rowspan="4">Use social technology to improve intra- or inter-organizational collaboration and communication</td></tr>
<tr><td>Co-create products</td></tr>
<tr><td rowspan="2">Operations and distributions</td><td>Leverage social to forecast and monitor</td></tr>
<tr><td>Use social to distribute business processes</td></tr>
<tr><td rowspan="4">Marketing and sales</td><td>Derive customer insights</td></tr>
<tr><td>Use social technologies for marketing communication/interaction</td></tr>
<tr><td>Generate and foster sales leads</td><td rowspan="3">Use social technology to match talent to task</td></tr>
<tr><td>Social commerce</td></tr>
<tr><td>Customer service</td><td>Provide customer care via social technologies</td></tr>
<tr><td>Business support[1]</td><td>Improve collaboration and communication; match talent to tasks</td></tr>
</table>

[1] Business support functions are corporate or administrative activities such as human resources or finance and accounting

Source: based on M. Chui, J. Manyika, J. Bughin and others, The social economy..., p. 8

For SME that exports its products on a foreign market the following social media applications from previously [13] enumerated are crucial:

- Product development – co-creation – the enterprise can acquire external assets (not only their own R&D) in order to solve design-stage problems. This allows for solving problems that were out of reach for the company until this method was used [14]
- Demand predictions – social technologies broaden the spectrum of potential information sources regarding possible demand for products, making faster reaction to demand changes possible, in turn increasing efficiency of the product distribution [15],
- Market and customer preference research – just as in case of engaging customers in design stage of the project, social media can be useful source of information about the product, brand, opinion regarding competition, and perceptions of the market share. Information acquired in this manner can be used in aforementioned design of product and image, as well as in advertising campaign planning, setting prices, decisions regarding packaging design, and nu-

merous other marketing and promotional activities. Information from social media allow for tracking of effectiveness of marketing operation, evaluation of company's image, as well as tracking activity of potential competitors, which in turn make fast reactions to their behavior possible. Enterprises may use social media for passive data acquisition (analysis of discussions and posts) or they may actively request feedback from their users [16],

- Marketing communication – using social media in marketing communication may improve efficiency of content deployment and simplify its tailoring to target group. Social media are a direct communication channel with a high potential for interactivity with the recipient, which in turns increases the recipient's engagement,
- Lead generation – acquisition of information regarding potential new customers. Users that post information about their lives on their social media walls, including important events (e.g. marriage, birth of a child), are easy targets for a tailored product or service offer [17],
- social commerce (s-commerce) – activities that increase product sales thorough application of social platforms (e.g. by adding a purchase option to company profile) or adding social media components in online shops (e.g. by posting recommendations, "share" button, possibility of posting comments, or plug-ins that use information from a social media portal to present recommendation based of friends' opinions) [18],
- Customer service – social media can be used in improvement of customer service in several ways. First, social media can serve as a customer service communication channel, partially taking over the role of a call center – or even completely replacing it. Moreover, in such case, questions and answers delivered in such fashion can create a product and brand information database that grows over time. Second, social media allow also for customer engagement in the role of brand ambassadors – people who talk with other customers and share their knowledge [19]. This application can also be useful in case in which a crisis scenario begins to develop – social medial allow for a quick reaction and fast application of damage control in customers' perception of the brand [20].

SME can profit from social media in following way: their use can increase sales and revenue, increase company visibility which in turn causes an influx of new customers, and gain access to new markets.

4. Examples of social media usage

Considering the great number of social tools and usually limited resources available to SME, one of crucial aspects of using social media is to make choices adequate to the profile of the enterprise. Making a wrong decision in either choice

of the medium or scale of its use can negatively influence the condition of the company. Table 3 presents base, easiest to use tools available in social media and potential gains their use may provide [21].

Table 3. The benefits of different types of social media

Type	General description	Tools for page creation	Benefits	Cost
Blogging	Targets both companies and individuals	Easy tools available for creating pages, possibility to use various content tools to make it more interesting	Easy to integrate with official webpage, an indicator of innovativeness and willingness to engage your customers	Depends on the excess of used content
Facebook	Targets both companies and individuals	Easy tools available for creating pages and editing design, developer support pages	Potential to connect to potential customer and to gather opinions about products, useful tool for advertisement and sales promotion	Free (for setting up page, and standard features)
LinkedIn	Targets both companies and individuals	Easy tools available for creating pages and editing design	Possibility to find people you may work with and to find people that are active in given market (for generating further leads) or establishing yourself as an expert in a given field	Free (for setting up page, and standard features
Twitter	Targets both companies and individuals	Easy tools available for creating pages and editing design, developer support pages	Possibility for short promotional discussion about idea or product, ability to promote some other content with short catching messages	Free (for setting up page, and standard features

Source: based on International Trade Centre materials

SME must not base their behavior on actions of large enterprises – both available resources and goals differ greatly. Large company can delegate employees and dedicate significant resources to social media activities, while SME cannot. But even using simplest tools may provide significant results. An example of SME that uses social media is WORK[etc], a digital services and specialized software development enterprise. WORK[etc] is the name of the company, founded in 2009 by D. Barnett, as well as the name of company's product. WORK[etc] is a web-based solution that simplifies company management, meant for smaller companies with remote teams working away from company offices. This software product provides system for customer management (CRM), project and sales management, invoice management, and a platform for cloud-based cooperation for employees, functional regardless of the device they use in their work [23]. Company founder worked out the attributes of the flag product based on his experiences with remote work. Most of the 22 employees of WORK[etc] work remotely. The product is constantly improved, for example by increasing means of personalization, adaptation to most

recent operating systems available on the market, and inclusion of tools for social media profile management [24]. This strategy is very efficient, as Deloitte Technology Fast 500 Asia Pacific 2013 ranking, in which WORK[etc] was classified on 75th place, with rate of revenue growth in the last three years reaching 427% [25]. The company uses following social media in its activity: a blog, integrated with company main WWW site, Facebook profile (for both the company and numerous employees), LinkedIn profile, Google+ profile, and a Twitter account. Those tools serve to provide a channel of communication to customers, allow for acquisition of new customers, make development of new ideas possible, provide promotion of offered products, and serve as platform for internal communication for the company itself.

5. Conclusion

Internet and ICT influence both the enterprises and environment they operate in with no regard to enterprise size or the branch it operates in. There are numerous papers in the source literature regarding Internet influence on trade flows that are results of reduced transaction costs, lower costs of information acquisition regarding new markets and potential customers, easier access to new markets, and other factors. In case of SME, the Internet is considered a tool that can significantly increase competitive advantage of an enterprise and cause increase in sales, including export sales. In this paper, due to its size limitations, the author focused on social media as a specific tool and presented possible means of taking advantage of them in company activities, especially in export. From the described applications of social media applications in activities of exporting SME, the most important applications are: improvement of your product, improvement in external and internal communication, higher sales, marketing and advertising, market research and customer service.

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EXPERT SYSTEMS IN MEDICAL RESCUE

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In the paper the conception of creating expert system in medical rescue is presented. As the result created application is introduced and discussed. This kind of expert system helps medical dispatcher in taking proper action with interaction of caller. Problem of creating such software is actual and there is no existing software to be used for comparison. Application is built in Java with usage of CLIPS system. Efficiency of working application is discussed. The basis architecture of experts system is introduced..

Keywords: Expert Systems, Artificial Intelligence, Medical Rescue, CLIPS, Java

1. Introduction

The aim of this paper is to create a prototype of an expert system which aids medical rescue dispatchers and checks whether such a system is practical in use. The expert system helps in deciding upon a course of action, based on the information gathered from the caller. The document, titled “The project of the initiative to aid the medical rescue system with notable emphasis on medical dispatchers” (pol. “Projekt inicjatywy wspierającej system ratownictwa medycznego ze szczególnym uwzględnieniem dyspozytorów medycznych”), contains the algorithms that serve as the basis for the rules used in the system.

1.1. Purpose of the paper

The main reason while deciding on the topic was the desire to check if expert system is good solution for this kind of problem. AI itself is broad and encompasses a huge variety of subfields. These are both general (learning and perception) and specialized (playing chess, proving mathematical theorems). As such, practical applications range from autonomous systems, like industrial robots, to systems aiding humans in the decision-making processes in business or medicine.

The spark to focus on medical rescue came from learning about the initiative project. The initiative started in March 2013 under the auspices of the Grand Orchestra of Christmas Charity (pol. Wielka Orkiestra Świątecznej Pomocy), with help from the Association of Medical Dispatchers in Poland and the Medycyna Praktyczna publisher [11]. A completed document was handed to the Minister of Health in May 2013. As of the 10th of January 2014, the initiative effectively received green light from the Ministry of Health to begin implementing their proposals.

As a result of these two reasons, the decision was made to see if an AI system to aid medical dispatchers could be created. Since the problem appeared complex and very specific, an expert system was selected as the tool to handle it. Due to the novelty of the selected project, there was no existing application that could be used for comparison at the time.

1.2. Goals of the paper

The main focus of the paper is to utilize the capabilities of expert systems and check their usability for medical rescue dispatchers. The goals are the following:

- Create an expert system in accordance with the information provided by the initiative document.
- Provide a clear and easy to use interface for the user that will work seamlessly with the expert system.
- Check the viability of the created system.

1.3. Scope of the paper

The created prototype is essentially a single application, but it can be divided into three components: a graphical user interface, the expert system itself and a data handler. All of them are necessary for the system to function properly and fulfil its purpose.

The expert system is the main focus of the paper. It is responsible for deciding on the threat level that is present in the current situation and, as a result, what advice is given to the user. The decision is based on the information provided by the user, which he gathers from the caller, and the rules laid out beforehand. The rules

are created with the help of the algorithms contained within the initiative document.

The user interface represents the part of the application the user can directly interact with. As such, it is imperative the interface is clear and intuitive. That way the user will not waste time during input and can easily read the decision and suggestions presented by the system as output.

The data handler is tasked with preparing and manipulating all of the stored data beforehand. It is also responsible for seamless interaction between the expert system and the user interface. This includes correctly transmitting information from the user to the expert system and sending back the resulting decision.

2. Expert systems

The central component of the created solution is the expert system. According to Edward Feigenbaum, "An Expert System (ES) is a computer program that reasons using knowledge to solve complex problems. (...) Traditionally, computers solve complex problems by arithmetic calculation (not reasoning using logic); and the knowledge needed to solve the problem is known only by the human programmer and used to cast the solution method in terms of algebraic formulas". Expert systems are therefore a part of the thinking rationally approach to AI, presented in Figure 1 [3].

The intent of the expert system is to achieve a level of competence in solving problems of a specific domain of work that would rival the performance of a human expert in that field. The need to pursue such systems came from the conclusion that most difficult problems originate from complex physical or social environments and do not have simple algorithmic solutions. Moreover, the people who could be relied on to solve such problems and give accurate expertise were too few to meet the needs. This sparked attempts to digitalize the specialized knowledge and emulate the problem-solving process of an expert. That being said, expert systems are mostly used as interactive aid to humans, rather than given any autonomy in making the decisions on their own [2], [3],[5]].

2.1. Software architecture

Expert systems are a part of the knowledge-based class of computer programs. They use a knowledge base and reasoning procedures to solve problems. The knowledge and methods are modelled on the experts in that particular field. The basic concept of an expert system is presented in Figure 1.

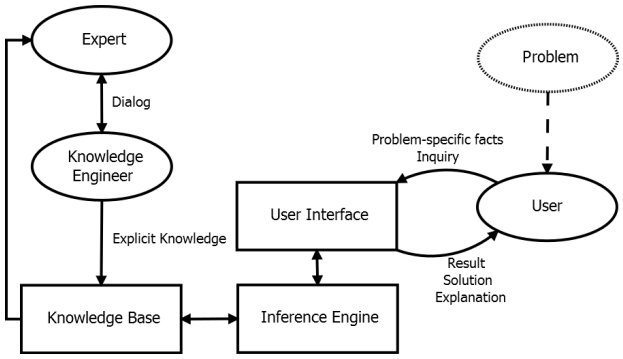

Figure 1. Basic concept of an expert system

The two crucial parts of an expert system are the knowledge base and the inference (reasoning) engine. The knowledge base contains known sets of information about the specific domain. That information is acquired with the help of an expert of the domain in question. The expert works with a knowledge engineer – a person who knows how to code information into the system. The expert's expertise and experience is turned into explicit knowledge by the engineer, with the expert providing comments and feedback on the accuracy and behaviour of the system. The inference engine is responsible for providing results, based on information from the user and the knowledge base. The user communicates with the expert system with the help of a user interface. Here, the user can provide information about the problem and receive a solution, along with the reasoning behind it, in return.

The knowledge in the system can be divided into the following 3 types, based on the source the knowledge originates from:

- Expert knowledge, which includes both factual and heuristic knowledge. Factual knowledge consists of knowledge that is widely shared in a given domain and commonly agreed upon by experts. Heuristic knowledge is the non-rigorous, practical knowledge of the expert.
- User-specific knowledge, which describes the information provided by the user about the problem and the situation surrounding it.
- Knowledge acquired as a result of the processes of the inference engine. This comprises both the final solution, as well as all the intermediary information that was deduced on the way to the solution.

The most popular way of developing expert systems is the rule-based system. Here, the heuristics for the inference engine are represented in the form of production rules, or simply rules. A rule consists of an IF and THEN part. The IF portion lists a set of conditions in some logical combination that needs to be fulfilled for the rule to be applicable. The THEN portion is a set of actions to be executed when the conditions for the rule are met. The process of matching known facts against

the rule condition patterns is called pattern matching. During execution time, the inference engine selects an applicable rule and then the actions of that rule are executed (which may affect the list of applicable rules by adding or removing facts). If there is more than one applicable rule, then the inference engine picks the one with the highest priority. After all the actions of the chosen rule are carried out, another applicable rule is selected. The engine continues this process until there are no valid rules left.

The method of finding viable rules and firing their actions is known as forward chaining. This means that the inference engine starts with a set of known conditions and moves towards some conclusion. Another possible method is known as backward chaining. In this case, the inference engine begins with a known conclusion and seeks out conditions under which the particular line of reasoning will be true [4].

2.2. The initiative to aid the medical rescue system

The Grand Orchestra of Christmas Charity got involved in the initiative to aid the medical rescue system in march 2013. The charity states on its official website that the decision was a consequence of a series of tragic events, which resulted in the death of a number of people in need of medical help, among them children. The designated goal of the project was to change the way the dispatchers gather medical information and to provide them with the tools that would aid them in that task. This would be done by turning the medical inquiry into a set of algorithms to be followed, based on the response from the callers. Ideally, implementing such a solution would aid the dispatchers in their everyday work and increase the safety of those in need by minimizing potential errors. The project was divided into three stages:

- The first stage was concerned with changing the existing regulations, so that it was necessary for the medical dispatchers nationwide to follow the prepared set of algorithms during the medical inquiry.
- The second stage was to prepare the correct algorithms of the medical inquiry and create a handbook and software containing the necessary procedures, questions and recommendations for the dispatchers to follow in their work. It was imperative that this part was prepared with utmost care and professionalism.
- The final stage is concerned with implementing the previous stages into real life, in the form of a training program for the dispatchers. This is to allow the created rules of conduct to be applied as quickly as possible.

The initiative gathered members from both the charity and the Ministry of Health, along with aid from the Association of Medical Dispatchers in Poland and the Medycyna Praktyczna publisher. The former was invaluable in signaling the needs of the dispatchers themselves during each stage of the project. The latter provided

its expertise both in preparing the proper procedures for the dispatchers, as well as the training techniques and necessary tools (among them computer software containing the procedures) [11].

3. Technologies used

Although there were a number of tools to choose from (such as JESS, Drools or Haley Rules), CLIPS was chosen for a number of reasons. First of all, it is maintained as public domain software, which means that the tool can be used without any serious restrictions free of charge. Secondly, over the years of its development, CLIPS has been fully documented. This includes a reference manual and a user's guide, along with an architecture manual, although the latter is slightly out of date. Thirdly, it is highly portable thanks to being written in C. CLIPS has been installed on a variety of computers, ranging from personal computers to CRAY supercomputers. Efforts are even made to adapt CLIPS to mobile systems. Additionally, it is easily integrated with other languages and extended by users if needed. The large number of custom versions of CLIPS, such as integration versions for ADA, Java, C++ or Perl, are proof of its flexibility. Lastly, its popularity throughout the government, industry and academia was also taken into consideration. All NASA sites, branches of the US military and numerous US federal bureaus, government contractors and universities are among the users of this expert system delivery tool [14].

3.1. Java Technology

Selecting CLIPS as the software tool to develop the expert system portion of the project allowed for relative freedom in terms of the programming language and framework to be used for the graphical user interface. Since CLIPS was inherently easy to integrate and was also available to the public community as public software for many years, any chosen technology would most likely have an interface or integration with CLIPS readily available. As such, the decision was mostly a matter of choosing the most subjectively preferred technology, as opposed to being restrained by the expert system itself. For the purposes of this project, the Java programming language was selected to create the GUI [6].

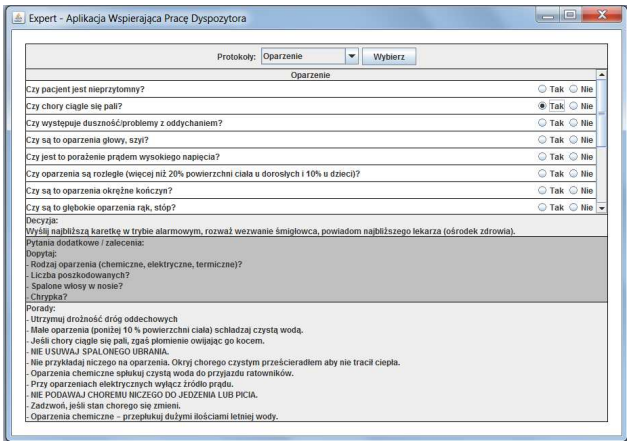

Figure 2. Example of GUI

3.2. Reasons for choosing

Beyond personal preference, there are 3 main reasons for choosing Java as the solution to building a graphical user interface over other programming languages. First of all, the selected solution's inherent portability to other platforms and hardware was a major factor. Created software will work on any JVM in exactly the same way. Further recompilations to meet the needs of a specific platform configuration are not required. Secondly, it is easy to build a GUI in Java. The Java API already has the necessary libraries for creating GUI's – the swing and awt packages. Lastly, prior experience with the CLIPSJNI was a factor in favour of selecting Java.

4. Implementation

As stated in the beginning, the goal of the system was to aid the medical rescue dispatchers in their work, based on the protocols inside the initiative project document. The first order of business was to translate the procedures and protocols of the document into a model interpretable by the system. Then, the necessary functionalities were laid out. Lastly, the application was built, one component at a time.

4.1. Procedures of the medical inquiry

During each medical inquiry, the rescue dispatcher is expected to follow a simple algorithm that will, ideally, allow to acquire all the needed information and

take the best course of action. The algorithm presented in Figure 3 can be divided into two main parts: the general inquiry and the situation-specific protocol.

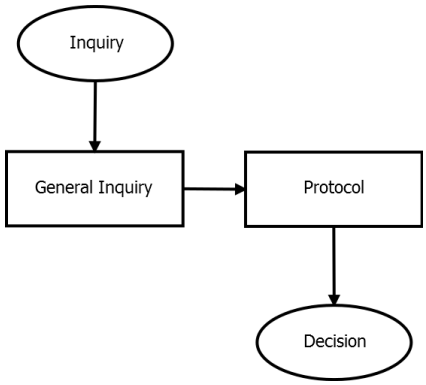

Figure 3. Medical inquiry algorithm

The call starts with the general inquiry. Here, the dispatcher asks for basic information that will allow him to better understand the situation. This includes questions where the incident has happened, how many victims there are and what type of incident it is. This part is done purely by the dispatcher. When the basics have been established, the dispatcher can then select the most appropriate protocol for the described situation and put the expert system into action. With its help, the necessary (if any) action is taken, such as sending an ambulance, notifying the nearest health centre, instructing the caller on how to perform CPR, and so on.

Structure of the chosen protocols

Over 30 protocols for different medical situations have been made for the initiative document. 5 out of those have been chosen to test the validity of the system. The protocols themselves were further divided into 3 subgroups (main medical ailments, accident/injury, urgent condition), but that was not necessary for the test system. As such, the division was omitted, though its later implementation would not be a problem.

The structure of the selected protocols, as described in the initiative document, is presented in the tables below. In general, each protocol has a number of 'threat levels', usually 3. These go from highest (immediate medical attention required) to lowest (no or minimal medical attention required) and decide upon the course of action that should be taken. The patient is categorized to a threat level with simple yes/no questions, where even one positive answer to a question labels the patient to that level. Each level can also have additional questions or other suggestions that the rescue dispatcher might ask the caller to receive more precise information. Finally, each protocol might have some other general tips or instructions that the dispatcher

can give to the caller, if applicable. The following is the shortcut one of protocols taken from the initiative document. (Protocol: Hypothermia)

Table 1. The hypothermia protocol

<table>
<tr><td colspan="3">Protocol: Hypothermia</td></tr>
<tr><td>Questions</td><td>Decision</td><td>Additional questions/suggestions</td></tr>
<tr><td>1. Is the patient unconscious?
2. Is the patient not breathing or the breathing is not correct?
3. Is the patient entangled?
4. Is the patient unable to move on his/her own?
5. …</td><td>YES
↓
Send nearest ambulance in emergency mode</td><td>Ask:
• How long the patient could have stayed in low temperature?
• Is the patient being healed from other reasons?
• …</td></tr>
<tr><td></td><td>NO</td><td></td></tr>
<tr><td>1. Does the patient have any shivers?
2. Is the patient battered, elderly or a child?
3. …</td><td>YES
↓
Send an ambulance (without signals)</td><td>Ask:
• What, if any, medication does the patient take?</td></tr>
<tr><td></td><td>NO</td><td></td></tr>
<tr><td>1. Does the patient have the feeling of cold?
2. …</td><td>YES
↓
Switch to primary care</td><td>• Contact a doctor
• Suggest measuring the temperature in case the patient feels cold (fever)</td></tr>
<tr><td colspan="3">Tips:
• Do not leave the patient without care. If possible, move the patient to a warm place or room.
• If unconscious, then switch to the unconscious protocol.
• If the patient has shivers, then suggest doing simple physical exercises.
• …</td></tr>
</table>

4.2. The data structure of the protocols in the system

Due to the relatively simple and uniform structure of the protocols, it was decided that using a database would pointlessly overcomplicate the system. Hard-coding the data into the project was also rejected, as this would greatly reduce flexibility. Instead, the data is stored inside a text file that is formatted using the eXtensible Markup Language (XML) rules. The reasons for this solution are as follows:

- The XML is an accepted markup language standard that is easy to use. The first version of the XML standard became a World Wide Web Consortium Recommendation on 10th February 1998 and, with modifications, has been in use since [1].
- Loading the data from an external file provides an easy way to extend the number of protocols without the need to recompile the whole system. Adding the rest of the protocols into the system only requires writing them into the file (with respect to the established format) and the application will take care of the rest.

- The standard Java libraries already have a built-in XML Parser, which is more than enough for the task.

The general structure of the .xml file is the following:

```
<Protocols>
    <Protocol Name="Name of Protocol">
        <Tips>
            <Text_Line>Tips text line 1</Text_Line>
            <Text_Line>Tips text line 2</Text_Line>
            <Text_Line>Tips text line 3</Text_Line>
        </Tips>
        <Threat Level="0">
            <Response>Response text</Response>
            <Suggestions>
                <Text_Line>Suggestions text line</Text_Line>
            </Suggestions>
            <Question>Question 1</Question>
            <Question>Question 2</Question>
            <Question>Question 3</Question>
        </Threat>
        [...]
    </Protocol>
    [...]
</Protocols>
```

Figure 4. General structure of the .xml file

All the protocols are stored inside the <Protocols> element, which is considered an obligatory root element of the whole file. A single protocol is embedded within a <Protocol> element. The name of a protocol is stored within the Name attribute. The tips/additional information for each protocol is stored inside the <Tips> element, divided into text lines in case there is a need to uniquely separate the text (for example, a list). As described in 4.1.1, each protocol has a number of threat levels, each consisting of a number of questions. The threat is embedded inside the <Threat> element, with the Level attribute defining the gravity of the threat. Note that the scale of the level goes from highest to lowest, meaning that 0 is the highest threat level. Each threat has a number of questions, embedded inside the <Question> element, as well as their own response and suggestions for the dispatcher (<Response> element and <Suggestions> element respectively). The suggestions are also divided into separate text lines, for the same reason as the tips.

4.3. Activity

The activity diagram depicts the workflow of the application – the sequence of steps needed to be done to accomplish each of the use cases. Due to the low amount of interaction available to the user and their dependency, it was possible to create one integrated diagram of the workflow. Figure 5 presents the full activity diagram of the created system.

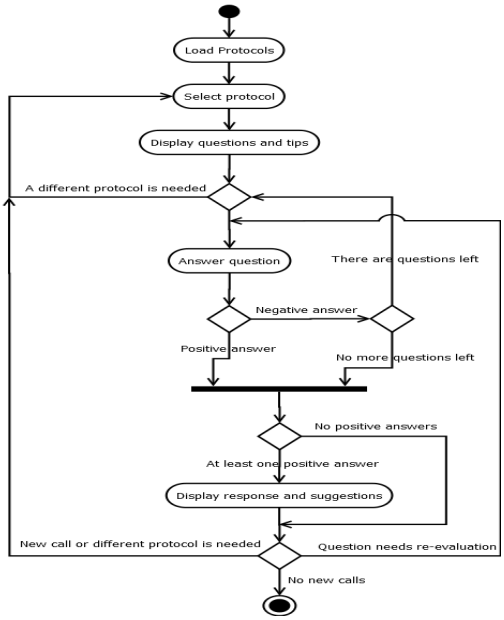

Figure 5. Activity diagram of the application

5. Results and conclusions

The goal of the project was twofold: to create an expert system with a easy to use user interface to aid the medical rescue dispatchers and to check the usefulness of the resulting creation. It means that not only the system needs to provide the expected response for each and every protocol, but also do it efficiently enough to warrant using an expert system.

Thankfully, the low number of possible use cases for the user meant that each and every possible interaction could be tested for errors. In this field, the system does indeed fulfil its designated role: each protocol was loaded correctly, each question was in its place on the list and every answer yielded the expected response and suggestions from the system. There was no form of interaction with the user interface that resulted in unexpected errors. However, the .xml file, from which the protocols are loaded, is very sensitive to mistakes. Incorrect data in that file did lead to unwanted behaviour and errors that made the whole application inoperable. Nevertheless, it can be concluded that the system has been created and works as intended.

However, when it comes to the usefulness of the expert system, the results are not very optimistic. The reason for this comes from the linear structure of the protocols. Expert systems work best in complex environments, with multiple set of

rules that need to be followed and large quantities of data to interpret. Here, the decision path is short and simple and could be easily handled with one loop.

As a result, it is authors' opinion that the expert system in this case is not a good solution. While entirely possible to use, it is simply not efficient when compared to the simplicity of the problem and the needed overhead of the expert system.

Should the application be continued, the best course of action would be to forgo using the expert system and instead implement a method to handle the decision-making process. Other than that, the system could use better protection against errors inside the .xml file the data is gathered from. Moreover, additional space to store information from the general inquiry could be made, as well as a system for saving whole sets of data (general inquiry, protocol(s) selected, as well as answers and the response) into separate files. Due to the way the protocols are stored, adding the rest would prove little trouble.

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SECURITY RISKS AND THEIR PREVENTION CAPABILITIES IN MOBILE APPLICATION DEVELOPMENT

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Mobile applications fulfill the more and more significant role in everyday life of the rapidly growing number of Smartphone users. IT companies try to establish new standards of data management as well as create mobile applications extending the functionalities of existing systems to enable the users to benefit from the newest technological advances. The paper presents a review of the known mobile application vulnerabilities for the two most popular mobile platforms, Apple's iOS and Google's Android, and proposes the secure development model to overcome the existing threats faced by mobile application developers.

Keywords: Mobile Application Development, Security of Mobile Applications, IOS Platform, Android Platform

1. Introduction

Together with the growth of the popularity and number of the smartphone users more and more real-life applications for mobile devices were invented and brought to life. Seeing this trend many companies incorporated mobile systems by establishing new standards of data management as well as by creating mobile applications extending the functionalities of their existing systems to enable the users to benefit from the newest technological advances. Nevertheless, after initial phase of going into raptures over the simplicity and multiple possibilities which mobile applications give to their users, the more serious issue of data and information security was raised. It is necessary to talk about the possibly mechanisms to secure

the mobile application, to talk about the development strategies which should be used to prevent capturing sensitive confidential data by third-party applications installed on our smartphones.

However, first of all the common and less common mobile application vulnerabilities should be established to find the incipient development solutions which aim to overcome the existing threats faced by mobile application developers.

The variety of applications embraces not only their functional differences, but also the different technologies they were created in. As the security of a single mobile application is greatly dependent on its target platform the review, presented in the first parts of this paper, will be divided into parts where threats specific for each considered platform will be discussed separately [1, 3, 15, 18].

The choice of the platforms seems to be easy looking at the current trends and usage statistics. Currently the market is led by two most popular mobile operating systems – Apple's iOS and Google's Android. Mobile applications written for these two platforms constitute the majority of the overall number of created applications with the stable position of iOS [2, 4] on the market recently interrupted by the increasing popularity of Android [5, 6].

iOS owes its popularity both to the luxurious brand status as well as to its reputation of being more secure and less prone to external attacks than any other system. However, the intuitiveness and ease of use of Android applications make it comparably attractive despite its known drawbacks in the area of security. Any developer of mobile application for these platforms should be aware of the threats and vulnerabilities that each of them carries and should adjust the development strategies in such a way so that the optimal level of safety is assured especially when interaction with confidential or sensitive data is required [13, 18].

The presented paper is composed as follows: section 2 presents the outline of iOS architecture from the security point of view and the possible security risks in development of iOS applications. Section 3 deals with the security issues of Android operating system architecture and shows the major vulnerabilities of its applications. Finally, section 4 describes the proposition of secure development model for mobile applications.

2. Security architecture and security risks in iOS application development

According to [2] security lies at the core of the architecture of iOS operating system. In fact a variety of mechanisms is implemented within the iOS framework which aims to protect the device and data without user knowledge or developer interference. Apple provides special precautions regarding system security itself as well as security of installed applications, the file system, network services and device control.

The general architecture of iOS system is based on layers (Fig. 1). This means that applications installed and running on the device do not have to communicate with the hardware directly, but instead they use a set of public APIs through which system requests are handled. The developer can freely use these APIs to achieve desired actions, but simultaneously he is limited to a number of operations that Apple made accessible through these APIs. In order to assure that developers do not try to perform forbidden operations the code-signing process takes place [2, 4].

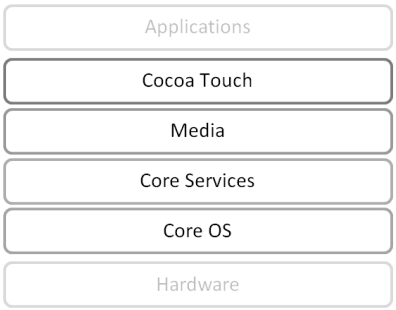

Figure 1. Overview of layered iOS architecture

The lower-level layers Core Services and Core OS contain fundamental technologies available on the device. The high-level layers provide the developers with more specific and sophisticated interfaces in order to accelerate the development process and make actions more understandable and accessible through abstraction and encapsulation. It is recommended that at all times applications should make use of these high-level interfaces instead of the low-level ones as there is better chance that they will conform to Apple implementation standards during code verification [16].

The core security mechanisms implemented as a part of iOS security architecture are as follows:

- layered architecture specifying public APIs for general use for application developers,
- *vetting* process,
- *System Software Authorization* process,
- encryption mechanisms,
- *Data Protection* feature,
- *Keychain* and code-signing.

In order to assess and find flaws in the security of any mobile application it is worth determining what are the possible points of interest for the potential attacker. The most obvious reasons for breaking into the application are stealing the confidential data like passwords, account or credit card numbers and other personal data. Sometimes also capturing the multimedia data like videos or photos, data contained

in the address book, mail or location info may be the target of the attack. Among other reasons one may also distinguish the will to omit some licensing issues or simply doing this "for fun".
The vulnerable points, significant risks of iOS operating system which may become potential security leaks can be named:

- stealing sensitive data stored in *key-chains*,
- installation of third-party applications invoking internal system calls,
- running unsigned code on the device by *jailbreaking* the device,
- *method swizzling* – changing implementation of methods during runtime,
- vast exchange of private personal information for the statistical and advertising purposes.

Basing on such potential aims that the attackers want to gain an access to one can deduce that the most vulnerable parts of the application will embrace:

- data storage points,
- permission management policy
- application file system and
- any kind of configuration files that may be stored within the device.

According to the Apple's security report the design ore of the iOS architecture is its security [2, 4]. And it is beyond doubt that a lot care has been taken to assure proper level of safety by incorporating such mechanisms as data encryption, code-signing and sandboxing (Fig. 2).

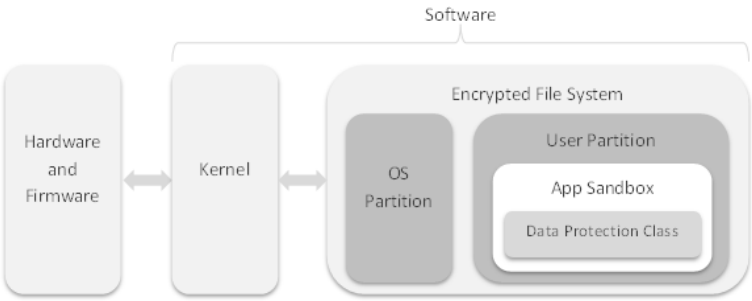

Figure 2. iOS security architecture [2]

Encryption is a standard mechanism and should prevent any unauthorized party from decoding information even if they are captured. *Code-signing* is connected with a strict procedure reserved for any application to be published in the AppStore which assures that only applications conforming to the Apple's standards, using allowed API's methods and submitted by registered distributors will let to be published. *Sandboxing* is a well-known mechanism for running programs separately from other system resources so that there is full control over the permissions and

allowed access that the application requires. Sandboxing is frequently used with untrusted programs which have to be run on the device but here it is used to prevent downloaded application to use the resources of other application or the system or accessing the kernel resources that they are not allowed to.

3. Security architecture and major vulnerabilities of Android applications

Android applications are reported to be the aim of malicious attacks significantly more often then iOS ones. Android developers recognized security as an essential feature of their system and consequently they decided to design the architecture in such a way, so that it provided basic but reliable security mechanisms for applications [5, 8, 10]. The main focus of Android security architecture is to assure proper protection of data and system resources as well as to achieve the effect of isolation of applications, so that they did not interfere with other resources if it is not necessary (Fig. 3).
The basic security techniques built into the internal architecture of Android operating system are the following:

- set of basic security functionalities assured by the used Linux kernel,
- separation of all processes and system resources,
- identification of applications by UID identifiers,
- complex encryption mechanisms,
- permission-based security policy,
- *inter-process communication* (IPC) and *code-signing*.

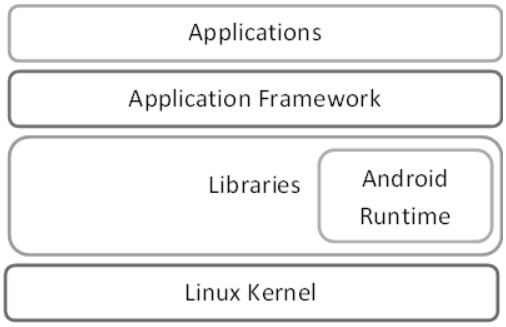

Figure 3. Layered Android architecture

Similarly as in case of iOS architecture the Android operating system can also be viewed as a layered structure. At the core of this structure lies the Linux kernel which assures the stable and reliable environment as it has been thoroughly studied and improved basing on experiences from the original applications on desktop computers.

The Linux kernel provides basic security functionalities such as:

- permission-based access model,
- user-based permissions,
- isolation of processes,
- secure inter-process communication (IPC),
- possibility to remove suspicious parts of the kernel.

Android provides a variety of mechanisms to protect sensitive content. The major focus is put on the separation of resources belonging to different applications which reflects in well-developed sandboxing techniques and widely used permission-based model of accessing resources and performing operations.

Compared with iOS applications, Android ones more frequently become the target of attacks of malicious software [11, 14, 17]. Even though they have been reported as more vulnerable are terms of security. This may derive from the fact that unlike Apple, Google is not performing a strict *vetting* process i.e. it does not check the compliance of the applications published on Google Play with the company's standards. Therefore more malicious software may be slipped through on to the market.

From among major risks connected with development of Android applications the following threats seem to be of utmost importance:

- running third-party applications with *root* privileges,
- reverse-engineering Android applications resulting in access to the application resources like *AndroidManifest.xml* file,
- changing byte code of the application,
- firing *activities* without user interaction,
- vast exchange of data for commercial purposes.

Android applications are commonly written in Java which makes them more easily reversible than iOS ones. As it was mentioned reversing any application allows gaining the information on its structure, data flow and controlling flow. Thus, the security risks for Android applications are in this case corresponding to the ones encountered when dealing with iOS ones. Although the changes that can be done to the application are a lot further-gone as after reversing an Android application it is possible to change the obtained byte-code and repackage the application. The target of such repackaging may be for instance an XML file containing permission configuration – *AndroidManifest.xml*. Among others the information which permissions does the application have is stored: Internet access permission, sharing location, accessing contact list, etc. By altering this file, doing which in fact does not require the changing of byte-code, one may easily increase the range of permissions available for an application. Reversing Android applications is the first step in finding all the information the potential attacker would have in his list. As prov-

en by [17] anything starting from configuration files, database files, certificates, key-stores with the use of proper and available tools can be recovered from the byte-code of the application and altered.

4. Secure Development Model

As was presented in the previous sections the field of security of mobile applications requires the elevated attention because of the privacy issues of millions of users of smartphones and the lack of adequate solutions to assure the security of data. Having this in mind it is worth to think about more ways of how to reduce the risks connected with mobile security in the context of development process itself. It is possible to provide a model that would assure less probability of capturing sensitive data by malicious software or hackers [9, 12].

The idea of *Secure Development Strategy (SDS)* was introduced for building mobile applications so that they would be less vulnerable to external attacks and leaks of sensitive data (Fig. 4).

The existing approaches to mobile application security focus mainly on the transmission of sensitive data to external services that is not always necessary and desired. Safe data transfer between mobile and external devices is undoubtedly a crucial link in the process of securing the applications, however not the only one. The idea of *Secure Development Strategy* assumes that application should conform to pre-defined security standards embracing storage, access and transfer of sensitive data. Conformation to the standards should be achieved by implementing threefold security pattern for each of the mentioned areas. The model specifies the assumptions on how to achieve a proper level of security in each field and provides necessary details on the implementation of mechanisms which will allow achieving desired safety effects.

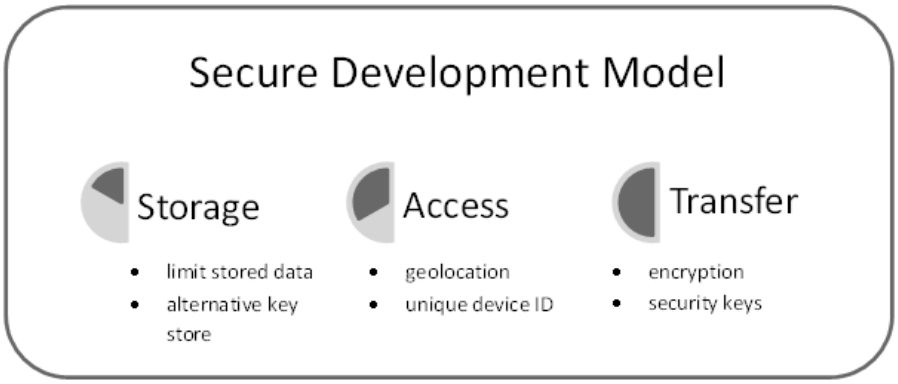

Figure 4. Pillars of Secure Development Strategy for mobile applications

The foundation of *data storage* pattern should be based on limitation of data stored on the device and application of an alternative storage space. The extraction of data from built-in key stores does not constitute a major difficulty. The best solution to this problem is to limit the amount of stored data especially the critical ones. However, as it is not possible to avoid it entirely, so additional precautions can be considered. The main focus for *accessing data* will be put on identification and verification of the device and user who wants to gain an access to the external resources. The last component which is *data transfer* is dependent on the operation of the system as a whole, therefore the most concerning aspects that will be taken into account are the format, encoding and permission checks of data which are going to be transferred. All of the mentioned mechanisms should be supported by appropriate encryption techniques.

4.1. Data storage security model

The first pillar of SDS – *storage* – concerns solely the application-side of the system. The major assumptions of data storage pattern embrace sensitive data encryption, limitation and restricted access (Fig. 5).

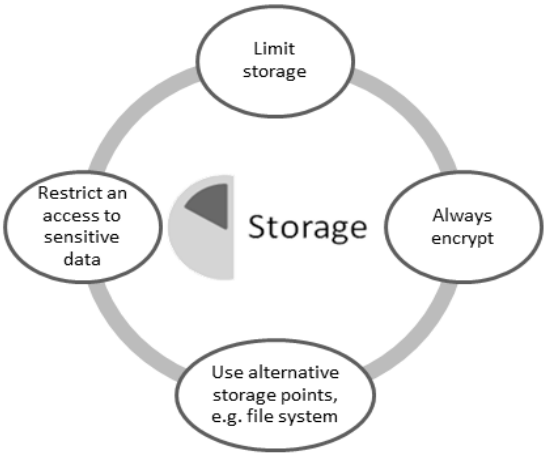

Figure 5. Assumptions of data storage model

While designing mobile applications the developer has two possibilities on where to store application data. He can choose external server where data will be stored in databases and special firewall mechanisms will block access to it. On the other hand if the amount of data is not too large he can choose to store some information on the device itself in the local database or file system.

The first option seems to be a better solution as it eliminates the risk of losing data when the device is damaged. Nonetheless, it requires a large amount of data

traffic between the application and the server. In that light the second option comes in handy – it reduces the amount of data transfer. However it seems to be less practical, as the data to be valid need to be updated. Moreover, the storage space of the device is also limited. Thus, the combination of both solutions comes from the need of keeping the data up-to-date and accessible by many devices at any time simultaneously giving the possibility to store a little number of crucial information on the device.

The storage mechanisms depend on the place of where the data is saved on the device. Two places for data storage which are also a potential risk points can be discussed for SDS: *key store* or *keychain* as it is called in iOS and *file system*.
The three rules regarding data storage can be formulated as follows:

- sensitive data should never be stored as plain text, but they should always be encrypted and stored as such in key-chains and any other storage places,
- sensitive data could be stored within the application database files and encrypted using encryption keys stored in the external server databases to limit the risk of reading the data,
- access to the internal database objects should be restricted only to the privileged functions (function calls).

4.2. Data access security model

The second pillar of SDS strategy concerns the *access* to data. This comes from the fact that mobile applications need to communicate with external services and other applications.

The major assumptions of this area of security embrace the three mechanisms which aim to enable identification of the user requesting access to application resources (Fig.6).

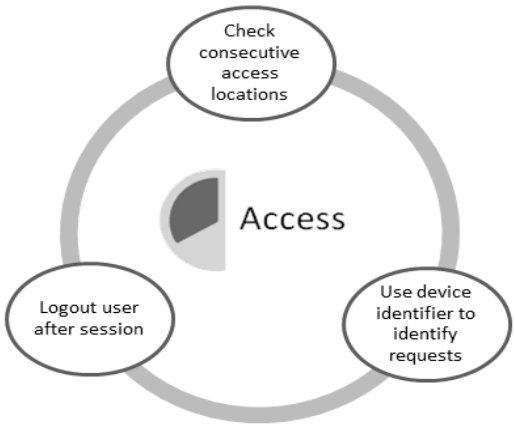

Figure 6. Assumptions of data access model

The fundamental SDS rules for data access are:

- mobile application should inform about the current location of the device every time it requires an access to sensitive data,
- mobile application should always present itself with a digital signature composed of unique device identifier,
- server should always check whether the device session is open before it realizes any requests.

4.3. Data transfer security model

Data *transfer* pattern refers to all mechanisms which involve exchange of data between the mobile application and external services. These mechanisms should incorporate in their action flow additional security procedures – *data encryption*, the use of *security keys* and check of requests integrity (Fig. 7).

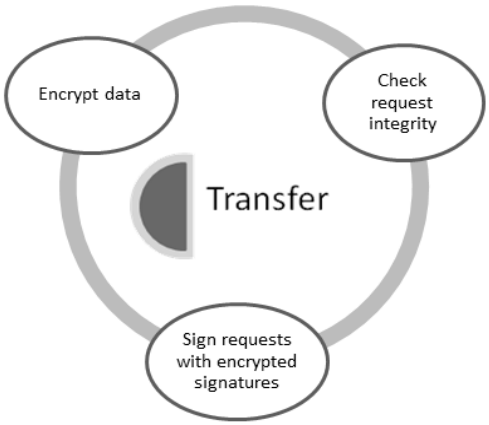

Figure 7. Assumptions of data transfer model

Although this is the last one of the described pillars of SDS, it is absolutely not the least important one. On the contrary data transfer seems to be the weakest link in the entire process of mobile application development. This comes from the fact that requests are travelling over the Internet in an unprotected space and they are prone to a special kind of attacks called *the man in the middle*.

This attack means that between the mobile and server application a third-party may be listening and waiting for exchange of information. There exist three types of attacks for the "man in the middle" scenario:

- attack on the privacy of data – stealing confidential information,
- attack on the integrity of data – changing the content of the message,
- impersonation – impersonating other device/user.

Firstly, the data sent to the server should always be *encrypted*. Special care should be of course taken of data which are considered sensitive like passwords, credit card numbers and others alike. *Encryption* is crucial in case of the first attack scenario regarding privacy – even in case of capturing the data, the content of the message will be difficult to read.

As far integrity of data is concerned it is a good and common practice to use the *digital signatures*. They enable to check whether the message received is exactly the same as message sent and if it was not modified on the way to the receiver. The digital signature mechanism relies on encryption which should assure the authentication.

The last suggested mechanism represents *security keys* which seem to be valuable in case of using checksum algorithms for digital signatures. Security keys introduced by SDS are for example 128-bit strings which should be sent to the server before the request for sensitive data. The security key can be unified for the entire application and independent from the device. When transferred it should also be encoded with the cryptographic algorithm.

5. Conclusion

The analysis of the current state of the art in the field of mobile application security enables to state that threats encountered in mobile application development do not vary significantly between the chosen platforms. Both iOS and Android operating systems are prone to similar threats and the existing solutions aiming to prevent them oscillate around the same issue of privacy leaks in applications.

While designing and building the mobile applications there will always be a tradeoff between functionality, optimization and security. In the long run however none of these areas should be omitted and treated with less importance than the others as only balanced combination of those three will enable to create reliable and useful solutions.

Currently there exists no standardized solution or methodology for developing the applications which would threat-resistant. Together with the invention of newer and newer strategies to prevent the security breaches the more sophisticated threats emerge and new vulnerabilities are detected by the platform developers.

The presented in the paper Secure Development Strategy for mobile applications introduces three pillars which should be taken into consideration while designing and implementing the mobile applications. All these pillars: data storage, data access and data transfer should be treated as equally significant in developing applications. The SDS provides details on its assumptions and mechanisms which should be implemented within the application framework in order to provide the security.

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INFORMATION SYSTEMS IN MANAGEMENT

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BUSINESS PROCESS IMPROVEMENT FROM THE ADAPTIVE CASE MANAGEMENT PERSPECTIVE

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This paper describes the risks, challenges and outcomes associated with the adaptive approach to business process change and improvement within an organization. The article focuses on aspects related to supporting the company's business operations (business processes) with information technology tools. This article explains that it is necessary to use Adaptive Case Management (ACM) systems instead of existing Business Process Management (BPM) solutions due to the fact that the latter are demonstrably inadequate in comparison to the more recent adaptive process management concept. The paper addresses the challenges and risks involved in business process optimization. The author argues that ACM is a better tool or approach for adaptive business process improvement, since it significantly reduces the risk inherent in business process improvement. The case studies provided in the paper serve to support this thesis.

Keywords: adaptive case management, business process management, BPM, ACM, Advanced Case Management, IT project management, risk management

1. Introduction

Faced with recession and a fast-changing business reality that demands adaptation and optimization of its business operations, an organization must embrace continuous optimization of its business processes in order to compete in the marketplace. Market dynamics indicate that a company's processes must increasingly evolve and change over time. However, addressing this area with IT support in the

form of BPM systems entails a substantial risk, since such systems cannot effectively support fast changing processes that require complex decision making.

A typical approach to business process management is to optimize business operations by automating work, with a strong focus on process centralization. Data is fed into and generated by every process. Moreover, every process defined in the BPM (Business Process Management) system is designed to achieve a repeatable goal through a sequence of specific steps performed in the right order. A participant in the process can only access a portion of process data as relevant to the specific process step in which he or she takes part.

Enterprise Business Process Management systems make it possible to define and manage the exchange of information within the company by using business process semantics. Process execution involves various parties, including employees, customers and business partners, and relies on IT systems and databases. BPM systems are IT tools that provide managers with the ability to monitor business process execution in order to better understand such processes and modify them to achieve better outcomes. The BPM standard enables companies to gain insight into their internal business procedures by using graphical notation to optimize communication processes. Graphical notation also makes it easier to understand and improve collaboration and business transactions between organizations. It enables companies to gain a mutual understanding of their operations and the individuals involved in such operations, making it possible to adapt to both new internal circumstances and changes in the external business environment.

However, with the classic BPM approach, the risk associated with adaptive business process improvement increases. There is a danger that if one cannot determine what the process involves and how it is going to change (e.g. in response to changes in stock market situation, stock prices, raw material prices etc.) at the beginning of the process using the BPM model, then the process will not be optimal due to its limitations (i.e. its static, specific and repetitive character).

Risk also increases due to the fact that the expenses and time required to create or re-engineer the process definition cannot be estimated unambiguously. In order to mitigate these risks, this article proposes an adaptive approach to business case management.

In contrast to the classic BPM approach, processes defined using Adaptive Case Management tools are dynamic. Unlike BPM's traditional processes described using BPMN, such processes are not finalized until they are actually executed. In order to make it easier to manage processes whose flow cannot be predicted due to high complexity and a large number of decision-making considerations, organizations increasingly choose an adaptive process management (case management) system. Literature refers to this approach as Adaptive Case Management [1] or Dynamic Case Management.

This solution helps manage difficult, unstructured processes, which have an unpredictable flow (and are, in most cases, the most expensive and complex ones), making it possible to improve such business processes adaptively.

The author of this paper stresses the fact that by choosing to use a BPM tool to support adaptive business process management, one runs the risk of losing the valuable experience possessed by the knowledge worker (who has a more efficient tool to support his work).

The paper also explains and structures certain concepts pertaining to the implementation of adaptive business process management systems by using actual market examples. This paper attempts to explain the most important aspects of the implementation of adaptive business case management systems in terms of both methodology and real use cases.

2. Business Process Management – state of the art

Business processes and the associated decisions are key to the operation of any organization. They set the pace of the company's business and determine its competitiveness. The way the company manages the flow of work and information along process paths has substantial impact on the speed, flexibility and quality of its decision-making processes. This is why implementing a platform that supports business process management should become a priority.

According to definitions quoted by G. Lee and B. G. Dale [2], business process management means:

- a structured approach to the analysis and continuous improvement of core activities, such as manufacturing, marketing, communication and other key aspects of a company's operations;
- a systematic, structured approach to analyze, improve, control and manage business processes with the aim of improving the quality of products and services (P. Elzinga, W. Horak, J. Chung-Yee) [3];
- creating and improving a synergistic set of horizontal processes that cross the boundaries between functional units both within the organization and outside its hierarchical organizational structure, intended to generate value for recipients (while cross-functional process teams are responsible for implementation, policy goals and guidelines as well as operational guidance are still cascaded down from the top levels of the hierarchy).

Companies often believe that they can solve most business problems in the area of process management simply by implementing a BPM system. This line of thinking, however, entails two risks, which can be fatal to any company:

- Operational innovation may be reduced due to restrictions imposed by business procedures or processes. Generally, there are two mutually reinforcing factors

that stifle innovation: delays caused by the bureaucratic processing of changes under approved process maps, and constraints that result from the beliefs of decision makers (who typically have no direct exposure to how the work is actually performed).

- The processes being executed may become "averaged" by the models.

Unfortunately, with the ever-increasing pace of changes in technology and the rules of market competition, the above risks will be even quicker to negate the benefits of implementing a traditional BPM model. In times of recession and crisis, when competition becomes fierce, enterprises already face the challenge of adapting key business processes to individual customers' requirements, correlating them with stock market performance etc.

At the same time, a business process used for example to deliver a construction project or process a loan application must be executed differently depending on the type of the project and the requirements of a particular customer. Since it is impossible to predict and model all types of projects and customer requirements, there must be an option to adapt the business process dynamically to the unique needs of a particular execution. In this case, process management may not be limited to routine, repetitive execution of the same process, no matter how well optimized. The risk associated with this approach is, more and more often, the reason why customers choose to invest in ACM systems. With the personalization of customers' requirements, it also becomes necessary to customize the company's business processes. The advantage smaller businesses have over their larger counterparts (even big multinationals) in terms of innovation and adaptability clearly demonstrates that the key to success is no longer an optimum business process, but rather the ability to skillfully and dynamically design business processes depending on customer demands. Large companies that spend enormous amounts of money on implementing new management methods and complicated IT systems are unable to achieve the operational flexibility inherent in smaller, family-run businesses, and their business process optimization efforts are exposed to major risks.

In most cases, these risks involve the increasing cost of adapting static workflows run in BPM systems to the fast changing business requirements. In addition to the visible increase in expenditure, the time to produce the final deliverable (e.g. response to loan application, correct evaluation of a customer's case etc.) also becomes longer, which may significantly undermine customer confidence and cause further financial losses.

The current approach to preventing and reducing the consequences of potential risks relies on a set of activities referred to as risk management. As a result of these activities, the probability of adverse events is reduced (preventive action), and appropriate measures and specific corrective approaches are prepared in order to reduce the adverse effect of events that occur due to the materialization of the previously identified risks (risk management techniques). Risk management is a

management technique that rationalizes decision-making under conditions of uncertainty (which, with respect to the area discussed in this paper, involves business process optimization). This approach is considered to be the most effective when operating under conditions of uncertainty (associated, for example, with supporting adaptive or time-variable processes), since it allows various types of security features to be reduced, thus improving the cost-benefit ratio.

The risk associated with business process improvement can be reduced significantly by using a methodology referred to as Adaptive Case Management (ACM). An enterprise managed according to the ACM concept inextricably combines day-to-day ability to create and validate innovations on a wide basis with its core business. By allowing process operators to change their processes dynamically, the entire enterprise management system becomes open to creative initiatives from a broad community of workers. At the same time, there is no risk of chaos that would result from uncontrolled changes to operational principles. Additionally, with the ability to trace the effect of changes, it is possible to enhance the organization's collective knowledge base by adding information as to which practices and solutions deliver the best and the worst results. This means real, day-to-day business process improvement and adaptation on the basis of knowledge possessed by a broad community of workers and validated by the customer. With the introduction of the ACM concept, a new definition also appeared to describe the workers involved in the processes. As opposed to traditional process participants, the new type of worker is referred to as a "knowledge worker". Professor Van Der Aalst describes the difference in definition between the two types using the "blind surgeon" metaphor [4]. The traditional process approach only gives the participant a partial view of the complete process, restricted in most cases to the specific process step as part of which the participant is expected to make a business decision.

Knowledge worker has full access to information on a given case or process. Knowledge workers are a new category of professionals whose primary responsibility is to use and exchange knowledge productively.

Due to the requirement to perform activities at the pace expected by the customer, and considering the sheer number of processes that run in parallel, the owner of a process executed using the traditional BPM model is unable to analyze, decide on, and modify the process as it is being performed. With ACM, this burden is shifted onto knowledge workers. Depending on their assigned authority, these workers (and not just process leaders as was the case in the past) need to be able to make on-the-spot changes to the process being executed.

In a standard BPM system, the workers who perform a given process are expected to follow an algorithm created according to a standard BPMN process map and designed according to the company's current best knowledge. In real life, there are no two identical sets of conditions for the execution of a process (e.g. two identical consulting or investment projects), so it must be possible for operators to

adapt the standard processes dynamically depending on actual operational requirements. The traditional process improvement cycle where process leaders model the processes, monitor their execution, draw conclusions and then use the resulting knowledge to make the processes better is too slow and generally inadequate. In addition, with conflicting customer (investor) expectations, it may prove impossible to design a "universal" process that is acceptable to all customers currently supported by the company.

A compelling argument in favor of the modern ACM approach is the ability to engineer processes whose structure is not known during the initial phase of the project. This approach significantly reduces project risk and helps mitigate business risks associated with business process optimization and adaptation.

Examples may include court cases and medical records. For such processes, participants must be able to modify existing or create new tasks in the process dynamically, and it is these process participants that the term "knowledge worker" applies to.

3. Examples of business process adaptation risk mitigation by using ACM

3.1. Vehicle insurance claims

By using a case management system, details of the claim and the applicant can be linked to the appropriate documentation that has been submitted. A business analyst can quickly make any required changes to the vehicle insurance claim solution. By configuring the solution with the ACM system, it is possible to reduce the risk of incorrect (e.g. incomplete) claim processing.

The challenge

Vehicle insurance claims may involve input documentation and supporting documentation from multiple sources, such as the applicant's claim, documents provided by the garage, police reports, and documents from other official sources of information regarding the value of the vehicle or traffic conditions. Moreover, various analyses are often required in order to evaluate and enter additional information in the insurance claim for the duration of the process. Complete documentation and all information associated with the claim must be easily accessible so that adjusters can properly assess and resolve the insurance case.

There may be significant differences between various claims. With such diversity, it may be necessary for case managers to initiate any processes that allow incorporating new roles and changing task execution method and timing as the claim is routed across various areas of the organization. Executing the above sce-

nario in a traditional BPM system would entail the risk of delays, or even a failure to handle the case properly.

The solution

A business analyst at an insurance company works on improving the process used for handling vehicle insurance claims. He or she creates roles for each step of the claim process and assigns privileges to these roles to accommodate groups of employees who execute tasks at each stage of the process.
The solution combines the following items:

- properties of the claim, such as policy number and details of the accident;
- roles, such as claim adjuster and assessor;
- types of cases, such as general claims, claims involving bodily injury or total loss claims.

When using traditional solutions based on a predefined workflow process map, the risk involved in handling dynamic cases or adaptive processes is enormous. In order to manage the risk, an adaptive approach to business case management should be adopted. This makes it possible to change roles quickly, and to process or add tasks as necessary.

Due to the flexibility of the case management system, case managers can solve problems much more quickly and effectively, and customers bring their claim cases to completion much more easily. The above case study uses the insurance sector as an example to demonstrate how the ACM approach reduces the risk involved in supporting dynamic business processes.

3.2. Financial services: credit card payment dispute resolution

Adaptive Case Management can provide card issuer banks with a case management solution to help resolve credit card disputes. ACM delivers a broad view of each case to the case managers, improves productivity, and reduces the risk of errors being made as the case is being processed.

The challenge

Banks that issue credit cards have observed a significant increase in the number of cases that involve disputes. Furthermore, regulatory changes and increased pressure to improve customer satisfaction force banks to resolve each case in the most efficient manner possible. This means that banks need a solution that will enable them to process any incoming dispute and decide (with the least possible risk of error) whether to submit the dispute to a particular credit card operator in order to issue a chargeback.

Credit card companies have strict requirements concerning case submission, and the bank's solution must provide the operator with accurate and relevant information that allows efficient processing.

The solution

A business analyst at the bank verifies the credit card operator's requirements for dispute processing. He or she determines the type of information required by the company in order to process a dispute. The analyst then uses Adaptive Case Management tools to quickly design and create a solution that will enable the bank's staff to capture all information required for the case and include additional records and documents. As in the first example, ACM significantly reduces the risk involved in working with dynamic and optimized business processes.

3.3. Banking sector: customer case management

Bank institution treats each customer as a unique business case and needed a system that would be able to support that philosophy. Existing technology did not provide any means to monitor the progress of existing client cases or corresponding business processes and did not promote the reuse of applications to increase time to value. Attracting new clients was a key objective of the bank and due to economic constraints, needed to be accomplished with existing staff. Improved customer interactions were an important aspect to meet the goal of growth, but existing systems did not foster timely or substantial customer service. Spar Nord needed a system to maximize effectiveness, improve competitiveness, overall performance and customer satisfaction.

The challenge

Bank recognized that an adaptive case management strategy would best meet its needs moving forward. The IBM team created a unified enterprise-wide case infrastructure built on IBM Case Manager V5.1 software. The service-oriented architecture approach will automate existing paper flow between business cases and centrally integrate systems between the front and back offices for better effectiveness.

The Solution

Bank has gained a new solution that acts as an enterprise-wide solution to standardize processes and maximize effectiveness. Expanding client base by adding 10,000 new customers utilizing only already existing staff is now possible and personalized customer interactions are expected to improve 45 to 55 percent. The Case Manager software helps provide a 360 degree view of all data - customer, accounts, line of business case systems and more - and automates the existing paper flow. The Bank can now truly treat each client as a unique business case –

monitoring the progress of each case from initial application to closed loan. The Bank has gained an integrated system for enterprise-wide improvements, boosting customer satisfaction and streamlining processes between the front and back office.

3.4. Life and Health insurance: disability claims system

Large Canadian Insurer recognized the need to update several systems associated with disability claim work processes to remain highly competitive in the marketplace. In order to meet the growing demands of customers and prospects. The company realized it needed to provide exceptional customer service while increasing service speed and productivity to increase market share.

The challenge

The Insurer recognized a unique mix of domain knowledge and specialized expertise were required to achieve the desired process changes and successfully transforming mission-critical processes. Using content and process automation technologies transformed operations with the least disruption of current operations. Subsequent phases will replace current unsupported technologies with a case management and rules-based, out-of-the-box solution.

Customer decided to strategically focus its efforts on integrating an all-inclusive new process and content solution to its existing line of business applications. The ACM software takes the scanned data, sets up incoming claims using workflows and arranges next steps. The Case Manager software acts as a highly functioning case management system, organizing and collecting all pertinent data that helps customer work more efficiently across all processes.

The ACM platform, integrates all the underlying software, acts as a solution accelerator and provides the user interfaces, allowing the company to implement and launch products quickly, while making the system easier for knowledge workers to manage and reconfigure.

Phase two will replace some of the client’s unsupported line of business systems with the more advanced e-Disability Claims functionality of the ACM solution.

The Solution

By implementing both ECM and ACM software, the customer achieved many benefits. The ability to scan, index and use electronic data and case structures has transformed processes. The company has gained the ability to scan in excess of 40,000 claims per year. Now all client collaboration is electronic, with information becoming more timely and cost effective. Users are more efficient and company expects, in subsequent phases, to realize productivity improvements of 30 percent. Real time monitoring allows management to control workload more effectively. Furthermore, extensive reports allow for better time management and workload

distribution, while electronic collaboration eliminates geography as a barrier. Finally, courier use has been eliminated, saving the company money and time.

Moving to an automated solution has helped the customer remain competitive and retain customers. Using ACM packaged software allowed the solution to be implemented and launched quickly, helped reduce disruption to daily operations and provided better solution agility to the team.

4. Conclusion

The traditional, static approach to process management works well in conjunction with BPM IT systems when process optimization is needed.

However, it entails the risk of serious issues in the event of unexpected adaptive changes.

The problem stems from the requirement for the process leader to make the decisions (which delays further action) and the inability to link the company's core business with knowledge management in a systemic, institutionalized manner via the process support system. At the current rate, boardrooms, boards of directors, management teams and process leaders are finding it difficult to keep up with adaptive changes.

An enterprise managed according to the ACM concept inextricably combines day-to-day ability to create and validate innovations on a wide basis with its core business, thus mitigating the risks and challenges associated with business process optimization. By allowing process operators to change their processes dynamically, the entire enterprise management system becomes open to creative initiatives from a broad community of workers. At the same time, there is no risk of chaos that would result from uncontrolled changes to operational principles. Additionally, with the ability to trace the effect of changes, it is possible to enhance the organization's collective knowledge base by adding information as to which practices and solutions deliver the best and the worst results. This means real, day-to-day business process improvement and adaptation on the basis of knowledge possessed by a broad community of workers and validated by the customer.

The main benefit of implementing a dynamic business process management model is that it brings back to large enterprises the speed and agility needed to operate and compete in an evolving market environment. Risk management becomes, so to speak, an integral part of all processes within the organization. If incorporated properly in all processes, it helps reduce the uncertainty inherent in these processes and optimize risk, thus delivering tangible benefits.

By truly empowering process operators to define and take responsibility for their work without the risk of losing control of ongoing processes, dynamic BPM enables large enterprises to manage knowledge in their day-to-day operations based on:

- creative, active experimentation that relies on continuous minor changes introduced by a broad group of process operators, leading to gradual collection and distribution of knowledge; and
- day-to-day validation of the existing knowledge base and elimination of obsolete knowledge that no longer matches customer requirements or competitive challenges.

Today, neither customers nor products can be treated as anonymous and repeatable. As a result, it becomes necessary to deliver a product tailored to the needs of a specific customer not only in areas of construction or consulting, but also (increasingly) in areas where volume production was previously the order of the day, such as financial services, automotive industry, or travel. This means that companies must adapt their operational principles every day, and update their understanding of individual customers' current and possible needs. Dynamic business process management expands on classic process management and attempts to bring it closer to the concept of a learning organization.

One of the core assumptions for ACM is the belief that the organization being managed should constantly expand and process its existing knowledge of the mechanisms present in the business environment [5] in which it operates, and that this management model is not simply more effective: it is necessary in order to respond to the staggering pace at which today's markets and their expectations evolve. It is often said that the goal of ACM is to establish a learning organization. Improvements to a company's internal processes are made in several dimensions, and this applies to both managers and employees.

It has to be emphasized that opportunities for managing business processes dynamically exist regardless of the type of the company's manufacturing or service operations, and that the efficiency of implementation depends on the professional level of the company's employees and its actual knowledge management efficiency, including the involvement of all employees in the development of new solutions. This paper addresses the question of how to approach the evaluation of business optimization after implementing an ACM system. To that end, it presents a methodology for evaluating the efficiency of a static BPM implementation.

ACM expands the typical business process management approach to include frequently changing or completely unpredictable processes. The economic situation, particularly during recession, shows that the traditional approach to business process management is not optimal.

Initially, attempts were made to use the BPM and Agile methodologies to create and implement business processes that could be changed over time. However, neither the time required to make the changes nor the cost of such operations were satisfactory.

This paper uses practical examples from the insurance sector to demonstrate that the ACM approach reduces the risk involved in supporting dynamic business processes.

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ORGANIZATION AND WAREHOUSE MANAGEMENT IN DAIRY COOPERATIVE Y

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In this paper, the organisation of warehousing and warehouse management in one of the leading Dairy Cooperatives in Poland, hereinafter referred to as "Dairy Cooperative Y" have been investigated. The selection of the Cooperative was made in a conscious and targeted manner. The main objective of the paper was to determine the role of warehouse management in the operation of an enterprise from the agribusiness sector. Data were collected on the basis of an interview with the employees of the enterprises. The data related to the year 2011. The indicator analysis shows that the warehouse management of the cooperative is quite good, and the company is a well-organised unit which successfully implements production and shipment plans and shows a high quality of customer support.

Keywords: warehouse management, dairy cooperatives, agribusiness sector

1. Introduction

According to the Polish standard, warehouse is defined as an operational and organisational unit designed for the storage of material goods (stock) in a separate space, storage building, in accordance with an established technology, equipped with adequate technical devices and measures, managed and operated by a team of people with appropriate skills [12]. H. CH. Pfohl defines warehouse as a link in the logistics chain where goods are temporarily stored and then routed to subsequent links in the supply network [13]. Warehouses may be both points of delivery and

receipt, and points of concentration or distribution of the flow of goods in the logistics system [8]. The basis processes occurring in warehouses are movement and storage. The prevalence of certain processes depends on the role to be fulfilled by the warehouse [1]. In addition to their primary function, i.e. storage, quite often, warehouses need to offer a number of other services to their customers. The most important of such services are: completion of shipments, customising, packaging, repackaging and labelling of goods, and quite frequently, the after-sales service [6, 10]. Some of the aforementioned activities are included in the very definition of storage, which is defined as a set of activities related to temporary receipt, warehousing, storage, completion, movement, maintenance, keeping records, controlling and release of goods [9].

In the warehouses should focus on the components of such facilities. The most important components are: stocks, separate space, costs related to the implementation of warehouse processes, organisation and personnel [11].

Warehouse management is defined as an activity involving a series of measures, organisational, technical and economic operations, associated with storage of warehouse stocks [3]. Storage and handling of stocks are activities, coordinated in time and space, involving stockpiling and storage of goods (including handling activities – change of location, in-house transportation), care and control [2]. The organisation of warehouse management should be governed by normative laws of corporate level in the form of orders, regulations, instructions. A set of such documents constitutes the formal and legal basis for warehouse organisation (or warehouse management) [5]. Warehouse management may be quite crucial in competing against other companies.

The agribusiness enterprises are still unexplored in terms of logistic solutions, including the solutions related to use of the information systems. The entities active in this sector differ from other production and service companies [7]. There are only a few detailed studies on management of logistics in agribusiness enterprises [14]. Therefore the subject taken is very important.

2. Methods of research

In this paper, the organisation of warehousing and warehouse management in one of the leading Dairy Cooperatives in Poland, hereinafter referred to as “Dairy Cooperative Y” have been investigated. The selection of the Cooperative was made in a conscious and targeted manner of the companies of dairy sector. The main objective of the paper was to determine the role of warehouse management in the operation of an enterprise from the agribusiness sector. Data were collected on the basis of an interview with the manager and the employees of the logistics department, and the employees of the cottage cheese production department. They enabled the author to define the organisation of warehouse management.

In addition, this paper suggests a number of improvements which could be introduced in the examined warehouse. The data related to the year 2011. For the purpose of evaluation of warehouse management, the author made use of operational and logistics indicators related to the functioning of the warehouse, as well as performance indicators of warehouse space. The data are presented in a descriptive and graphic manner. This paper describe the organization of the warehouse. The best for this purpose are descriptive and graphical methods.

3. Results

Problem to be solved is define the organisation of warehouse management. In addition, this paper be suggested a number of improvements which could be introduced in the examined warehouse.

Dairy Cooperative Y has become one of the leading processors of milk in Poland through the use of various types of storage, IT and organisational solutions. One of the lasts solutions applied in the cooperative is the introduction of the SAP information system. This is an ERP system supporting the management of company's resources. The advantage of this solution is the possibility to use a single system for all areas of company's operation.

Another solution facilitating the work in the warehouse is the application of the ABC/XYZ analysis in the storage of goods. The analysis is based on such a distribution of goods in the warehouse as to allow their collection as quickly as possible. The choice of the place of storage is made on the basis of the analysis of the frequency and the volume of collections for a given assortment group. Moreover, the method is adapted to the specifics of individual customers. For instance, pallet units stored for the most important customer (who regularly orders large quantities of goods), are placed closest to the goods release zone. The ABC/XYZ method is applied in this manner in the case of export orders which do not constitute a large percentage of the total number of shipments. Most orders are processed for domestic customers where the ABC/XYZ method is applied by analysing the frequency and the volume of collections for a given assortment group [10].

Another solution applied in the warehouse management of the enterprise is associated with the methods of order completion. The employee working in the picking zone, compiles loading units in accordance with individual orders, i.e. processes one order at a time. He applies to so-called "goods-to-man" method which facilitates the process of picking, and does not require the employee to move around the picking zone, unlike the traditional method of "man-to-goods". Having completed the order, the employee of the picking department carries out a quantitative check in order to ensure its compliance [4].

The size of the cottage cheese production hall was inadequate to its needs. The passage from the production hall to the picking zone was very often quite busy and consequently there were congestions in this area of the plant. Moreover, the way between the individual production lines was too narrow to accommodate two loaded manual stackers. Containers for one production line and carton trays for another line were supplied from the same picking zone (Figure 1). The production hall was not suitable for the storage of such materials on its premises. Quite often, materials were stored wherever space was available. The employees had to focus on problem solving instead of limiting their activities to the support of the production line.

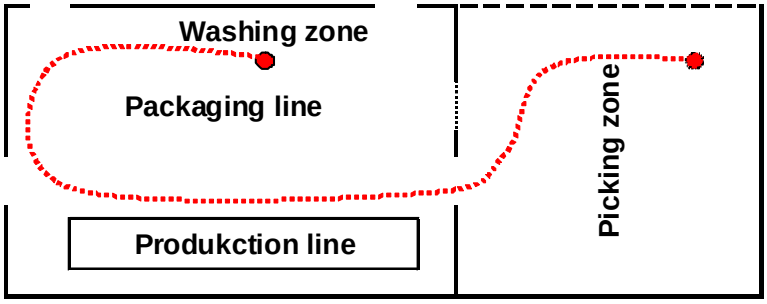

Figure 1. The road between washing zone and packaging storage

Another problem was the length of the passage between the container cleaning zone, for containers used for production at the other line, and the zone where the containers were stored. The employee had to move quite long distances in order to transport clean containers to their place of storage. There were also some issues related to the process of completion. The only tool at the disposal of the employee who had the task of evaluating the degree of order completion was a calculator. There were no other supporting tools enabling him/her to control the person in charge of order completion. Evaluation of the degree of order completion, carried out merely on the basis of the expertise of the employee, could result in incomplete supplies, and consequently, dissatisfaction of the customer. A similar problem was observed at the point of packing of finished goods into appropriate containers at the production line. Sometimes, as many as 60 packages are placed into containers, and also in this case, the success of order processing depends on the person responsible for the task.

Quick shipment processing was hindered by the lack of a loading ramp. Loading was performed from the level of warehouse floor. The problem was particularly acute whenever there was a large amount of orders to be processed. The aforementioned problems stemmed from the fact that, prior to its adaption to warehousing functions, the facility was used for different purposes.

Another difficulty in the warehouse management was caused by the lack of a modern system for recording inventory in the finished goods warehouse. When loading the trailer, the employee identifies loading units on the basis of logistics labels. Employees with certain expertise in this area were able to load the trailer seamlessly. With a larger number of orders, this manner of order processing may become insufficient. Recording systems used nowadays are more economical. Modern systems require both investment in equipment and human resources, and improvement of the IT system, but in the long run, they lead to a measurable cost reduction.

Warehouse management may be evaluated in a number of ways. One of the best methods in this area is an indicator analysis. It is carried out by interpreting the values of indicators determined on the basis of parameters which are characteristic for the warehouse. In this paper, the author used selected indicators which suit the examined warehouse of semi-products and finished goods. Calculations were made on the basis of figures received from the test company for the year 2011.

The first group of indicators are logistics indicators related to the operation of the warehouse. The percentage ratio of orders accepted for processing to the total number of received orders in the test period indicates the capacity of the company to process customer orders (W1 = 99.5%). The value of the ratio should be evaluated positively, very few orders were left without processing. Another indicator is the percentage ratio of processed orders to the total number of accepted orders (W2 = 99.8%). The value of the ratio indicates that almost every order is processed. The percentage ratio of error-free supplies to the total number of completed supplies enables you to determine the efficiency and accuracy of the work performed in the warehouse (W3= 96.7 %). The value of the ratio is indicative of the well-organised work in the warehouse, however there are still some areas for improvement. Another indicator relates to the timeliness of supplies. The percentage ratio of orders completed with delay in the Dairy Cooperative Y in 2011 was low (W4 = 8%). This value indicated that in the test period, the facility showed a high level of customer support. One of the key indicators is the indicator of supplies which received customer complaints, at least partially, illustrating the level of customer support. Also in this case, the company makes its best efforts to keep the indicator as low as possible (W5 = 0.5%). The value of the indicator shows a negligible number of complaints, in terms of supplies, which proves good work organisation and a high level of customer support. Logistics indicators related to the operation of the warehouse were high. The warehouse showed high levels of customer support, as well as a good and accurate work organisation.

Performance indicators allow for the evaluation of storage efficiency, or the efficiency of surface use or space use in the warehouse. This paper presents two of the most important indicators in this group. In the finished goods warehouse of the

cottage cheese production plant, storage is performed in blocks, and no storage devices are used. In this case, the optimal values of indicators are different from those attributable to shelf storage. The first index value is the indicator of efficiency of the use of warehouse storage surface (W6 = 0.651). The value of the indicator proves a good level of storage surface use in the warehouse. It is assumed that the optimal value of the indicator should be around 0.75 for the storage method applied at the Dairy Cooperative Y. Another index value is the indicator of the efficiency of space use (W7 = 0.489), which shows an average use of the warehouse capacity. On average, this indicator amounts to 0.50 – 0.56. The values of both indicators are typical of block storage and close to the optimal level. The level of the use of the capacity of the warehouse should be evaluated positively. Shelf storage could enable easier access to selected loading units, however, the level of the surface use and space use indicators would be significantly lower. The analysis made use of indicators which are most adequate for finished goods warehouses, the storage method, the specifics of the company and the FMCG (Fast Moving Consumer Goods) industry.

The basic problem of the examined cottage cheese production department is the lack of available space. After investing in the expansion, a number of changes could be introduced on the plant premises. One method of cost and storage space reduction is for plants to specialise in the production of certain goods. In the examined plant, free space could be used for storing materials for their production, such as containers of package foils. With more space, there would be an opportunity to develop another passage between the dirty zone and the picking zone. This would improve internal transportation.

Another suggestion is to improve the process of picking by exercising more control over the loading unit being completed. At the route of the tray with the goods, a gate calculating the number of passing items, should be installed. This would reduce the number of incorrectly completed units.

Another investment to be consider is the development of a loading ramp. Loading from the level of the floor significantly lengthens its time. Fork lifting trucks, or trucks with lifts, should be applied. The cost of expanding the warehouse to include the loading ramp would be considerable, but as a result, the loading process would be much quicker. All these solutions could improve the flexibility of the plant and enable it to respond to the changing conditions with more speed. Any investment in infrastructure is expensive, and the benefits are spread over a number of years.

4. Summary

The purpose of the paper was to examine and describe the operation of the warehouse management on the basis of Dairy Cooperative Y, one of the leaders in the milk processing sector. Warehouse management may be quite crucial in competing against other companies. The paper focuses on the cottage cheese production department. The organisation of the warehouse management was evaluated positively, as satisfactory, but the author identified some problems which need to be solved. The most important problems are: low availability of warehouse space, irregular arrangement of zones, and lack of up-to-date system for recording of loading units in the warehouse. The indicator analysis shows that the warehouse management of the cooperative is quite good, and the company is a well-organised unit which successfully implements production and shipment plans and shows a high quality of customer support.

A number of suggestions for warehouse management improvement have been made. The most important change to be considered is the specialisation of the plants in a particular type of production. Manufacture of specific products will lead to cost reduction and storage space demands. A suggestion for the improvement of the picking process has been made as well, by means of installation of a system for calculating the number of products delivered to the picking zone.

The companies may benefit much from implementing logistic solutions in their activity, among others, by using modern IT tools. A limitation, especially for small businesses is the cost of purchasing and implementing these solutions.

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INFORMATION ASYMMETRY IN FOUR IT PROJECTS: THE CLIENT'S PERSPECTIVE A MULTIPLE CASE STUDY

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The IT system market belongs to the group of markets characterised by imperfections in information access both amongst the suppliers and the recipients. Literature studies indicate a research gap concerning the phenomenon of information asymmetry between the supplier and the recipient in an IT project. My research thus far has indicated that an excessively high level of information asymmetry between the supplier and the recipient, occurring during the entire life cycle of a management support IT system, is an important factor, which has a key significance to the success of the project. The scope of this article is to present the results of research on the phenomenon of asymmetry in information access both amongst suppliers and recipients as part of a conducted case study.

Keywords: information asymmetry, IS, IT management support system, IT system implementation, client's perspective, multiple case study

1. Introduction

Why do IS projects fail if we know what leads to failure? This is one of the most intriguing questions. The answer is that we still do not know the nature of IS failures. Interaction of many small, not particularly important factors creates a complex amalgam which is difficult to break down [1]. R.Ackoff [2], Lyytinen & Hirschheim [3], Sauer [4], Keil [5], Beynon-Davies [6], Schmidt et al. [7], Ewushi-

Mensah [8] and Avison et al. [9] have been conducting wide and detailed research on IS failures for more than forty years. Since the 1980s, many frameworks have been established to better understand the idea of an information system (IS) failure. We can divide IS failures into expectation failures [3] and termination failures [4]. Expectation failure happens when the implemented system is incapable of meeting the business needs of the stakeholders. These types of failure can be further divided into failures of correspondence, process and interaction. Correspondence failure occurs when IS is evaluated in comparison with previously defined project goals. A lack of correspondence between project goals and the evaluation is viewed as a failure. Process failure takes place when the results of development are not satisfactory, i.e. when an attempt to create a working system or to deliver it within the time frame and cost defined by the budget ends in failure. We sometimes call these failures "runaways" or "project escalation" [10] [11]. Interaction failure occurs when users' requirements and acceptance do not align – it happens when the users do not use a given IS. An additional dimension of this problem, not included in these descriptive models, has been identified: Outsourced Information System Failure (OISF). In order to explain OISF, we can use agency theory, according to which the problems occurring in the environment of outsourcing result from three elements: the differences of goals, the differences of risk behaviours and information asymmetry. OISF is a failure which happens during an IS project in the environment of an outsourced project, i.e. when the client orders the implementation of an IT system from an external supplier.

Both as a practitioner and as researcher, I focus on understanding and explaining the causes of such numerous failures of IT projects consisting in implementing Enterprise Resource Planning, Customer Relationship Management, Business Intelligence, Document Management Systems and E-learning class systems through external suppliers in SMEs. My research thus far has indicated that an excessively high level of information asymmetry between the supplier and the recipient, occurring during the entire life cycle of a management support IT system, is an important factor, which has a key significance to the success of the project. I believe that the factors that are crucial to the success of an IT have changed throughout the years and their character has become more nuanced. It results from a number of factors, i.e. the quickly evolving technology, the proposed methods of project completion, the fast increasing saturation of IS markets and hypercompetition amongst suppliers. The scope of the article is to present the results of research on information access phenomenon amongst suppliers and recipients as part of a conducted case study carried out from the client's perspective. In my research, I use the case study method. The subjects of research are four SMEs in Poland, which have implemented and use management support IT systems, i.e. ERP, CRM, DMS. The article belongs to a cycle of articles that I wrote to present the results of research on the phenomenon of information

asymmetry in IT projects. My aim is to present the logics and the important traits of information asymmetry in IT projects from the client's perspective on the stage of bidding, implementation and operation, using the agency theory.

2. Using agency theory in IT project implementation

The positive agency theory [12] [13] has already been used to describe different phenomena in chosen IS projects. The majority of ERP, CRM, BI, DMS and E-learning class IT systems is implemented through external suppliers with the use of outsourcing. These projects are implemented in an environment where at the stage of bidding, implementation and operation, we can observe three factors [1]:

1. The conflict of goal and interests of both sides, i.e. the supplier and the client. The client's major goal is to obtain economic and non-economic benefits, which in case of enterprises will allow them to achieve temporary competitive edge. The major goal of the supplier is to achieve profitability of the implemented project. We need to stress that the conflict of goals and interests appears at three stages, i.e. the bidding stage, the project implementation stage and the system operation stage.
2. Activities linked to minimising the risk of not being able to achieve the planned goals and interests, on the supplier's side and on the client's side.
3. Information asymmetry between the supplier and the recipient.

According to agency theory, in relations between the buyer and the supplier in IT projects, we have the following players:

1. The client, who decides to purchase a management support IT system software licence and an implementation service – Principal.
2. The supplier of licence and implementation services – Agent.

Agency theory relates to relationships where one of the parties (principal) commissions work to another party (agent), who then carries it out according to the contract that they both agreed on. Both sides selfishly act in their own interest and have conflicting goals. This leads to two problems [1]: 1) ex-ante, before the agreement is signed: the problem of negative selection and 2) ex-post, after the agreement is signed: the problem of moral hazard. Negative selection appears before signing the contract because of the private or hidden information that the agent has about the real quality of their services which are unavailable to the principal. This results in information asymmetry, where the principal's position is an unprivileged one, dealing with a group of bidders who frequently lack sufficient qualifications. The principal who decides to implement an IT system finds it very difficult to see the difference in quality of two groups of goods offered by the agent, analogically to what Akerlof presented in his article [14], i.e. the licence of a specific software and the implementation service for a given software.

Moral hazard appears after signing the agreement when the principal is not able to monitor and validate the actions of the agent, and they may be put in a situation where the agent is carrying out hidden activities without considering the principal's interest as a result of differences in their goals. Hidden information and hidden activities (also known as opportunistic behaviour) occur when the principal is not able to observe the behaviour and performance of the agent without facing agency cost [12].

Apart from information asymmetry and differences of goals, there is one more important factor: differences of risk behaviours. IS implementation poses a high risk as the outcome is not always defined as a measurable output, and the members of a given organisation may only be partially able to verify it. A failure is very likely mostly because the possible outcome is not certain. Agency theory is a well-known theory, used in research on IT projects carried out by external suppliers [15] [16]. Even though researchers accept the significance of agency problems, the majority see them as one-sided: opportunistic behaviour is associated with the agent. Few researchers understand in greater depth how, and why, agency problems appear. Here, using case study research, I would like to uncover and explain the appearance and culmination of agency problems from a dual perspective.

3. Research methodology

In my research, I have used the multiple case study method. Four enterprises which implemented and are currently using management support IT systems, i.e. ERP, CRM and DMS, constituted the subject of research. These selected enterprises belong to the SME group and operate in Poland. Four projects were chosen from a group of 150 projects. The main criteria of selection were: implementing ERP, CRM and DMS systems as the leading management support applications implemented in Poland, annual turnover below 100 mln EUR, total implementation budget below 250 000 EUR, implementation agreement based on a fixed budget, and the partial failure of all implementations. The scope of the case study is theory creation linked to the issues of information asymmetry in IT projects consisting in the implementation of management support IT systems. I analyse the case study as it allows to develop the existing theory, provide explanations of phenomena unrecognised before, such as information asymmetry in IT projects, and understand the course of management support IT systems implementation in the context of information imperfections. Further development of the research, i.e. confirming the hypothesis presented in the article on information asymmetry in IT projects from the client's perspective, will be a quantitative study employing the method of nonlinear regression using the results presented in this article. Here, I focus on the client's perspective during the whole life cycle of an IT project in an enterprise, i.e. from the bidding stage to the

operation of management support IT systems. My choice of research method – case study, is motivated chiefly by two circumstances [17]:

1. The early stage of knowledge development in the given research area, i.e. information asymmetry in IT projects.
2. Recognising the current phenomenon in real conditions.

Table 1. Five main criteria of case selection

Criterium	Information on the fulfilment of criteria
Data availability	Guaranteed
Distinctiveness of the case, clearly [unequivocally] illustrating studied patterns	Projects that ended in partial failure, but not interrupted during the implementation
Variation in analysed cases	Variation in analysed cases is expressed in the selection of: - IT projects consisting in the implementation of management support IT systems, i.e. ERP, CRM, DMS - Client profile - Sales value and the number of client's employees - The results of project implementation
Critical character of the phenomenon allowing to formulate a general statement	The level of information asymmetry between the supplier and the client as part of the whole life cycle of project implementation from the client's perspective influences the results of project implementation.
Metaphor allowing to point the researcher's attention towards a specific course of the studied phenomenon.	Aiming to analyse the phenomenon of information asymmetry in the entire project life cycle, I selected cases that could be studied on the stages of: bidding, contract negotiations, implementation and information system operation.

Source: Flyvbjerg B. (2004) *Five Misunderstandings about Case-Study Research*, Seale C., Gobo G., Gubrium J.F., Silverman D. [eds]: Qualitative Research Practice, Sage Publications, London-Thousand Oaks, UK

The nature of „case study" research means that the researcher does not presuppose the existence of defined patterns or particular characteristics of the phenomena in question. As opposed to the quantitative research, the beginning is not marked by a prediction of reality included in the hypothesis, but the state of ignorance. We need to underline that it is not a general state of ignorance, but a knowledge gap resulting from literature research and observation of reality. Ignorance, which constituted the starting point of case research, is thus an inter-subjective state, not referring to the researcher as such.

As part of the multiple case study analysis, I would like to pose the following research question:

> What factors influence the level of information asymmetry between the supplier and the recipient in project implementation from the client's perspective?

The choice of studied cases was carried out through purposive sampling. According to B. Flyvbjerg [18], there are five main criteria of case selection. Table 1 presents the criteria along with their characteristics in the context of conducted research.

4. Research results

Table 2 presents information characterising the four projects.

Table 1. The characteristic of researched projects

	Company X	Company Y	Company Z	Company A
Client (principal) profile	Sales and service company	Distribution company	Manufacturer of electromechanical elements	Legal firm
Client turnover	EUR 45 mln	EUR 30 mln	EUR 90 mln	EUR 20 mln
Number of client's employees	50	35	150	65
Supplier (agent) profile	Reseller of ERP software designed by the market leader	Reseller of CRM software designed by the market leader	Reseller of ERP software designed by the market leader	Reseller of DMS software designed by the market leader
The type of purchased IT system	ERP	CRM	ERP	DMS
Total project budget (the cost of licence and outsourced services)	EUR 200 000	EUR 50 000	EUR 0.5 mln	EUR 35 000

Total operation cost declared by the supplier at the bidding stage without system expansion in a 3-year period	EUR 25 000	EUR 20 000	EUR 300 000	EUR 10 000
Total real cost of system operation (licence and additional services purchase) in a 3-year period	EUR 75 000	EUR 120 000	EUR 0.6 mln	EUR 15 000
Implementation period	March – December 2005	August - December 2007	January - December 2006	November - December 2005
Operation period	7 years	5 years	6 years	7 years
Implementation results	Project completed on time, within budget, not all the business goals completed.	Project not completed on time, within budget, not all the business goals completed.	Project not completed within budget, on time, all the business goals completed.	Project not completed within budget, not on time, not all the business goals completed.
Type of implementation service agreement	Fixed budget	Fixed budget	Fixed budget	Fixed budget

Source: Own study

Table 3 presents the respondents' answers as part of the case study research.

Table 3. The respondents' answers as part of the case study research

Did the supplier guarantee fixed prices of licence purchase during the operation?	NO	NO	NO	NO
Did the software producer increase the price of licence during the operation? If "yes", by how much?	YES (30%)	YES (30%)	YES (70%)	Software producer was sold to a different company, which significantly changed the price policy, leading to a 120% increase in software licence price
Did the software have important producer flaws (making some system functions impossible to use), which should have been eliminated during the entire project?	YES	YES	YES	YES
Evaluation of knowledge transfer quality during the implementation	Bad	Very Bad	Bad	Good

The causes of transfer knowledge quality during the implementation	Consultants' lack of skills in transferring knowledge	The supplier used information embargo policy in reference to system development in order to lock the client in	Consultants' lack of skills in transferring knowledge	Consultants' high level of skills in transferring knowledge
Did the supplier conceal the implementation cost at the bidding stage?	YES	NO	YES	YES
What are the proportions of costs linked to the system operation? I.e. what percentage of costs linked to the system development and day-to-day system administration?	40% development, 60% administration	30% development, 70% administration	60% development, 40% administration	30% development, 70% administration
Did the supplier inform about the system administration cost during its operation at the stage of bidding?	NO	NO	PARTLY	NO
Did the supplier assign consultants with implementation knowledge and experience to the project?	YES	YES	NO	NO

Did the supplier present implementation methods in detail?	NO	NO	YES	NO
Where project group meetings held regularly?	NO	NO	NO	YES
Was risk management conducted formally in the project?	NO	YES	NO	NO
Did the supplier hand over a project management support IT system?	NO	NO	NO	NO
Did, at the implementation stage, the client know what resources would be managed and developed by the implemented IT system?	NO	NO	NO	NO
Did the client design detailed business requirements for the IT system?	Only general	Only general	Only general	Only general
Did the client design detailed technological requirements for the IT system?	NO	NO	NO	NO

Did the client design an economic analysis of the IT system investment (ex-ante) ?	NO	NO	NO	NO

Source: Own study

For the first time in the available literature, research on information asymmetry between the agent and the principal in an IT project concerned all the stages of product life cycle, i.e. the bidding stage, as well as IT system implementation and operation, not only the bidding stage. The subject of analysis were implementations of ERP, CRM and DMS-class management support IT systems, completed as part of a contract based on a fixed budget. All the analysed implementation projects ended in partial failure, however their completion was not halted. I diagnosed four factors influencing the high level of information asymmetry between the client (principal) and the supplier (agent) in IT projects from the principal's perspective.

Factor 1. Software licence and implementation services sale policy of the producer and the supplier.

In all the cases, at the bidding stage the agent gave a lowered value of system maintenance cost (TCO – Total Cost of Ownership) to the principal, both when it came to implementation services and licence purchase cost, despite having earlier received assumptions linked to application development from the principal. Agent's behaviour was caused by hypercompetition in the given IT industry sector and pressure for their project to win. Additionally, we need to stress that during project implementation and operation, the principal was prone to the risk of frequent changes in the software licence price list, which is the responsibility of the software producer, and not the agent, who is only a reseller. Research has shown that in the four analysed cases, the risk factor materialised and, as a result, the producer increased the software price during its operation by, respectively, 30%, 30% 70% and 120%.

Factor 2. Knowledge transfer from the supplier to the client.

Research has shown that during the implementation period and system operation, the principal's evaluated the knowledge transfer from the agent to the principal as "bad" in two cases, in one case as "very bad" and as "good" in one case. An in-depth analysis of the knowledge transfer from the agent to the principal evaluated as "bad" indicated that there were two main causes of this phenomenon, i.e.:

– The quality of knowledge transfer completed by the agent's consultants to the key principal's users was low or very low, resulting from the low level of consultants' competence.
– The agent consciously used the policy of limiting knowledge transfer to the principal in order to render it impossible to complete certain tasks independently, which would have significantly lowered system maintenance cost during its operation.

To sum up, ineffective knowledge transfer from the agent to the principal may have an influence on the failure to achieve planned business goals because the principal will not receive:
– Sufficient amount of information on how to modify work organisation in the enterprise in order to increase its effectiveness.
– Sufficient amount of information about system technology and functionalities, to make it possible to consciously manage and possibly carry out post-implementation system servicing as part of the operation. In this case, TCO may increase.

Factor 3. Preparing the client for an IT project implementation.

We need to stress that relevant preparation for project implementation, along with a rational and effective preparation for the stage of designing project requirements and collecting offers from potential suppliers, is an important factor securing the principal against an excessively high level of information asymmetry.
As the research shows, neither of principals carried out an ex-ante economic analysis of the IT project investment, i.e. before project implementation. At the same time, we should consider the fact that the principals, from the perspective of 7, 5, 6 and 7 years, i.e. the operation period, unequivocally agreed that their preparation for the implementation was not complete, because their functional requirements for the system were defined in far too general terms, i.e. lacking clearly defined business goals and perfunctory organisational changes accompanying the implemented system not leading to the achievement of a competitive edge.

Factor 4. Information system between the supplier and the client at the bidding stage, implementation and operation.

An important factor influencing the level of information asymmetry is an information system including:
– Project risk management.
– Management of changes during project implementation and operation.
– Management of resources during project implementation and operation.

The information system may be supported by an IT system, aiding the communication between the agent and the principal and, as research showed, the agent did not offer using this tool in any of the four analysed cases. Research

indicated that in 3 out of 4 cases the agent did not present the concept of implementation method to the principal, along with the tools of communication necessary for the information system in question, as part of the implementation. In 3 out of 4 cases, project meetings, aimed at discussing project status and the work progress, were not regularly held. To sum up, a lack of an effective information system during project implementation and later operation entails and deepens information asymmetry between the agent and the principal.

5. Conclusions

Presented research results indicate four factors influencing the level of information asymmetry between the client (principal) and the supplier (agent) in IT projects from the principal's perspective. We need to point out that the four factors presented above were diagnosed in the entire product life cycle in the principal's enterprise. This fact constitutes my innovative input into the research and will allow us to obtain a fuller picture of information asymmetry in IT projects. My research to date has shown that an excessively high level of information asymmetry between the supplier and the recipient occurring in the entire life cycle of a management support IT system currently constitutes a significant factor crucial to the success of the project. This is why attempts aimed at minimising the influence of these factors on the level of information asymmetry in an IT project may have an impact on limiting the number of projects ending in complete or partial failure. The presented research results will be verified using quantitative methods.

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