



VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF BUSINESS MANAGEMENT
DEPARTMENT OF BUSINESS TECHNOLOGIES

Dmitrij Lipaj

**EVALUATION OF INFLUENCE OF INFORMATION SYSTEMS ON
BUSINESS PERFORMANCE**

Master's degree Thesis

Business management study programme, state code 621N10004

Information activity management specialisation

Business study field

Vilnius, 2014



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VERSLO VADYBOS FAKULTETAS
VERSLO TECHNOLOGIJŲ KATEDRA

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OBJECTIVE FOR MASTER THESIS

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For student Dmitrijui Lipaj
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Master thesis title: Evaluation of influence of information systems on business performance.
Approved on 2nd of November, 2012 by Dean's decree No. 374vv.

The final work has to be completed by 6th of January, 2014.

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Data: EBSCO Publishing database, information provided by the engineering consultancy services providing company.

Explanatory note : perform theoretical study and analyse the connection between business performance and implemented information systems, justify the importance of information systems in business management process, analyse the structure of integrated information systems and identify processes, that are influenced by the information systems. Create the model for evaluation of influence of information systems on business performance, approbate created model and provide conclusions and recommendations.

Figures: tables, figures, slides, visual tools

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Brėžiniai: lentelės, paveikslai, skaidrės, vaizdinės priemonės

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Annotation

Information systems are used to increase business performance to gain competitive advantage. Information systems affect both financial measures and internal processes, thus providing different benefits to organisation.

The main objective of the thesis is to create a model for evaluation of business performance through implementation of information systems.

The thesis consists of three parts. In the theoretical part definition on what are information systems, enterprise resource planning systems and how do they correspond to each other were given. Explanation on how information systems can increase business performance and what business processes and indicators might be affected were analyzed. Integrated information system that refers to enterprise resource planning systems group is presented in the more detailed way. In the second part description was provided on how model was created for evaluation of influence of information systems on business performance. Information how the hierarchical organizational structure and selected performance indicators might be used for evaluation the general business performance index. In the practical model approbation part the results on the evaluation of information Systems, implemented in different branch offices in different countries of company providing engineering consultancy services, was made. Research results analysis has revealed that information systems have a great effect on business performance and can enhance performance indicators in comparison to the obsolete, not so efficient information systems.

At the end of the thesis conclusions and recommendations are presented.

Volume of the thesis - 79 p. text without appendixes, 24 figures, 22 tables, 82 bibliographical entries.

Keywords: Enterprise resource planning system, virtual organisation, information system, evaluation model, business performance.

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Pavadinimas **Informacinių sistemų poveikio įmonių veiklai vertinimas**
Autorius **Dmitrij Lipaj**
Vadovas **doc. dr. Vida Davidavičienė**

Kalba: anglų

Anotacija

Informacinės sistemos naudojamos siekiant pagerinti įmonės veiklos rodiklius ir įgyti konkurencinį pranašumą. Informacinės sistemos turi poveikį tiek finansiniams, tiek ir vidaus procesų rodikliams, taip suteikdamos naudą įmonei.

Baigiamojo darbo pagrindinis tikslas yra sukurti informacinių sistemų poveikio įmonių veiklai vertinimo modelį.

Baigiamąjį magistro darbą sudaro trys dalys. Teorinėje studijoje pateikiami informacinės sistemos, įmonių vidinių išteklių planavimo sistemų apibrėžimai ir aiškinama sąsaja tarp šių dviejų reiškinių. Analizuojama, kaip diegiamos informacinės sistemos didina verslo efektyvumą, gerina rodiklius, paveikia verslo procesus. Antroje dalyje nagrinėjamas informacinių sistemų poveikio įmonių veiklai vertinimo modelis. Išanalizuota, kaip esama hierarchinė organizacijos struktūra ir pasirinkti veiklos rodikliai gali būti panaudoti bendro verslo veiklos rodikliui paskaičiuoti. Praktinėje dalyje buvo atliktas modelio aprobavimas inžinierines konsultacines paslaugas teikiančioje įmonės filialuose, įsteigtuose skirtingose šalyse. Tyrimo rezultatai parodė, kad informacinės sistemos turi didelį poveikį verslo rodikliams ir gali padidinti įmonės efektyvumą.

Baigiamojo darbo pabaigoje pateiktos išvados ir pasiūlymai.

Baigiamojo darbo apimtis – 79 p. teksto be priedų, 24 pav., 22 lent., 82 bibliografiniai šaltiniai.

Prasminiai žodžiai: Įmonės vidinių išteklių valdymo sistema, virtuali organizacija, informacinė sistema, vertinimo modelis, įmonės veiklos rodikliai.

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**DECLARATION OF AUTHORSHIP
IN THE FINAL DEGREE PAPER**

December 30, 2013

I declare that my Final Degree Paper entitled „Evaluation of Influence of Information Systems on Business Performance“ is entirely my own work. The title was confirmed on November 2, 2012 by Faculty Dean's order No. 374vv. I have clearly signalled the presence of quoted or paraphrased material and referenced all sources.

The academic supervisor of my Final Degree Paper is Assoc Prof Dr Vida Davidavičienė.

No contribution of any other person was obtained, nor did I buy my Final Degree Paper.

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INTRODUCTION

In a fast moving and continuously changing world, when the needs and preferences of customers change very fast, only the companies that are able to keep up with innovations and adapt to the situation by making the adjustments in its business processes, can expect to keep their performance on the required level and stay competitive. In recent years the success of any enterprise is directly related to the level and quality of information technologies that are being used in the company and ability to use that information correctly (Roja, 2012).

The importance of information systems (IS) has dramatically increased during past decade and more and more businesses have realised it (Davidavičienė 2008; Paliulis *et al.* 2012). Modern organization could not be imagined without efficient information system. After lots of researches has been made, no one doubts that implementation of information system in organization can bring a lot of benefits dealing with the internal and external tasks that company may face in day to day operations and long term decisions (Pabedinskaitė 2010).

Continuously technology development that caused an increase of hardware and software performance, lowered the price and caused the higher availability of information systems for most of the business was another factor that caused the spread of computerized systems all over the globe.

Relevance: information system integrated to the business processes of the enterprise is one of the major factors that increase the business performance if implemented right (Pabedinskaitė 2009; Yahaya *et al.* 2004; Merkurjev & Tambovcevs 2009). The increase in business performance is one of the major tasks of almost any business in order to achieve organizational goals.

Problem: it is very hard to evaluate the effect of implemented information system on business performance due to a big number of indicators affected. Existing evaluation methods and models sometimes lack of possibilities to adapt them to specific business processes and organizational areas and do not provide complex result of evaluation.

Investigatory object: process of evaluation of influence of information systems on business performance analysis.

Objective: the main objective of the thesis is to create a model for evaluation of business performance increase through implementation of information system.

In order to accomplish set objective, the following tasks should be carried out:

1. Analyse information System importance and impact on business performance from the theoretical point of view;

2. Create model for information system's implementation impact on the performance;
3. Perform practical model approbation on the Company „X“ example;
4. Provide conclusions and recommendations how to improve business performance in Company „X“ using the information system.

Research method: for the performance of given tasks such research method was used: analysis of scientific literature, research synthesis and summaries, multi-criteria evaluation method.

Structure: this work consists of three parts:

The first part analyses information systems and integrated information systems from the theoretical point of view. At the same time business challenges, which might be overcome by the implementation of efficient information systems, were provided. Definition on what are information systems, enterprise resource planning systems and how do they correspond to each other were given. Explanation on how information systems can increase business performance and what business processes and indicators might be affected were analysed. Integrated information system that refers to enterprise resource planning systems group is presented in the more detailed way.

The second part consists of a description was provided on how model was created for evaluation of influence of information systems on business performance. This part explains how do hierarchical organizational structure and selected performance indicators might be used for evaluation of general business performance index. Information on what kind of decisions might be made based on the information received is also provided in this section.

In the practical model approbation part the results on the evaluation of information Systems, implemented in different branch offices in different countries of Company „X“ providing engineering consultancy services was made. Research results analysis has revealed that information systems have a great effect on business performance and can enhance performance indicators in comparison to the obsolete, not so efficient information systems.

In the end of this work conclusions were presented.

Volume of this thesis is 79 pages without appendixes. There are 24 tables and 22 figures in this thesis. Literature list consists of 82 information sources. This work discusses integrated information system evaluation processes with information collected from scientific articles and one of the engineering consulting services providing company, located all over the world.

I. INFORMATION SYSTEMS IMPACT ON BUSINESS

1.1. New challenges in business

Human society is in a continuous process of development, change and transformation, and as a consequence, the economic context has become dynamic and turbulent. The opportunities and the arguments for studying the emergence of new forms that current or future organizations may take can be found at the confluence of the social and economic trends with the technological ones.

The current economic environment, which becomes increasingly complex due to many challenges faced by organizations during their development, offers opportunities to those organizations that have the ability to use their potential to become competitive. The organizations operating in dynamic and turbulent environments, characterized by frequent and important changes, become competitive only if they have a greater capacity for organizational innovation.

The emergence of virtual organizations paradigm lies in the natural sequence of time evolution of the business sectors and of the influence of many factors from fields such as the economic, technological and social ones.

Progress in areas such as communication networks, telecommunications and information technology is characteristic to a knowledge-based and interconnected society where new structures emerge, allowing activities and business processes in a collaborative manner.

Virtual organizations are the result of collaboration between organization, individuals and teams and a result of the convergence of the economic environment influences, technological progress and the changes that have taken place in the social environment (Roja, 2012).

The turbulent time dictate significant changes for the corporate environment. Emergence of Global economies, transformation of industrial economies and business enterprise pushes lots of companies to digital firms. The globalisation becomes more complex within application of information systems, which especially leads to decreasing transaction costs and international economic efficiency. That might also be characterized by management and control in a global marketplace, competition in world markets, global work group and global delivery systems. The industrial economies changes are vanish for knowledge and information-based economies, productivity, new products and services, knowledge: a central productive and strategic asset, time-based competition, shorter product life cycles, increasing dynamics and limited employee knowledge base (Bohl, 2008).

There are various application for virtual organizations identified. (Bohl, 2008)

- **C2C:** Consumer to Consumer. (Web advertisement)
- **C2B:** Consumer to Business. (Job exchange)

- **C2A:** Consumer to Administration. (Tax computation of employees)
- **B2C:** Business to Consumer. (Internet shopping mall)
- **B2B:** Business to Business. (Orders from suppliers)
- **B2A:** Business to Administration. (Tax issues of companies)
- **A2C:** Administration to Consumer. (Web based handling benefits)
- **A2B:** Administration to Business. (Public procurement)
- **A2A:** Administration to Administration. (Transaction between countries)

One of the most significant features of virtual organization is the cooperation. The advantage is usually reached by outsourcing. The opposite insourcing, however, usually offers additional profit (expressed in advantage of specialisation). Both out and insourcing allow to concentrate on competences. Finally, the risk can be divided by several partners.

Mews (1997) describe driving forces towards the virtual organization. These are described in the Figure 2, below:

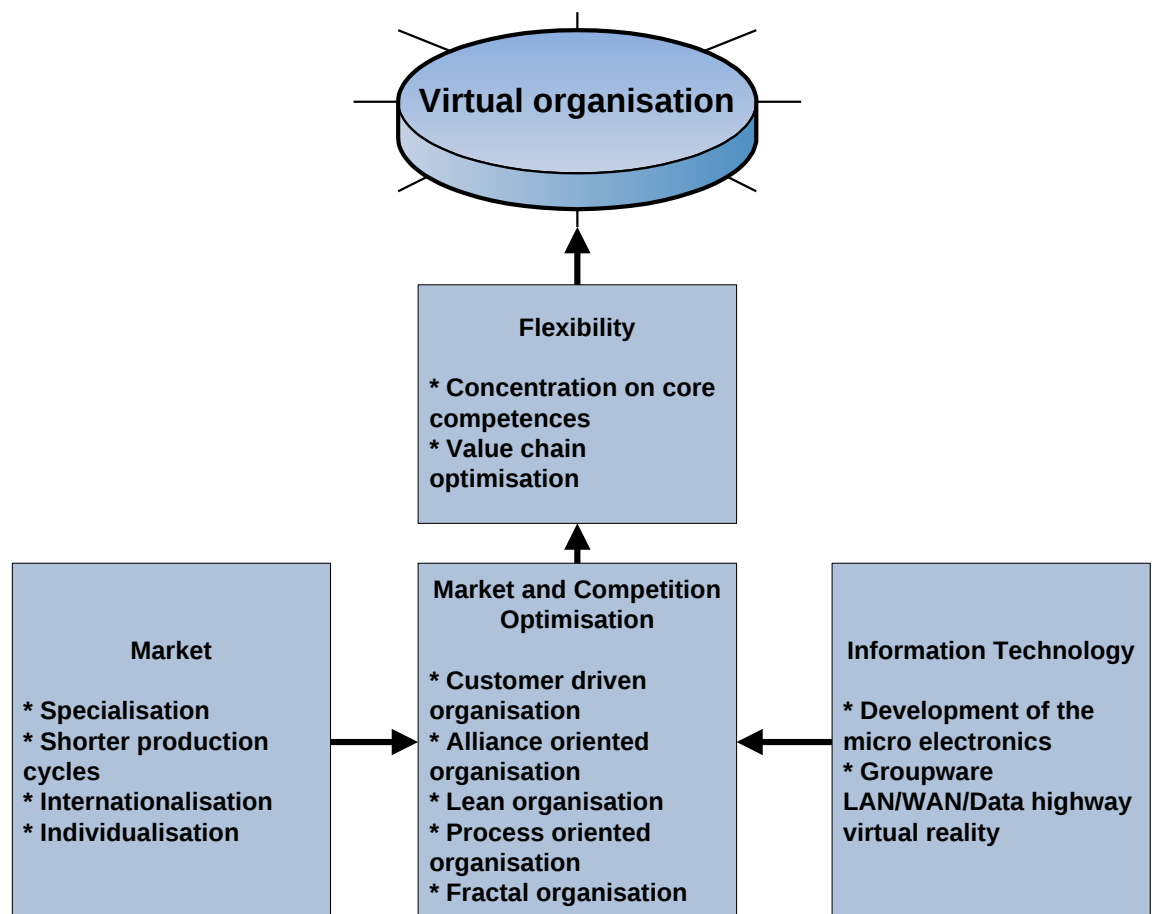


Fig. 1. Driving forces of virtual organization (source: Mews, 1997)

When we are talking about the selection of possible countries that would be acceptable for doing virtual business, we should take into account lots of risks that business might encounter. A

number of authors who have researched and written about this area have identified where risk arises in a virtual organizations. Risk categories that do influence the decision of country selection might be related to areas of delivery time, cost and quality, etc. (Mohammad & Keith 2011). The selection criteria important for possible country selection might as follows:

- **Cultural differences.** There may be several cultures within a VO and this may lead to lack of alignment between processes and inaccurate communication impacting on the sharing of information (Grabowski & Roberts 1998; Chen & Feng 2002; Prefontaine 2003; Camarinha-Matos & Afsarmanesh 2007). The fundamental values and beliefs of any culture, together with value norms and the customs underpinning the behaviour of people within an organisation, define it (Lemken et al. 2000; Singh & Kant 2008). However, where there is no over-arching culture in any organisation this has a negative impact on the successful management of knowledge (Chase 1997).
- **Geographic location.** Risk may be increased by geographic locations with there being a direct correlation between distance and risk. Some locations throw up more problems because of, for instance, political and legal difficulties (Ritchie & Brindley 2002; DeWitt et al. 2006). Prater et al. (2001) looked at the size of any geographic area that a network covered, what political areas it encompassed and which borders were crossed, considering these all to be elements contributing to the partners' exposure to risk. Porter (1998) observed that geographic distance gives rise to complications and to an increase in logistic cost. Also Grabowski & Roberts (1998) and Chen & Feng (2002) considered that there was increased risk as a result of geographic distance.
- **Wrong partner's selection.** According to Bullinger (2003), Bamford et al. (2004), Camarinha-Matos & Afsarmanesh (2007), and Westphal et al. (2007) such things as objectives, strategies, core competencies and capabilities that are irreconcilable cannot be complementary. While Sari et al. (2007) considered insufficient information about partners to be an obstacle to the VO selection, others including Grabowski & Roberts (1998), and Chen and Feng (2002) thought that a range of interests increased the risks to a VO. Furthermore, Wong (2009) acknowledged that conflicts between partners are one of the obstacles of virtual networks.
- **Heterogeneity of partners.** Heterogeneity means the differences that exist between partners in terms of incompatible hardware and operating systems, differences in language and the recording of data and in the meaning of the terms that are used. Camarinha-Matos & Afsarmanesh (2007) and Sari et al. (2007) have all referred to this heterogeneity between

possible partners as it exists in information technology infrastructures, working methods and business practice, as a possible obstacle to the VO operation. Where there is poor technological infrastructure this makes it difficult to put in place knowledge management (Singh & Kant 2008). Jung (2008) saw variations between these categories as an impediment to the progress of efficient cooperation since the semantics of the information from various entities may differ.

All mentioned obstacles can occur within the virtual organization and therefore shall be treated very seriously. Virtual organizations, despite having physical form we used to, deals with similar to traditional business problems and thus shall analyse the micro and macro-economic situations in different countries they have core activities in.

Macroeconomic situation differs a lot along various countries and therefore shall be analysed deeply in order to achieve the best result. Besides such important factors as overall economic wellbeing, the growth of GDP, fluctuations in currency rate, such factors as current situation in business environment shall be taken in consideration.

Initially it was supposed that virtual organization's partners could be quickly and easily identified and selected from the wide universe of existing organisations. However, nowadays it is known that this is not as simple as it seemed to be (Camarinha-Matos *et al.* 2005a). One idea superseded during the last years is that costs and dates would be enough to suggest VO partners. Works like those developed by Rocha & Oliveira (1999) and Li *et al.* (2000) proposed to select VO partners using a multi-agent system where each partner candidate is represented via an agent and all of them reach the final agreement, through negotiations, utilising protocols for multi-criteria restrictions fulfilment (Fabiano *et al.* 2009).

For some time not only the criteria to select VO partners were unclear, but also the whole VO creation process was not completely understood. Especially concerning the VO creation process, Camarinha-Matos *et al.* (2005b) presented VO creation process, where seven different activities were identified, namely:

- collaborative organization identification and characterisation;
- rough virtual organization planning;
- partners' search and selection;
- negotiation;
- detailed virtual organization planning;
- contracting;
- virtual organization launching.

Although always considered an important topic of discussion, the use of different criteria to select partners for VOs started to be characterised after the works developed by Grudzewski *et al.* (2005), Seifert & Eschenbacher (2005) and Bittencourt & Rabelo (2005). Besides using costs and dates-related information, they introduced the utilisation of performance measures, usually known as PIs, to better compare and select the suitable partners for every specific VO. These approaches reinforce the idea about the importance of suggesting partners using a well-defined set of criteria based on common attributes known by every interested organisation (Petersen 2003).

In order to find and select the right partners and employees for virtual organization the following four main actions should be taken (Fabiano *et al.* 2009):

1. Get as much information as possible about the description of those partners that compose the entire set of indicators used to measure performance among the organisations below to a specific virtual organization.
2. Understand what these performance indicators mean, through the processing of unstructured textual information and the recognition of relevant words that explain what they exactly represent and measure.
3. Get the collaboration organizations requirements description and translate them in relevant terms that can be further used to filter and to select performance indicators.
4. Select the proper performance indicator for a specific collaboration organization, applying information retrieval technique, and having the relevant terms translated from collaboration organization requirements into account.

Before *going to international* the company shall take deep analysis on the current situation on labour market of the particular regions or countries. That will reflect the general wellbeing of the economy and suggest if the market can provide with possibility of hiring different competence specialists. Such analysis might become the cutting edge in market choice, as labour force is one of the most important success factor and also the element requiring the most money.

1.2. Business performance and IS

Analysis of research made by Awais *et al.* (2012) showed that over the past few decades' companies all over the world started to notice the great need of information systems in the business field. It started to be hard not to pay attention to significance of benefits and possibility to increase business performance through such an investment. The reason is that it was noticed that IS that can help business to save money also increase the competitive advantage and to improve performance, thus creating more profits.

Increasing business performance through implementation of some information technologies solutions is very common process nowadays. Business performance increase could be expressed as the intermediate step between the information technology and the business strategy. The structure of business performance that lies in between business strategy and information technology in information system is shown in the Figure 1.

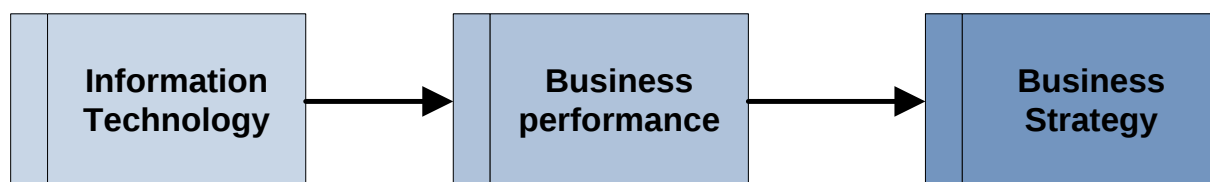


Fig. 2. Business performance position (created by author)

The figure could be understood that on the way of reaching business strategic goals through information technology, business performance can be increased. Or in other words saying, information technologies in business could result in impact on business performance, which could help to achieve company's strategic goals.

Research by Sward (2006) supports, that performance is the result of some benefits brought for the business units and the whole organization by the information technology solutions or services related to it, expressed in different parameters. All the improvements in IT or information systems, could result in lower cost of business processes and increase efficiency of activities performed by the workers. These solutions mentioned above improve the monitoring and coordination inside of organization (Hendershott 2006). So we could state that the overall impact on business performance could be defined by analysis of benefits, both tangible and intangible, that were received after implementation of information system. This is the common economic challenge for all kind of investments, not especially in IT, but in other resources (Paliulis & Uturytė-Vrubliauskienė 2012). It is an issue because it's not that simple to evaluate effects of investment on the way how the business performs its activities. Research by Silvius (2006) states that those effects should firstly be understood and after that financially calculated.

Investment in design and implementation of information systems, according to Merkuryev & Tambovcevs (2009), might be very important strategy for the company. This could help to achieve competitive advantage and improve quality of service provided and increase performance in relation to the company's strategy.

In order to better understand the influence of information systems on the business performance the definition, components and types of Information systems should be set first.

1.3. Information systems in business management

In today's fast changing world, enterprises face great challenge of expanding markets and increasing customer expectations and wants. It became harder than ever before to meet those needs and wants. This force the business to lower the costs indicated in the production process, review all the supply chain of the materials, shorten delivery times, reduce amount of inventories stored, increase the variety of products and services provided, improve quality of those products or services, provide better customer service, more reliable delivery and more efficiently coordinate the production, supply and foresee the demand on the global market (Umble et al., 2002). Different sources of information should be gathered and analysed by the managers of a company to be competitive. Nowadays information is recognized as the life-blood of the enterprise. Without the information modern business is dead (Papows, 1998). Possible sources of information for the company are expressed in the Figure 2:

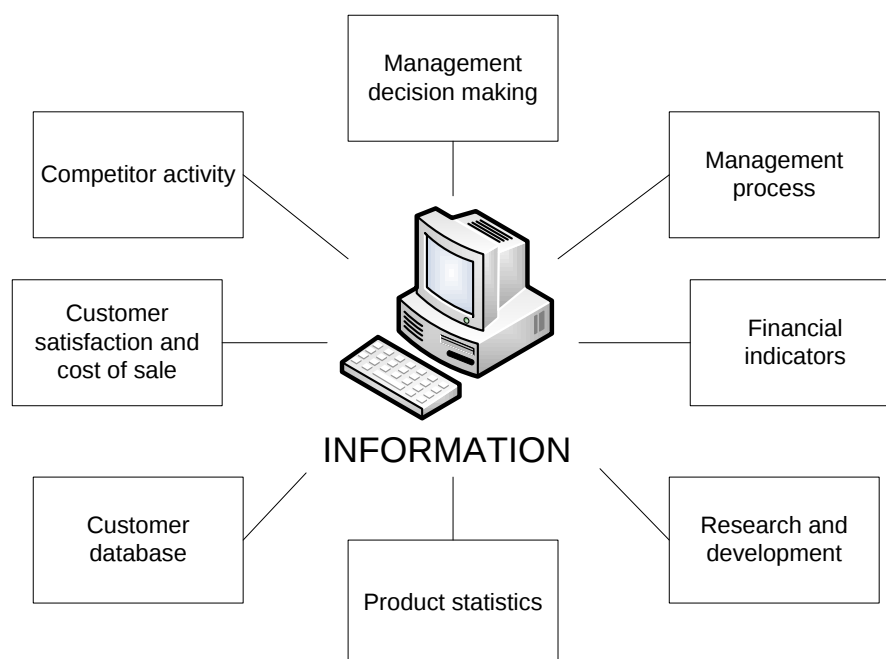


Fig. 3. Information is a life blood of the company (source: Papows, 1998)

Most of those criteria mentioned above could be achieved with the help of information systems that became valuable tools that help to make the right decisions in an organization and that support communication among business units and the entire business (Alter, 1999; Ross & Beath, 2002). Information systems not only ease the process of communication, but enhance it, providing relevant information and data that could be used.

Recent research on the business-level has shown that investment in information technology affect business dramatically by increasing productivity levels, growth and share market value of an

enterprise (Brynjolfsson & Hitt, 2000). This represents the influence of information systems on business from the external environment perspective.

Very important strategy for the company would be to invest money into information systems. This could help to achieve competitive advantage and improve quality of service provided (Merkuryev & Tambovcevs, 2009).

But these are not the only fields, where companies are forced to compete between each other nowadays. Such criteria as availability of products, costs, prices, quality of products and services are not the main ones. After appearance of information systems, they now were able to compete in the quality and speed of information they collect process and distribute (Bond et al., 2000). Due to a different origin of information that the company must analyse and process, in order to achieve organizational goals, various information systems might come into play. Commonly each of the System type is responsible for its own area and internal company's processes.

1.4. Types of information systems

Information systems could be defined as a set of components that help to collect process and share the information and data in with the help of software, hardware, core ware and organ ware. According to Nikjoo *et al.* (2011), these kinds of systems are the fundamental principles for economic development of any size of business, both small and large.

Awais *et al.* (2012) provides few other definitions of information systems, by defining information systems as a combination of information technology and human resources, whose actions using these technologies help to perform some actions to support business processes. These could also be named as application landscape. Term Information systems could also be used to describe interaction between users, algorithmic processes, information and technology. Also information system could be understood as semi-formal language that enables better decision making process and supports other actions. Information system's main function is to process (collect, transfer, store, process, and share) information.

There might be a lot of different terms for information systems as these might be reviewed from different points of view but they all refer to the systems, which are commonly grouped into five categories that are shown in the Figure 2 (Molla & Heeks 2003; Nowduri 2010; Awais et al. 2012; Reddy et al. 2009; Chichernea 2009):

- Office Information System (OIS)
- Transaction Processing System (TPS)

- Management Information System (MIS)
- Decision Support System (DSS)
- Executive Support System (ES)

These groups of systems are interrelated among each other in the data and information flow. The arrows show the information transfer that goes from one system to other shows what is being analysed in each of the category. Executive support systems get the information from the management information system and decision support system. Management information system is using data from the office information system, transaction processing system and decision support system. Decision support system uses data from the management information system, transaction processing system and office information system. Office information system is supported by the management information system. Transaction processing system is the only system in the following network that serves as an information “provider”, and not the “consumer”.

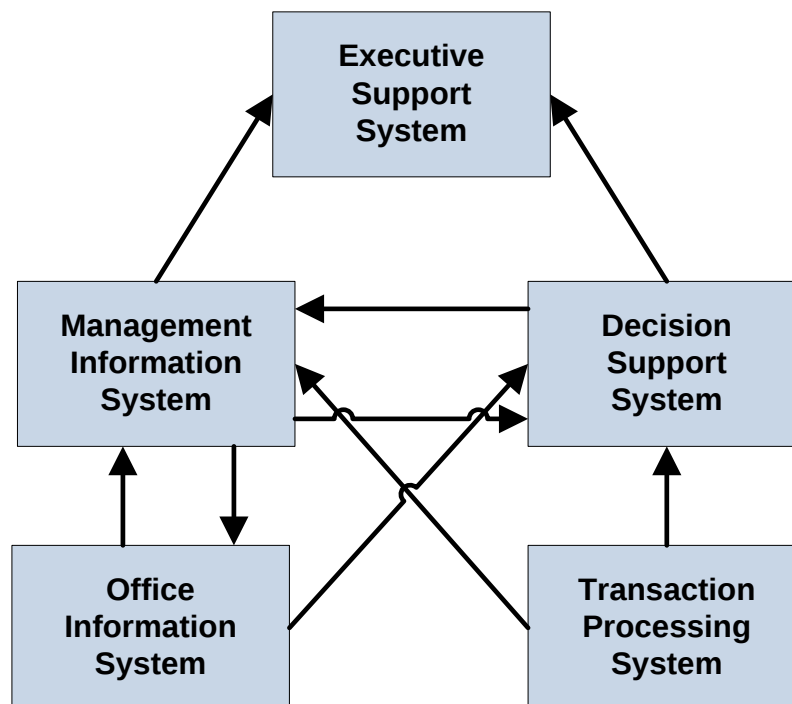


Fig. 4. Classification of information systems (source: Awais *et al.* 2012)

There are different descriptions provided in various scientific sources on purpose of systems provided above, how do they work and what are the main areas covered by each of them. In order to get a better understanding on the information systems, how they influence improvement of business performance, the most relevant explanations of every system is provided.

Office Information System (OIS) is an information system that enhances business processes and makes communication between users easier through use of hardware, software and networks. Using the computers and other electronic devices, employees perform most of the task

automatically instead of manual work (Awais *et al.* 2012). Study of Molla & Heeks (2003) stated, that Transaction Processing System (TPS) is an information system that collect, store and process information that is collected over the day by the company from the everyday transactions. These systems help to answer the routine questions of the business. Reddy *et al.* (2009) explained that Management Information System (MIS) is an information system that is concerned with the collection, processing, storing and transferring important information to help managers to perform activities in any enterprise. Management information system provides relevant and timely information that is used in the decision making process and help the managers to plan operations and control them to be performed in the most efficient way. Research by Nowduri (2010) illustrated, that Decision Support System (DSS) is an information system that helps to analyse the helpful for business information and present it in a suitable for decision making way for the users of this system. This helps to make decisions in a more efficiently way. Chichemea (2009) claimed that Executive Support System (ESS) is an information system that is mostly used as reporting software where you can transform company's data and information into summarized reports. These reports are mainly used by executive level managers that can be used for long term planning and scheduling.

As every of these systems are covering specific business areas and supports only specific business processes it is wise to have them integrated and connected among each other so that one information system would be able to meet business needs for processes to be made in an electronical way. For these purposes enterprise resource planning systems, as an example of integrated information system, covering various application levels is presented and analysed further in this article.

1.5. Enterprise resource planning (ERP) system

According to Framinan (2008), enterprise resource planning systems are held to be one of the best business information technology solutions in the last few decades for most of the large (and lots of medium and small-sized companies) businesses that have implemented enterprise resource planning systems.

ERP systems were also analysed by Chung & Skibniewski (2007), where it was stated that these kinds of systems are created to process the information, enterprise transactions and foster integrated production, planning and customer feedback. Enterprise resource planning designed to combine all systems of different departments of the company to one system, to one integrated programme that runs one database in such a way that different departments and business units can

freely share information with other users and communicate more (Waxer 2006). Optimization of information and materials flow in organization among different parts of business could be reached only if the system is integrated. That is considered to be the most important in enterprise resource planning system (Nikjoo *et al.* 2011).

Merkuryev & Tambovcevs (2009) have analysed, that enterprise resource planning systems are fully integrated and cover all the activities in the company. It might consists of several modules, such as finance and accounting, human resources management, quality management, sales and distribution, production management, purchasing management, marketing, planning and material management modules (Scapens & Jazayeri 2003; Olson 2004; Shanks *et al.* 2003; Dery *et al.* 2005). Different modules and the structure of ERP system are presented in the Figure 3. Next to the traditional modules that were mentioned, extensions like supply chain management, business data warehouse and customer relationship management (CRM), could be installed.

Usually, enterprise resource planning system consists of four levels: network level, resource level, application level and decision level. The whole scheme of enterprise resource planning system's structure is presented in the Figure 3 (Merkuryev & Tambovcevs 2009).

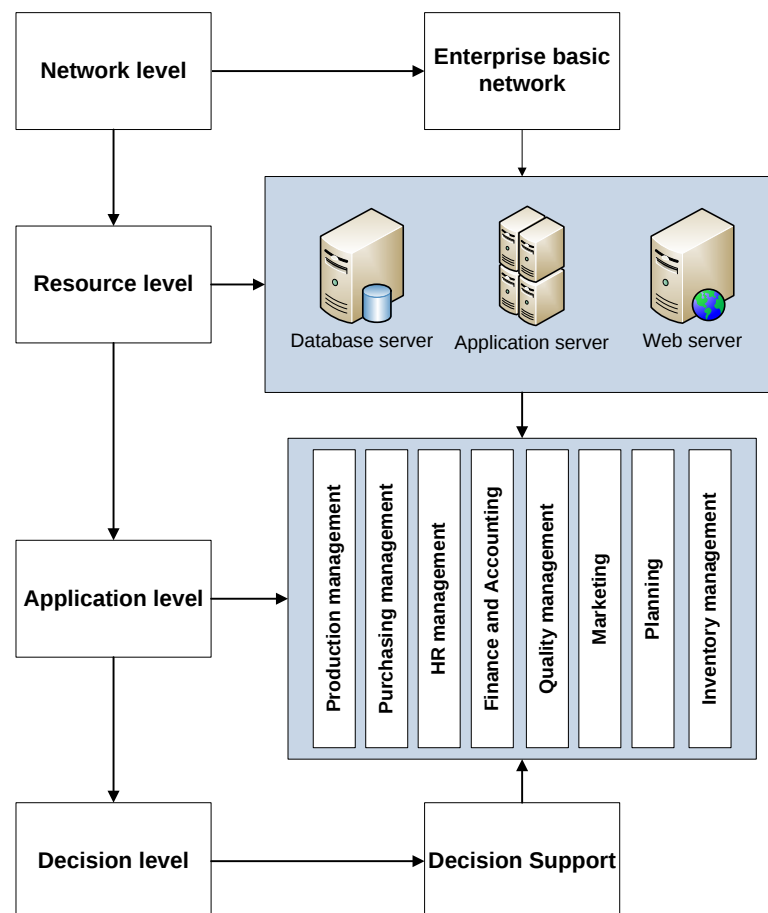


Fig. 5. Four level ERP System structure (source: Merkuryev & Tambovcevs, 2009)

In order to have a better understanding of the ERP system, the description of the four levels of enterprise resource planning systems are presented.

- Network level: this level is responsible for smooth flow of internal and external information in the company. Infrastructure of the system is based on this level.
- Resources level: this level stores all the software, hardware and data required for ERP. Database servers, application servers and web servers are stored here.
- Application level: subsystems that are used by users from different business units for the performance of different tasks are held here. Managers by using these subsystems fill enterprise resource planning system with information or obtain information required.
- Decision support level: resources, such as data, information are processed for decision making on this level. Models and methods for decision making also are employed here.

The main goal of an enterprise resource planning system is to combine in one integrated system as much functions and capabilities as possible, that would work using one database, so that all the business units could easily get the required information and communicate between each other. This method can cause a huge payback if the information system is implemented successfully (Davidavičienė & Raudeliūnienė 2010; Merkuryev & Tambovcevs 2009). If implemented right, system will also combine all the part of organization in an integrated system and give Access for the clear and common data (Yahaya *et al.* 2004).

ERP system improves productivity by creating transaction structure in the enterprise that integrates main functions of different business groups within enterprise resource planning system platform (Merkuryev & Tambovcevs 2009). Business managers can make decisions based on information retrieved from the information system. Ordinary workers can gain access to information, thus increasing delegation of authority for more efficient interaction with customers and production decisions (O'Leary 2000).

The research made by Merkuryev & Tambovcevs (2009) showed, that by implementing these systems, companies can achieve competitive advantage. Over the last few years, big amount of companies have invested money in ERP systems and this number is increasing constantly. The competitive advantage could be achieved by improving the business performance. In order for companies to evaluate the general performance increase, benefits should be identified and categorised and evaluated.

1.6. Business performance through ERP implementation

There are no doubts already that the ERP implementation fosters productivity and efficiency increase. By providing different benefits, that could be easily visible and evaluated or could be just assumed performance increase could be reached (Bingi *et al.* 1999; Cronin *et al.* 1994; Koushik & Pete 2000). For example research, that an ERP system brings numerous competitive advantages to enterprises, including the reduction of business cost, quick response to customers, and the acceleration of corporate connections, among others has been made by Cronin *et al.* (1994) and Koushik & Pete (2000). Bingi *et al.* (1999) in their paper stated that it helps simplify work processes, hasten corporate responses, increase validity and timeliness of data, and reduce secretarial work processes. While the Dykeman (1997) said, that it can also improve output sales value and lower inventory turnover rate.

When the value chain of the Internet is applied to marketing and product-related research, an ERP system may effectively increase an enterprise's market share, reduce marginal cost, and boost customer satisfaction (Cronin *et al.* 1994).

Tsaia *et al.* (2011) have managed to classify all the benefits into two categories so that all effects contribute to the performance of a business. The scheme of business performance could be expressed as the Figure 4.

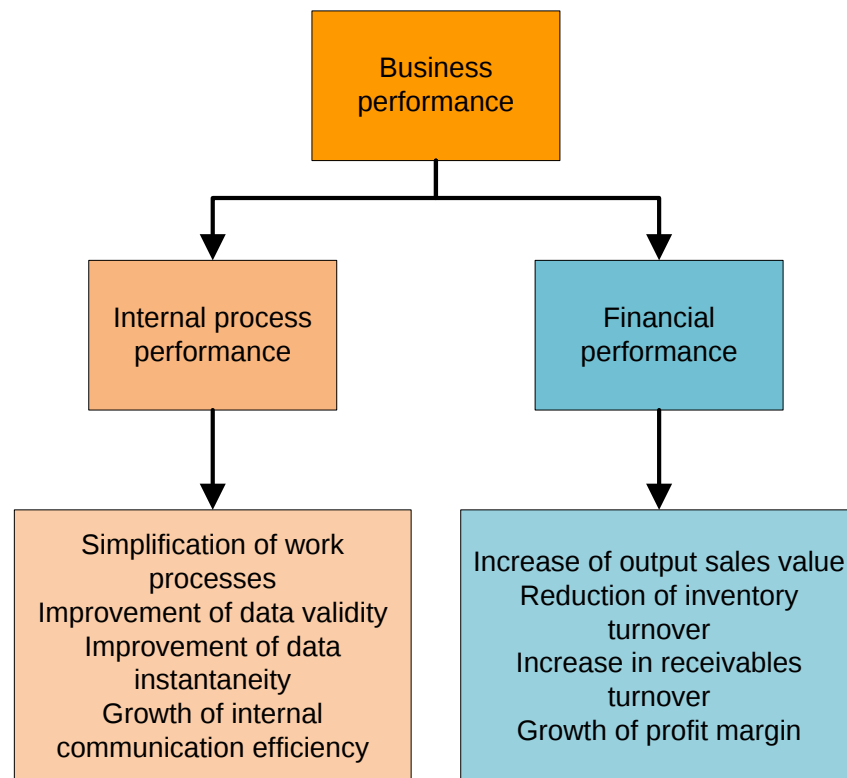


Fig. 6. Business performance groups (source: Tsaia *et al.* 2011)

The figure expresses that there are mainly two indicators that might show how the business performance was changed after implementation of information system. They are internal process performance and financial performance improvements. Tsaia *et al.* (2011) in their work explained the meaning of these two categories. In essence, internal process performance refers to the simplification of work processes, improvement of data validity and instantaneity, and the growth of internal communication efficiency. Financial performance refers to the increase of output sales value, reduction of inventory turnover, increase of receivables turnover, and growth of profit margin.

The potential benefits that might be obtained after implementation of ERP are huge and may vary from improved information management to reduced operational and other costs. (Davenport 2000). Actually, all those benefits do not happen immediately or just with the purchase or instalment of information system. Soh & Markus (1995) stated that the benefits might arise only the whole organization start using IT assets that were bought or created in the effective way. This shows that this is a long process which requires a lot of resources, such as financial, people, time.

Information systems through better information management can help persons or groups of persons in the enterprise, or even among customers or suppliers, perform their duties in more efficient manner, that would lead to the emerge of benefits (Davenport *et al.* 2001; Marchand *et al.* 2000). It is also was noticed by Peppard *et al.* (2007), that only managers of the company and users that will be using the system both directly or indirectly, could release benefits. In order to justify the money spent on implementation of IS, benefits should be identified and that is sometimes can be hard to do because of several of reasons (Chand *et al.* 2005). Some of the researches managed to identify different groups, according to which, benefits could be defined in an easier way, thus helping managers to identify the value of this decision for the company (Shang & Seddon 2000; Gattiker & Goodhue 2002; Nafeeseh & Al-Mudimigh 2011; Murphy & Simon 2001).

Research that was made by Shang & Seddon (2000) has found that the benefits of IS can be grouped into five categories: operational, managerial, strategic, IT infrastructure and organisational benefits.

It may take some time in order to fully observe all the benefits brought by the implementation of the system, thus analysis of them have to be done during the implementation and post-implementation periods (Kim 2009).

Business performance could be increased only after when it will be defined in details. The task is to express benefits of information systems in terms that would be easily understood by the managers of the company (Gammelgård *et al.* 2006). These researches emphasize the importance of managerial staff in the success of IS implementation process and further use.

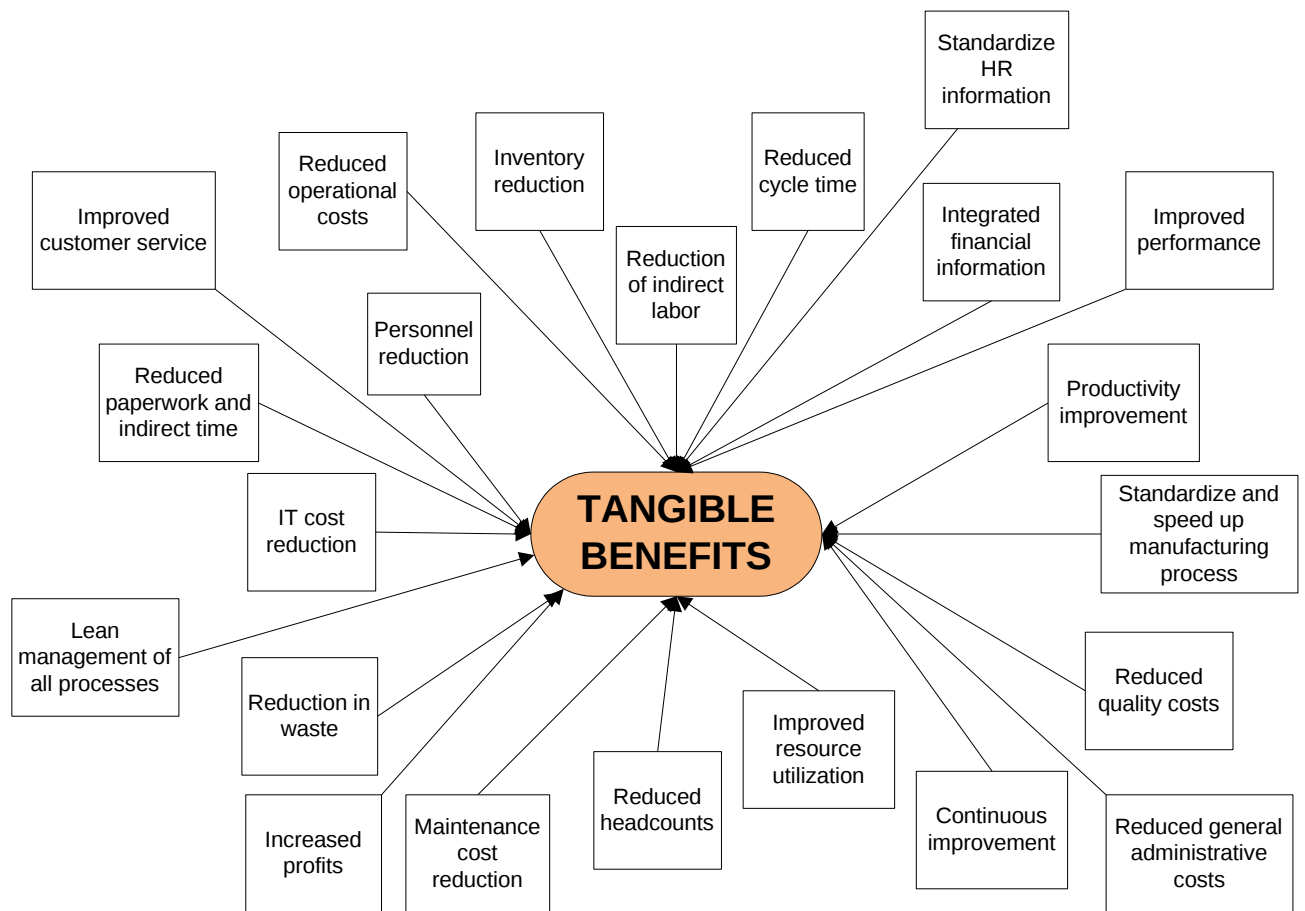


Fig. 7. Tangible benefits of an ERP System (source: Dustin, 2010; Jutras, 2009; Murphy & Simon, 2001)

Another proposition was to group ERP benefits into four categories: those, that improve information flow between business units, thus improving communication and coordination among the employees, that enable centralized administrative activities, that reduce maintenance costs of information systems and creates new possibilities to deploy new functionality of systems and those, that provide tools for business to move from inefficient business processes and move towards best of practice processes (Gattiker & Goodhue 2002).

But usually, benefits are categorised into two groups: tangible benefits and intangible benefits. Tangible benefits are those that could be quantitatively measured (Nafeeseh & Al-Mudimigh 2011). In this article tangible and intangible benefits that influence business performance will be analysed so that the initial factors that make changes would be analysed.

The business enterprises that are planning to invest money in ERP information systems could expect to have such tangible benefits that are shown in Figure 5. They are: inventory reduction, reduction in indirect labour, reduced cycle time, standardize HR information, integrated financial information, improved performance, improved productivity, standardized and faster manufacturing process, reduced quality costs, reduced general administrative costs, continuous improvement

possibility, improved resource utilization, reduced headcounts, reduced maintenance costs, increased profits, reduced waste, IT cost reduction, lean management possibility of all processes, reduced paperwork and indirect time, personnel reduction, improved customer service, reduced operational costs.

Intangible benefits caused by IT investments are usually grouped into two categories: internal improvements and the benefits related to the customers of the company (Hares & Royle 1994).

Murphy & Simon (2001) have offered to define intangible benefits as the opposite to the tangible benefits in terms of ease of measure and could not be quantitatively evaluated in the same way. In other words saying, these are the benefits that could not be reformed into quantitative value or to a business value.

Intangible benefits could also be the outcome of successful implementation of ERP system and are shown in Figure 6. These could be following: greater flexibility, improved management decision making process, enhanced teamwork, improved morale, people development, greater adaptability, improved information visibility, increased user satisfaction, integration, possibility to spot market trends, standardization, internal improvement, improved cost structure.

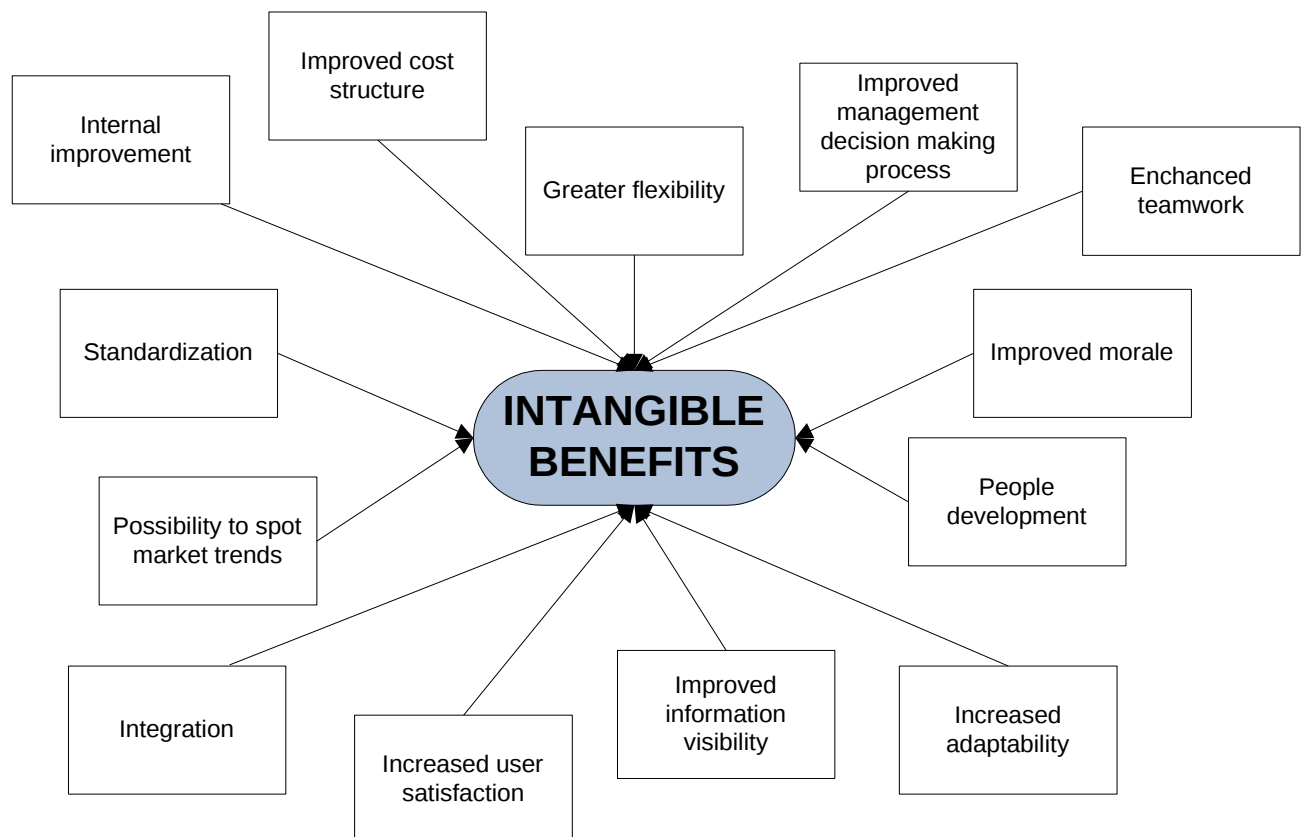


Fig. 8. Intangible benefits of an ERP (Dustin, 2010; Hares & Royle; Myrphy & Simon, 2002)

II. MODEL FOR EVALUATION OF IMPACT OF INFORMATION SYSTEMS ON BUSINESS PERFORMANCE

2.1. Model development

Evaluation of information system impact on business performance can be conducted using different evaluation methods and tools, steps and evaluation criteria combined together in one single model, providing the reliable result. The complexity of information system, its suitability for specific economic sector, field, implementation spread over the company and other factors will determine how big impact on the company's performance will be. In the beginning, a trigger should exist, influencing company's decision to start evaluation of impact of information System on business performance. After this, the set of activities and actions should be taken to fully perform the evaluation process. In this thesis the following model shown in Figure below will be analysed.

Firstly, in the proposed evaluation model, roles of the employees, who are using the system, should be identified and described. Roles for the evaluation might be the same as the ones used for the authorization and access control in the organization, while the performed activities of these groups of people might be based on the job description and their responsibilities. This is the initial and very important step as the further data analysis will be based on this information.

The next step is to identify which of the responsibilities and activities are performed using the information system analysed. This is done in order to identify the areas and most important processes that could be counted as the indicators influencing the business performance from different perspectives.

After that, selection criteria grouped into internal process performance indicators and financial performance indicators should be found out. It is important to describe which roles could evaluate these indicators, as some employees might have the access to more system capabilities than the other employees that belong to other roles, thus having more competences to evaluate one indicators or another. Information system will be analysed on the benefits for each of the role of employee using the system.

Each evaluation criteria and the evaluation of specific role should receive a weight used for calculations. This is done under the assumptions, that some performance indicators might have bigger influence on processes in organization, thus influencing the performance more. The same assumption is used for roles selected, as some employee roles might have a better understanding of the whole picture and could better identify whether the specific area in the information system provide the required benefit to the organization.

When the results will be gathered they should be analysed and the general performance index should be calculated. Assumptions should be made on whether the general performance is satisfactory or not should be based on business and management expectations. The results should be carefully analysed and in case the total results would not be satisfactory or some areas would show bad performance, the information system should be changed or improved and the process should start again from the evaluation of implemented change impact on business performance.

All together, these steps provide an evaluation model that should help the company to evaluate effect of information systems on the business performance.

This model will be lately used to empirically test and measure the effect of selected factors on the company's performance. Based on the evaluation results, assumptions can be made on what is the impact on the business performance is made by the current information system in use.

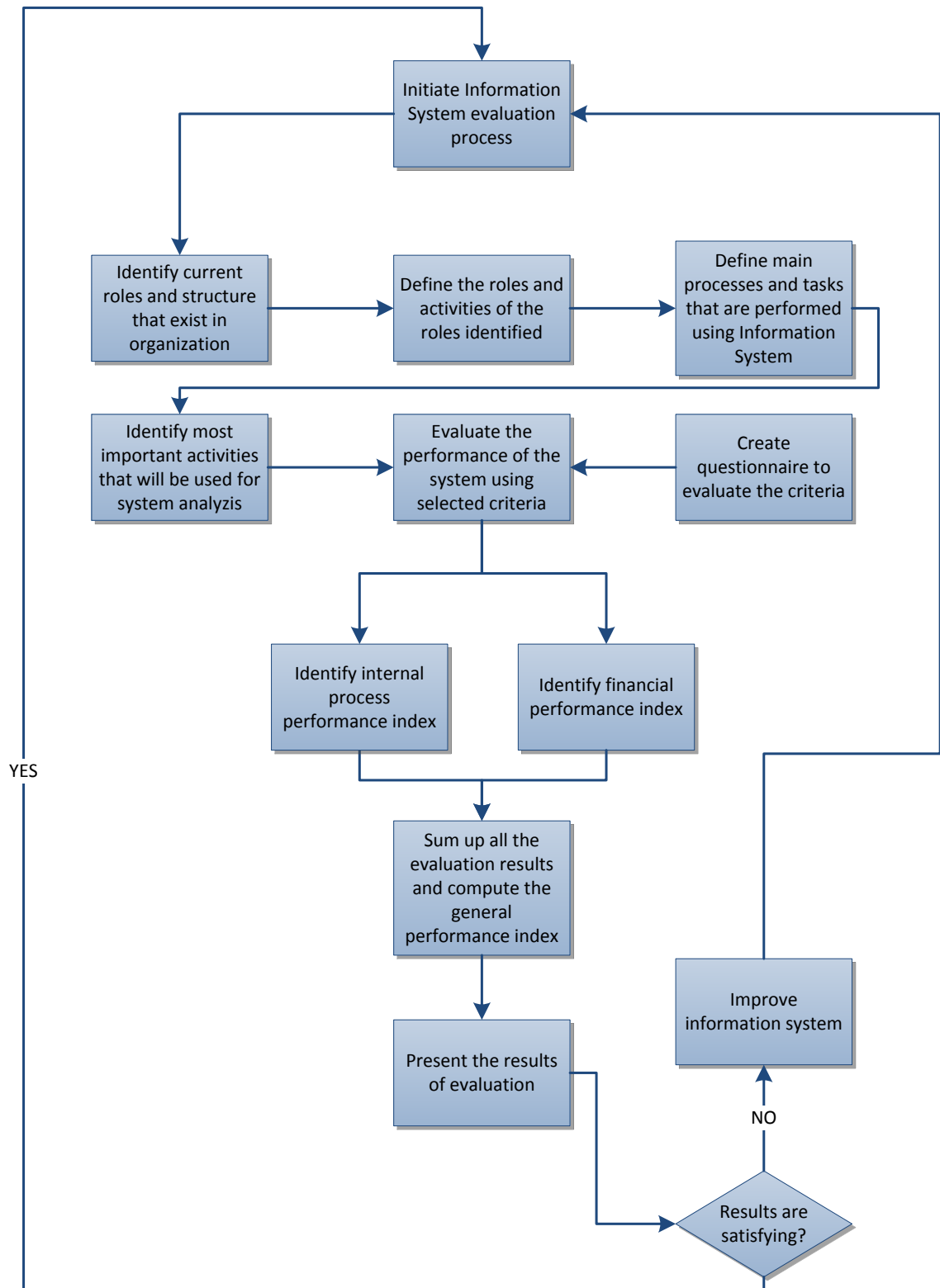


Fig. 9. Model for evaluation of information systems on business performance

2.2. Roles and hierarchical structure

In this thesis a five level hierarchical structure with different employees' roles will be analysed. These roles are: head of department, resource manager, portfolio manager, project manager, activity manager and employee. In the figure below we can see the roles and levels of positions that could benefit from the implemented information solution:

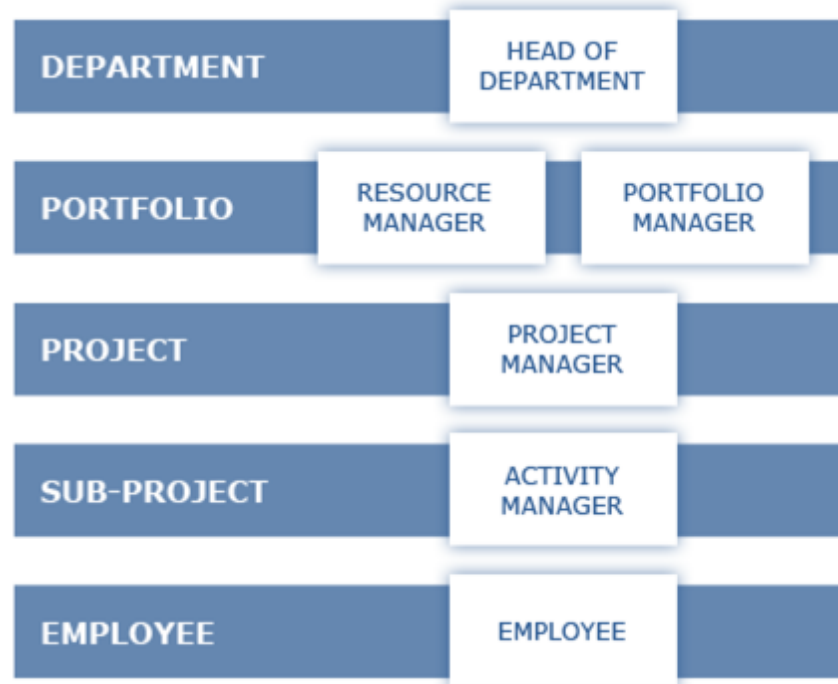


Fig. 10. Hierarchical structure of roles (created by author)

We can see the head of departments on the department level, resource managers and portfolio managers and portfolio level, Project managers on Project level, activity managers on sub-project level and employees on an employee level.

In order to understand what processes, tasks and activities are performed by the employees, affected by the information systems, it is relevant to present role responsibilities:

- **Head of department.** The head of an organizational unit with profit and loss responsibility is called a P/L manager (profit and loss manager). The manager is responsible for the total financial result, both the project profitability (project account) and the resource profitability (resource account). The manager may delegate the portfolio and resource manager roles to others.
- **Resource manager.** The resource manager is responsible for approving staffing of projects based on input from project managers. His responsibility is to oversee resource allocation both for short-term and long-term periods.

- **Portfolio manager.** In large organizational units it may be necessary to split the projects into portfolios. Also it may be beneficial to track a set of projects across departments. This can be achieved with the portfolio manager role. Portfolio manager's responsibility is to oversee the designated set of projects and acts as coach to the project managers.
- **Project manager.** There is one person responsible for a project: the project manager. With Information System the project manager gets up to date information and function to ensure profitable projects. Project manager's responsibility is to plan and a budget project from tender phase and until the project is switched to "contracted" in Information System. Part of the budget planning is to get the right resources allocated to the project. Execution and monitoring of contracted project until it is closed and handling all project dynamical changing orders, managing risk, etc.
- **Activity manager.** An activity manager is responsible for one or more work packages in a project (ATRs) but not the entire overall project. They are accountable for the specific deliverables. Focused mostly on delivering within the allocated hours.
- **Employee.** All employees are users in Information System. Every week all activity during the week must be registered and travel and expenses must be reported. Their main responsibility is to keep project input up-to-date - at least weekly.

The roles in information system are available to departments to support their business. Exactly how the roles are implemented depends on the business model in each department. In some areas, roles may be shared by the same person. Different perspectives in the roles might be more and more used to increase system performance.

2.3. Business performance indicators

In this thesis information's system performance will be evaluated based on the functionality and performance of the system for different roles of employees provided above.

In order to identify the impact of information systems on business performance it was offered to analyse it based on two aspects - internal process performance and financial performance. A number of evaluation criteria were identified and grouped into internal process performance (IPP) and financial performance (FP), based on their nature and processes being improved.

Financial performance indicators that were identified are presented in the table below:

Table 1. Financial performance indicators (created by author)

FINANCIAL PERFORMANCE INDICATORS
Finance control
Agreement handling
Follow-up on project/portfolio finances
Project planning and data maintenance
Project monitoring and follow-up
Risk assessment
External communication

Among the financial performance indicators, finance control, agreement handling, follow-up on project/portfolio finances, project planning, data maintenance, project monitoring and follow-up, risk assessment and external communication were identified.

Internal processes performance indicators that were identified are presented in the table below:

Table 2. Internal process performance indicators (created by author)

INTERNAL PROCESSES PERFORMANCE INDICATORS
Resource control and task delegation
Internal communication
Number of errors on job
Business process
Daily activities execution time
Data accessibility and accuracy

Following internal processes performance indicators were identified: resource control, task delegation, and internal communication, number of errors on job, business process, daily activities execution time, data accessibility and accuracy.

Due to the access restrictions and lack of competences, not all of the employees in particular roles have the possibility to evaluate impact of the selected criteria on business performance. So in order to define what criteria should be evaluated by an employee, the following table was created

showing which indicators could be evaluated by an employee. All indicators were grouped into financial performance indicators and internal process performance indicators:

Table 3. Summary of financial and internal indicators with relevant roles assigned (created by author)

GROUPING	BUSINESS PERFORMANCE INDICATORS	RELEVANT ROLES
Financial performance	Finance control	✓ Head of the department
	Agreement handling	✓ Head of the department
	Follow-up on project/portfolio finances	✓ Project manager ✓ Portfolio manager ✓ Activity manager
	Project planning and data maintenance	✓ Project manager ✓ Activity manager
	Project monitoring and follow-up	✓ Project manager ✓ Activity manager
	Risk assessment	✓ Project manager ✓ Activity manager
	External communication	✓ Project manager
Internal process performance	Resource control and task delegation	✓ Head of the department ✓ Resource manager ✓ Project manager ✓ Activity manager
	Internal communication	✓ Head of the department ✓ Resource manager ✓ Project manager ✓ Portfolio manager
	Number of errors on job	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager
	Business process	✓ Head of the department ✓ Resource manager ✓ Employee

		✓ Project manager ✓ Activity manager
	Daily activities execution time	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager
	Data accessibility and accuracy	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager

In order to evaluate the impact of information systems on business performance, a questionnaire was designed. It is composed of the questions that were designed to get the information on the general profile of the respondent, including his role and position in organization, performed activities in organization. For the evaluation of financial performance and internal process performance indicators, different questions with a set of answers were introduced.

Questions for evaluation of financial performance:

Table 4. Question list for evaluation of financial performance indicators (created by author)

FINANCIAL PERFORMANCE INDICATORS	QUESTIONS
Finance control	Does the IS help to keep a track on company's financial performance? 1. There is no IS for finance control 2. There is no effect on finance control 3. Yes, a little 4. Yes, a lot
Agreement handling	Does the IS ease the process of handling agreements on internal cooperation? 1. There is no IS for agreement handling 2. No, it has no effect 3. Yes, it helps a little

	4. Yes, it helps a lot
Follow-up on project/portfolio finances	Does the IS help to follow-up on the projects and portfolios? 1. There is no IS for follow-up 2. No, it is just another copy of data 3. Yes, sometimes it helps 4. Yes, it is very useful
Project planning and data maintenance	Does the IS help to plan and maintain project information? 1. There is no IS for this 2. No, it doesn't help 3. Yes, it has small positive impact 4. Yes, huge positive impact
Project monitoring and follow-up	Does the IS help to monitor and follow-up on project results? 1. There is no IS for project monitoring 2. No, no impact was identified 3. Yes, small impact 4. Yes, huge impact
Risk assessment	Does the IS help to identify and reduce risk in organization? 1. There is no IS for risk assessment 2. Sometimes 3. Yes, a little 4. Yes, a lot
External communication	Does the IS effect your capabilities to communicate with customers? 1. There is no IS for external communication 2. Nothing has changed 3. Yes, some impact 4. Yes, huge impact

Questions for evaluation of internal processes performance:

Table 5. Question list for evaluation of internal processes performance indicators (created by author)

INTERNAL PROCESSES PERFORMANCE INDICATORS	QUESTIONS
Resource control and task delegation	Does the IS influence the way how you control resources and delegate task? 1. There is no IS for resource control 2. Not very much. 3. Yes, sometimes 4. Yes, it has a great effect!
Internal communication	Does the IS help to make you more integrated with other departments and teams? 1. There is no IS for internal communication 2. No, it had no effect. 3. Yes, a little. 4. Yes, very much.
Number of errors on job	Does the IS reduce the number of errors performed when doing daily activities? 1. There are still lots of possibilities to make errors 2. Number of errors is the same 3. Number of errors decreased a little 4. Number of errors decreased a lot
Business process	Does the IS provide more knowledge to you concerning the company and business processes? 1. There is no information on business processes 2. It is hard to find information on business processes 3. Information is easy to find 4. Process is very easy to understand
Daily activities execution time	Does the IS help to save you time performing daily activities? 1. It takes too much time to perform daily activities 2. It doesn't take much time to do this. 3. Time consumption was reduced a little 4. Time consumption was reduced a lot

Data accessibility and accuracy	Is it easy to access the right information in the IS? 1. It made the process of accessing information even harder 2. No, it is not so efficient 3. Yes, a little 4. Yes, a lot
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The following table summarise all of the indicators assigned to particular roles in organization, and the questions that will be asked in a questionnaire:

Table 6. Summary of performance indicators with questions and roles assigned (created by author)

GROUPING	BUSINESS PERFORMANCE INDICATORS	QUESTIONS	ROLES QUESTIONED
Financial performance	Finance control	Does the IS help to keep a track on company's financial performance?	✓ Head of the department
	Agreement handling	Does the IS ease the process of handling agreements on internal cooperation?	✓ Head of the department
	Follow-up on project/portfolio finances	Does the IS help to follow-up on the projects and portfolios?	✓ Project manager ✓ Portfolio manager ✓ Activity manager
	Project planning and data maintenance	Does the IS help to plan and maintain project information?	✓ Project manager ✓ Activity manager
	Project monitoring and follow-up	Does the IS help to monitor and follow-up on project results?	✓ Project manager ✓ Activity manager
	Risk assessment	Does the IS help to identify and reduce risk in organization?	✓ Project manager ✓ Activity manager
	External	Does the IS effect your	✓ Project manager

	communication	capabilities to communicate with customers?	
Internal process performance	Resource control and task delegation	Does the IS influence the way how you control resources and delegate task?	✓ Head of the department ✓ Resource manager ✓ Project manager ✓ Activity manager
	Internal communication	Does the IS help to make you more integrated with other departments and teams?	✓ Head of the department ✓ Resource manager ✓ Project manager ✓ Portfolio manager
	Number of errors on job	Does the IS reduce the number of errors performed when doing daily activities?	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager
	Business process	Does the IS provide more knowledge to you concerning the company and business processes?	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager
	Daily activities execution time	Does the IS help to save you time performing daily activities?	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager
	Data accessibility and accuracy	Is it easy to access the right information in the IS?	✓ Head of the department ✓ Resource manager ✓ Employee ✓ Project manager ✓ Activity manager

In order to prepare the model for system performance evaluation, for each of the employee roles and listed benefits, the indexes were assigned to use for further calculations.

Indexes from FP1 to PF12 were assigned to the financial performance indicators:

Table 7. Financial performance index (created by author)

FINANCIAL PERFORMANCE INDEX (FPI)							
Role	Finance control	Agreement handling	Follow-up on project/ portfolio finances	Project planning and data maintenance	Project monitoring and follow-up	Risk assessment	External communication
HoD	FP1	FP2					
Resource manager							
Portfolio manager			FP3	FP4	FP5	FP6	
Project manager			FP7	FP8	FP9	FP10	FP11
Activity manager			FP12				
Employee							

These indexes will be further used for evaluation of financial performance index (FPI) that will be calculated using the following formula (1):

$$FPI = \sum_{z=1}^k S_i \sum_{i=1}^n P_i \sum_{j=1}^m A_{ijz} \quad (1)$$

Where:

m – number of indexes,

n – number of financial performance indicators,

k – number of roles,

S_i – the weight of role of index i ,

P_i – the weight of indicator i ,

A_{ijz} – score of index i , indicator j and role z .

The weight of each criteria depends on the importance of the benefit from business perspective and was defined by the internal group of specialists from different work areas. The results are presented in the table below:

Table 8. Weight for the financial performance indexes (created by author)

FINANCIAL PERFORMANCE INDEXES (FPI)							
	Finance control	Agreement handling	Follow-up on project/ portfolio finances	Project planning and data maintenance	Project monitoring and follow-up	Risk assessment	External communication
Weight	0.3	0.05	0.2	0.15	0.15	0.1	0.05

The weight of each role depends on the relevancy of information system for particular role for financial performance indexes from business perspective and was defined by the internal group of specialists from different work areas. The results are presented in the table below:

Table 9. Weights for organizational roles in regards to financial performance indexes (created by author)

ORGANIZATIONAL ROLES						
	Head of the department	Resource manager	Portfolio manager	Employee	Project manager	Activity manager
Weight	0.2	0	0.3	0	0.4	0.1

The total score of evaluated indexes of financial performance might be presented in a following formula:

$$FPI_i = \sum_{j=1}^m A_{ijz} \quad (2)$$

Where:

m – number of indexes,

A_{ijz} – score of index i , indicator j and role z .

If the score of an evaluated item is less than $m * 4 / 2$, it shows that the business performance is not seem to be received from the business point of view and needs to be improved.

Indexes from IP1 to IP34 were assigned to the internal process performance indicators:

Table 6. Internal process performance index (created by author)

INTERNAL PROCESS PERFORMANCE INDEX (IPPI)						
Role	Resource control and task delegation	Internal communication	Number of errors on job	Business process	Daily activities execution time	Data accessibility and accuracy
HoD	IP1	IP2	IP3	IP4	IP5	IP6
Resource manager	IP7	IP8	IP9	IP10	IP11	IP12
Portfolio manager	IP13	IP14	IP15	IP16	IP17	IP18
Project manager	IP19	IP20	IP21	IP22	IP23	IP24
Activity manager	IP25	IP26	IP27	IP28	IP29	IP30
Employee			IP31	IP32	IP33	IP34

These indexes will be further used for evaluation of internal process performance index (IPPI) that will be calculated using the following formula (3):

$$IPPI = \sum_{z=1}^k S_i \sum_{i=1}^h P_i \sum_{j=1}^m A_{ijz} \quad (3)$$

Where:

m – number of indexes,

h – number of internal processes performance indicators,

k – number of roles,

S_i – the weight of role of index i ,

P_i – the weight of indicator i ,

A_{ijz} – score of index i , indicator j and role z .

The weight of each criteria depends on the importance of the benefit from business perspective and was defined by the internal group of specialists from different work areas. The results are presented in the table below:

Table 7. Weight for the internal process performance indexes (created by author)

INTERNAL PROCESS PERFORMANCE INDEX (IPPI)						
	Resource control and task delegation	Internal communication	Number of errors on job	Business process	Daily activities execution time	Data accessibility and accuracy
Weight	0.1	0.2	0.15	0.1	0.25	0.2

The weight of each role depends on the relevancy of information system for particular role for financial performance indexes from business perspective and was defined by the internal group of specialists from different work areas. The results are presented in the table below:

Table 8. Weights for organizational roles in regard to internal processes performance indexes (created by author)

ORGANIZATIONAL ROLES						
	Head of the department	Resource manager	Portfolio manager	Employee	Project manager	Activity manager
Weight	0.2	0.15	0.15	0.25	0.15	0.1

The total score of evaluated indexes of financial performance might be presented in a following formula (4):

$$IPPI_i = \sum_{j=1}^m A_{ijz} \quad (4)$$

Where:

m – number of indexes,

A_{ijz} – score of index i , indicator j and role z .

If the score of an evaluated item is less than $m * 4 / 2$, it shows that the business performance is not seem to be received from the business point of view and needs to be improved.

Evaluation results get by the evaluation of internal process performance index and financial performance index shows the impact of information systems on the overall business performance. The equation for calculation general performance (GP) is in the following formula (5):

$$GP = \frac{P_1 * IPPI + P_2 * FPI}{2} \quad (5)$$

Where:

IPPI – evaluated value of internal process performance index,

FPI – evaluated value of financial performance index,

P_1 – weight of IPPI,

P_2 – weight of FPI.

This formula will provide the final evaluation of the general performance index in the company, existing under the information System used. In the further calculations, the weight for IPPI will be 0.4 and the weight for FPI will be 0.6. The weight for the financial index performance is higher, as in the current situation the bigger attention is set to the financial focus of the enterprise.

III. PRACTICAL MODEL APPROBATION

3.1. Company presentation

For the practical information system influence on company's evaluation in this work, I have selected three branches of Company „X“ located in Denmark, Norway and Lithuania. Name of the company is not mentioned due to the management request. These both companies have been selected as these are the only companies and countries where at the moment the System was successfully implemented and used for more than one year time period. For the company's overview, whole Group will be presented as the exclusion of the features of specific companies is not relevant.

Company „X“ is a private limited company registered under the laws of the Kingdom of Denmark. Company „X“ has rendered independent multidisciplinary consulting services to public and private customers throughout the world in close to 80 years.

The core business of the company lies within the spheres of their three service lines ranging from classical engineering through environmental science to modern economic analyses. All listed services within the business units are presented in the table below:

Table 9. Service lines of Company „X“ (created by author)

Business Units	Services
Economics, Management and Planning	• Economic analyses and tools • Financial analyses and law • Evaluation and impact assessment • Social studies and organizational development • Communication and policy advice • Transport planning and modelling • Public transport and ITS • Urban and spatial planning and design

Business Units	Services
Water and Environment	• Health, safety and environment • Water supply and wastewater • Water and natural resources management • Environmental impact assessment and monitoring • Solid waste management • Contaminated sites • Strategic environmental consultancy
Geographical information and IT	• GIS and IT • 3D visualisation and modelling • Maps and geodata products • Mapping and data capture • Surveying • Property rights and land administration
Railways, Roads and Airports	• Roads and highways • Railways • Light rails • Metros • Airports

Business Units	Services
Bridge, Tunnel and Marine Structures	• Bridges • Tunnels • Structures for infrastructure • Offshore wind • Marine, and geotechnical engineering • Operation and maintenance • Risk management and analysis • Service life design
Buildings	• Building design • Sustainable and green buildings • Fire engineering • Hospitals and health care • Project management consultancy • High-rise • Urban development and master planning • Refurbishment and retrofit
Industry and Energy	• Industry • Energy • Oil and gas

Company „X“ is operating in the 7 sectors including Economics, Management and Planning, Water and Environment, Geographical information and IT, Railways, Roads and Airports, Bridge, Tunnel and Marine structures, Buildings and Industry and Energy sector with a number of services provided by each of the departments.

Company „X“ is a leading consulting group that creates value for customers, people and society through their unique 360° approach. With offices all over the world, they combine global

presence with local knowledge to take on projects anywhere in the world - no matter how large or small.

The head office of Company „X“ is located in Copenhagen and is supplemented by 12 regional offices throughout Denmark. Further, the Group maintains 36 branch offices and affiliated offices in Asia, Europe, the Middle East, Africa and the Americas.

Company „X“ has carried out more than 85,000 projects in over 175 countries, mainly in Europe, Asia, the Middle East, Africa and the Americas. The company is currently engaged in some 10,000 projects within a wide range of disciplines. Company „X“ is a leader within its field because their more than 6,200 employees are leaders within theirs.

Consulting engineering is a professional service that provides independent expertise in engineering, science and related areas to governments, industries, developers and construction firms. Most consulting engineering services are offered through consulting engineering companies, but are also frequently offered by sole practitioners. Consulting engineering companies can range in size from a partnership of two people to multinational corporations with tens of thousands of employees in offices world-wide.

Consulting engineering firms are responsible for designing and building cities' infrastructure which is vital to our social, economic and environmental quality of life. Within a consulting engineering firm, projects are usually carried out by teams that are comprised of a variety of professions and disciplines in addition to engineers and technologists, but the team leader is usually a professional engineer. Large firms may be able to assemble the entire team from within their ranks, whereas smaller firms may need to partner with other firms to assemble the team (Singh & Kant 2008).

Consulting civil engineering firms play an initiating, cementing and added value role within the construction chain. Advisory services are provided to governments and private investors, to contractors and developers, to buyers or end-users while sometimes these firms act as principal. Demand for civil engineering consultancy services is therefore closely linked to the general economic environment and construction output. The market of civil engineering consultancy is characterized by a competitive environment with low entry barriers and a strong impact of political decision-making. Demand for basic engineering services especially is very price driven (commodity).

While developed countries, such as UK traditionally have rather strong and developed sector of engineering companies, the developing countries often form an integral part of construction companies or industrial conglomerates. In 2012 the UK had the biggest engineering consultancy sector in Europe with a turnover of approximately €50 billion per year. As a share of the

construction market Sweden has the largest engineering sector with 32.5% followed by Denmark with 29.8%. In most countries small engineering enterprises dominate the market. For example in Germany over 90,000 engineering companies are registered. However, a limited number of major players form the front line. These players usually have established networks in several countries (ING Wholesales Banking report, 2008).

Civil engineering consultancy companies grasp opportunities derived from perceived trends in the world, as these trends and developments affect their clients. Although the list of global dynamics is almost inexhaustible, a few are mentioned below:

- Global warming, resulting in droughts and serious water safety issues for many public authorities.
- Demand for sustainability, resulting in all sorts of studies and advisory services.
- Inner city developments, resulting in highly complex logistical and construction issues.
- Urbanization, resulting in concentrated demographic pressure in relatively smaller areas.
- Leisure consumption, resulting in the design of entirely new concepts and landscaping.
- Outsourcing by governments and multinationals for instance resulting in increased demand for facility management services and the like, with seriously higher margins.
- Environmental demand resulting in demand for remediation services and a diversity of soil and water quality treatment projects.
- Mobility resulting in complex logistic challenges with implications for nature, pollution and the technologies applied.
- Increasing sanitary standards, resulting in entirely new concepts of care and health, but also growing attention to safe drinking water and an ecologically safe food chain.

The business of civil engineering becomes more complex within years. In order to remain competitive in nowadays business world, civil engineering organizations shall enhance their technical skills with business expertise and particularly consulting. (Sears, 1999)

3.2. Introducing the information solution

In order to deal with the increasingly tough markets; Company „X“ has started Project called to develop and implement Company's „X“ new global way of doing project management. The project delivers an IT-solution including a financial business model that defines Company's „X“ way of managing their business. The System is Company's „X“ global solution for project and business management. It is in operations in Denmark, Norway and Qatar with more than 5000 active projects. The solution is used by all employees as it integrates all core business processes

from time registration, travel and expense claims and project management, to financial control and business intelligence.

With Information System solution Company „X“ is able to:

- Professionalise project management;
- Establish a global project-centric solution for running projects;
- Improve the financial results.

The System, the financial model, and a competent organization can ensure an exciting, profitable future for Company „X“. Implementation of system is must win battle #1 in the Company's „X“ strategy.

The System focuses on the financial aspect of project management from drafting feasible offers, defining project budgets, manage contingency, allocating resources, controlling cost during project execution; define payment plans, and managing cash flow etc.

Depending on current project management competences this may open new knowledge areas for project managers to study. Project managers who do not crave for this business mind-set and the financial tasks can be responsible for one or more work packages in the project.

Financial control of projects is a must and will benefit Company „X“ and their Clients.

The System is designed to suit the role and responsibility of each employee. This means that tools and each screen display reflect the actual tasks of the employees in question.

The integration of solution gives the possibility for different employees work on the same projects having different perspectives and views depending on their hierarchical position in the company and their role in the Project management and coordination process.

The System is a highly integrated solution. It's integrated across the Company „X“ companies, vertically from project participants to line managers, and across the project life cycle.

The System is an important tool, but the battle is only won with competent and engaged employees. All employees will be affected and especially project managers and line managers must adapt.

The solution will bring change to their way of working. Not because the solution in itself requires it, but because it represents the strategically chosen business model for Company „X“.

Having one global solution gives them a cost-effective solution they can continue to invest in. Also it enables greater mobility; international projects are easier to manage and it is easier to identify the right resources across their companies.

One solution also means that time registration project management, line manager reporting, and business intelligence are integrated and build on the same data. The same set of data share in many ways:

1. Across departments and companies.
2. Between Project participants and the Project manager.
3. Among Project managers, resource managers, and portfolio managers.
4. Across the Project process from planning tenders to executing projects in contract.

An hour registered on a project is a straight away visible in the project and in the line managers' financial reports.

The System supports the entire project life cycle from drafting offers to client with full financial insights, controlling project progress during execution, and taking care of cash flow from the project.

3.3. ERP implementation in Company „X“

At the moment it is in operations in Denmark and Qatar with more than 5000 active projects. The new solution will be implemented across all business units during 2012-2015 starting in Denmark and Qatar in 2012, Norway in the summer of 2013, and Sweden in 2014. Other business units will follow thereafter. It is planned that after Sweden, India and the United States of America will join the common global solution.

In the figure below you can see the implementation plan with time line and key implementation stages explained:

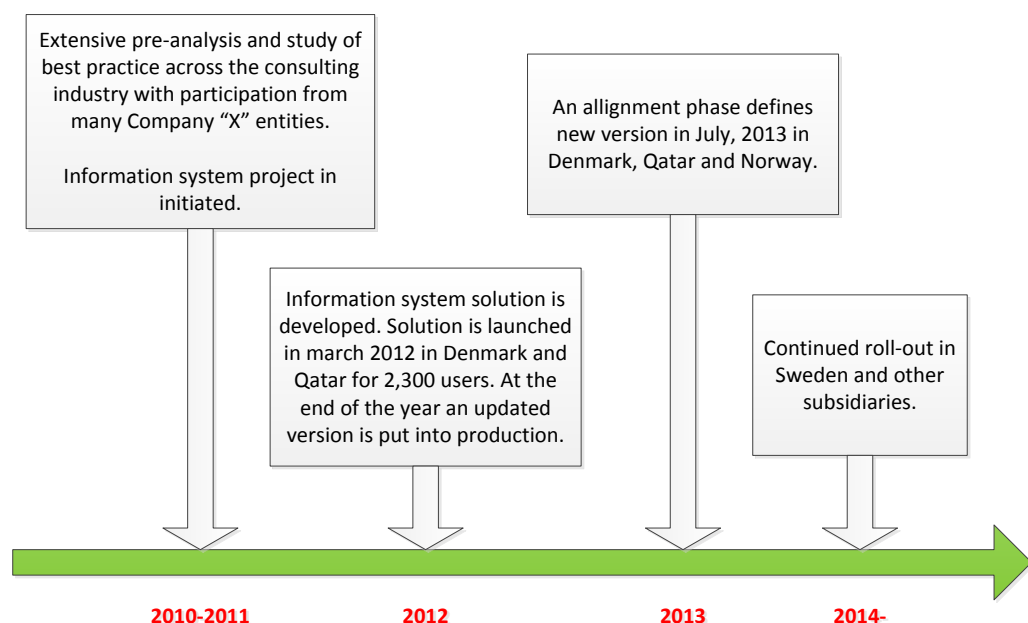


Fig. 11. Information System implementation plan in Group (created by author)

3.2. Evaluation of impact of information systems on business performance results

In order to analyse the impact of information systems on business performance, it was decided to compare the results of both counties that already have efficient Information System implemented (Norway and Denmark) and another country (Lithuania), where the System will be still implemented in the future, and where not so efficient business management tools are being used.

Questionnaire has been sent out via corporate mail service. In the table below, number of employees, who answered the questions provided, their main roles and the percentage of total number is presented:

Table 10. Basic information on the recipients within organization (created by author)

		EMPLOYEES IN LITHUANIA		EMPLOYEES IN DEMARK		EMPLOYEES IN NORWAY	
Position	Head of department	2	9.52%	3	4.84%	4	8.51%
	Resource manager	1	4.76%	4	6.45%	3	6.38%
	Portfolio manager	3	14.29%	5	8.06%	3	6.38%
	Project manager	4	19.05%	13	20.97%	9	19.15%
	Activity manager	4	19.05%	11	17.74%	10	21.28%
	Employee	7	33.33%	26	41.94%	18	38.30%
Total:		21	100.00%	62	100.00%	47	100.00%

In total, 21 employees from Lithuania, 62 from Denmark and 47 from Norway have answered to the provided questions. Employees for filling in the questionnaire have been selected randomly from the whole list extracted from the database. The most answers have been received from user type „employee“, having basic access rights in the System. They could be counted for more than 39 % of all recipients. The second biggest number of answers has been received from Project managers, who are counted of 20 % of all recipients.

In further calculations, data for each country will be separated, except of data for Denmark and Norway. For these countries data, that was received, will be merged, due to the fact that they are using the same common System and the same business processes for business management.

This will be done for comparison reasons to see the evaluations of the same factors by employees, working in different organizations.

In the schemes below, answers of both users already using sophisticated IS and those who are not, are presented in different colours with identification of average value that they have selected for each of the factors being analysed:

-  Users from Denmark and Norway, using more efficient Information System;
-  Users from Lithuania, still using old, not so efficient Information System.

Firstly, the financial performance indexes will be analysed and presented as a result of evaluation of each employee role, mentioned previously. Only four user groups, due to their areas of responsibilities, have been asked to evaluate financial performance indexes: head of the departments, portfolio managers, Project managers and activity managers.

The results of Heads of the departments are presented below:

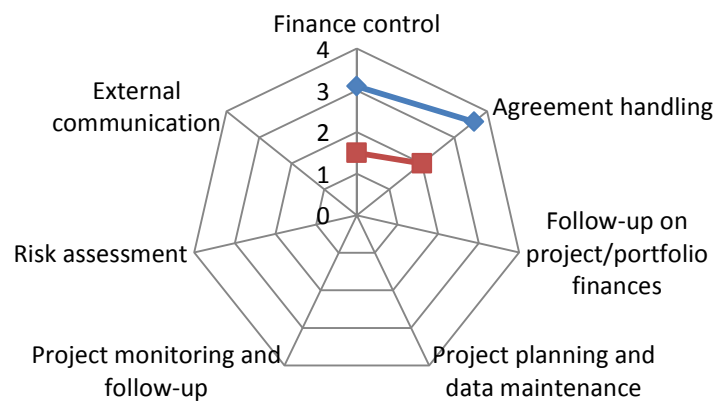


Fig. 12. Head of the department's evaluation of financial performance indexes (created by author)

Employees having main role of Head of the departments were obliged to evaluate only two factors: finance control and agreement handling. More efficient IS has proved to be more suitable for performing tasks under these factors, as evaluation received from foreign users are higher than the ones received from locals. Higher evaluations have been received for both factors.

Next, the evaluation of financial performance indexes made by portfolio managers is presented:

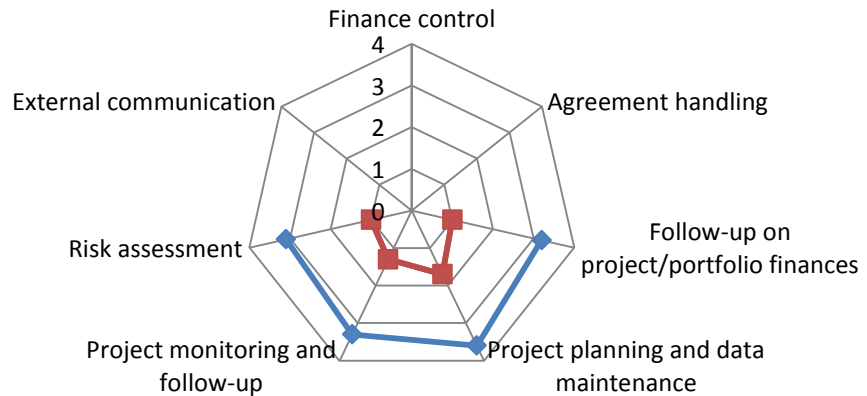


Fig. 13. Portfolio manager's evaluation of financial performance indexes (created by author)

Portfolio managers were evaluating four out of seven financial performance indexes: follow-up on projects/portfolios finances, Project planning and data maintenance, Project monitoring and follow-up, risk assessment. It was identified, that the Systems used in Lithuania was not design to meet business needs for some processes, such as risk assessment or follow-up on project finances, while in another System analysed, main focus is put on monitoring of financial data by finance department, Project managers, portfolio managers and others.

Project managers have also performed the evaluation of System based on the provided criteria. The results are shown below:

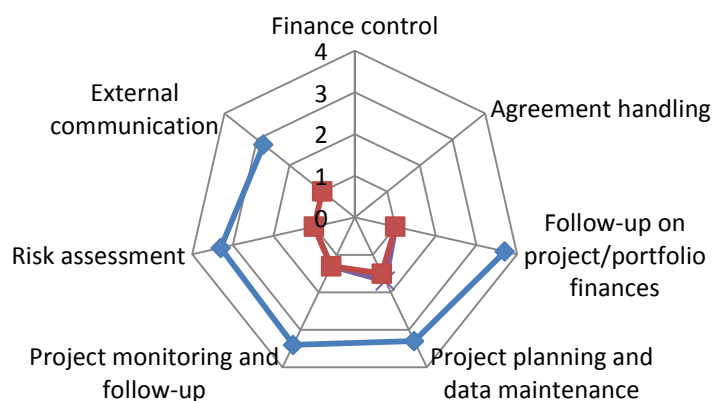


Fig. 14. Project manager's evaluation of financial performance indexes (created by author)

Project manager's role has one of the biggest Access in the System, so five out of seven factors were analysed by this user type. Average evaluation of all factors of Danish and Norwegian

employees was equal to 3.3, while the average evaluation of Lithuanian Project managers was 1.25. Difference of 2.05 for total factors is showing that the more sophisticated information System is designed to meet needs of Project managers in a better way.

Activity manager's results are presented below:

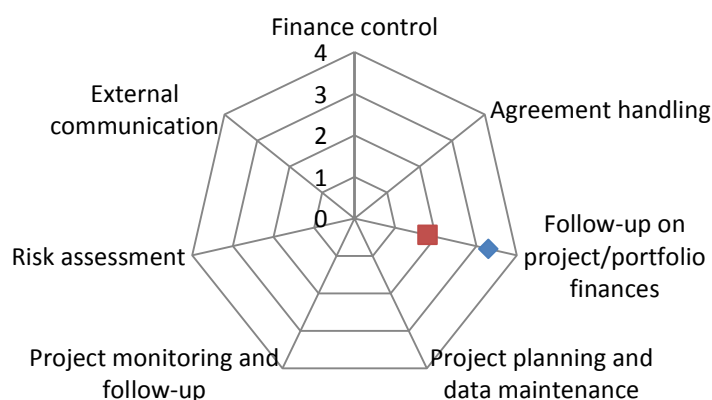


Fig. 15. Activity manager's evaluation of financial performance indexes (created by author)

Only one factor, which is follow-up on Project/portfolio finances, was evaluated by the activity managers. This happened due to the processes and limited responsibilities of activity managers, that are delegated to activity managers by Project managers. The average evaluation of this factor for Lithuanian employees is equal to 1.8 and is 3.3. for Danish and Norwegian employees.

To sum up all of the received results for each of the factors of financial performance indexes, the following table was made:

Table 11. Average evaluation of financial performance indicators (created by author)

INDICATOR	HoD (DK,NO)	HoD (LT)	PT. M. (DK,NO)	PT. M. (LT)	PM (DK,NO)	PM (LT)	AM (DK&NO)	AM (LT)
Finance control	3.1	1.5						
Agreement handling	3.6	2						
Follow-up on project/portfolio finances			3.2	1	3.7	1	3.3	1.8
Project			3.6	1.7	3.3	1.5		

planning and data maintenance								
Project monitoring and follow-up			3.3	1.3	3.4	1.3		
Risk assessment			3.1	1	3.3	1		
External communication					2.8	1		

For further calculations, we will sum up all of the received results per employee category for each indicator and again, will separate results per country. The average evaluation of indicators for financial performance index calculation for both systems is presented in the table below:

Table 12. Sum of evaluations of financial performance indicators (created by author)

INDICATOR	DENMARK AND NORWAY	LITHUANIA
Finance control	3.1	1.5
Agreement handling	3.6	2
Follow-up on project/portfolio finances	10.2	3.8
Project planning and data maintenance	6.9	3.2
Project monitoring and follow-up	6.7	2.6
Risk assessment	6.4	2
External communication	2.8	1
Total:	39.7	16.1

The results above show how different employees working with two different systems in three different countries evaluate the impact of information System on their business performance and capabilities to perform the business processes using the information systems in place. For the financial performance index indicators we can see a big difference in the results. We can assume that the efficient information System has a big positive impact on business performance from the financial indicators perspective.

Next, the internal process performance indexes will be analysed and presented as a result of evaluation of each employee group. This time, all six user groups have had possibility to evaluate

given indicators: head of the departments, portfolio managers, Project managers, activity managers, resource managers and employees.

The results of Heads of the departments working both in Denmark/Norway and Lithuania are presented below:

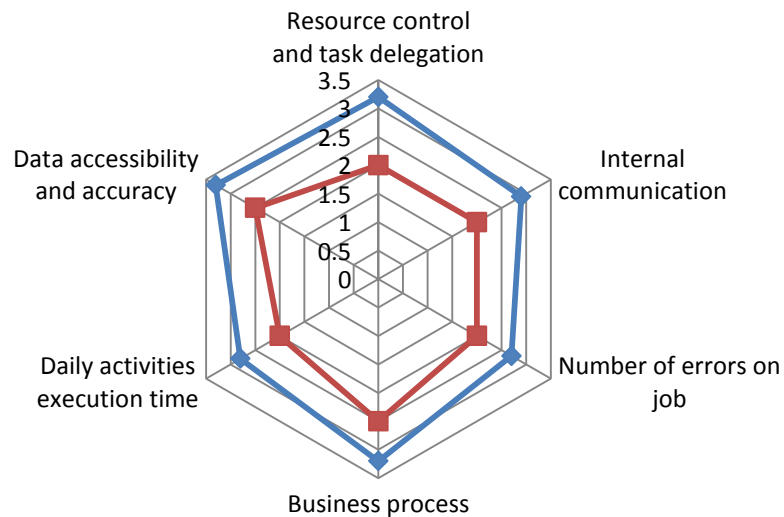


Fig. 16. Head of department's evaluation of internal processes performance indexes (created by author)

Head of the departments in all countries have evaluated all of the provided indicators. Top two indicators, having the highest evaluation for Lithuanian HoD's were for Daily activities execution time and data accessibility and accuracy and was equal to 2.5. Top indicators for employees from Denmark and Norway were the following three: resource control and task delegation, business process and data accessibility and accuracy. The evaluations were 3.2 , 3.2, and 3.3. respectively. As a result, the evaluations for named indicators were higher for employees from Denmark and Norway.

Resource managers, that did not participated in evaluation of financial performance indicators, have also evaluated all of the internal processes performance indicators. Results are presented below:

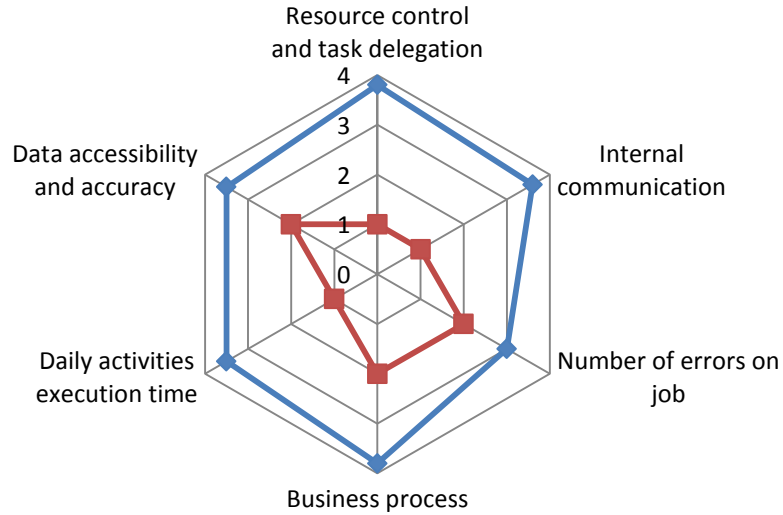


Fig. 17. Resource manager's evaluation of internal processes performance indexes (created by author)

The results for Lithuanian employees were based on the answers of only one employee, working in Human resources department, so the results might not be so reliable. Nevertheless, the evaluation was not so high in comparison with the data received from Danish or Norwegian employees, due to a limitation of functionality of the currently used software. As a result, we have received the lowest possible evaluation, equal to one, for the following indicators: resource control and task delegation, internal communication and daily activities execution time.

Portfolio manager's results are the following:

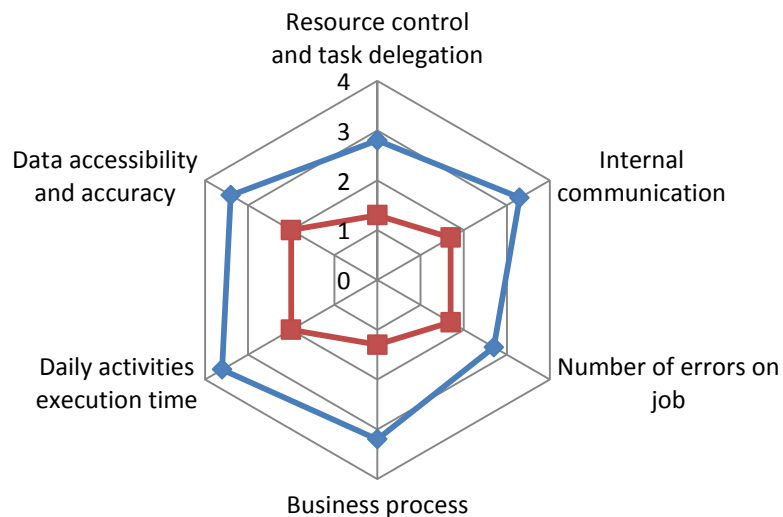


Fig. 18. Portfolio manager's evaluation of internal processes performance indexes (created by author)

In total 8 employees in Denmark and Norway working as a portfolio managers have evaluated internal process performance indicators in a range between 2.8 and 3.6. At the same time 3 portfolio managers from Lithuania evaluated their System in a range between 1.3 and 2. Even the

lowest average evaluation of Danish and Norwegian employees is higher than the highest average evaluation of Lithuanian employees. We can also assume that the portfolio managers having obsolete information system don't have enough IT tools for performing their daily activities at work.

The evaluation of impact of Information System on internal process performance indexes presented by Project managers are the following:

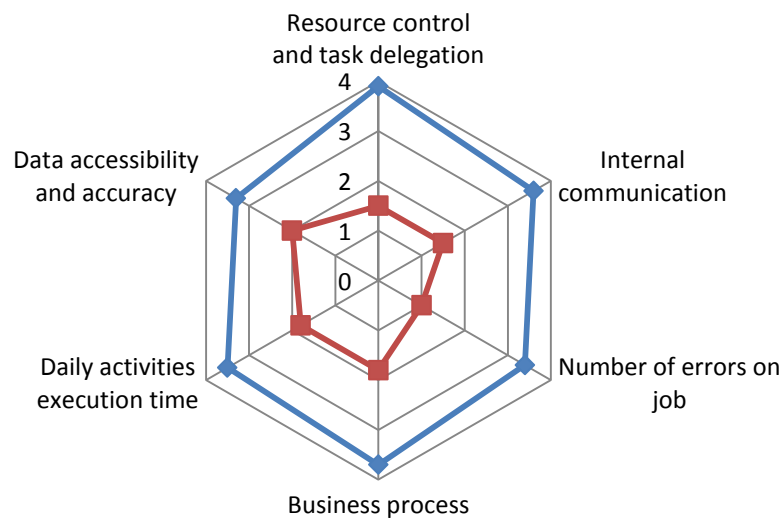


Fig. 19. Project manager's evaluation of internal processes performance indexes (created by author)

Project managers from Denmark and Norway have evaluated resource control and task delegation indicator as the most valuable one, having the most impact on the business performance from their activities. This resulted in the evaluation equal to 3.9. At the same time PM's in Lithuania gave only 1.5 points to this indicator. The lowest evaluation was given to number of errors on job by Lithuanian Project managers. The reason for this might be no System and logical checks in the IS they are using, resulting in additional work they need to constantly perform. This shows once again the importance of efficient information systems, meeting the needs of business.

Results received from activity managers are shown in the following graph:

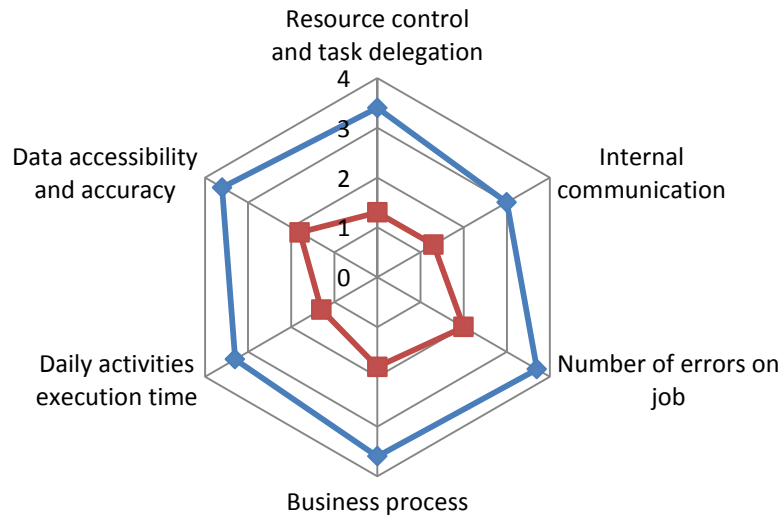


Fig. 20. Activity manager's evaluation of internal processes performance indexes (created by author)

Results of activity managers are similar to the results of Project managers, represented in the graph below. The major difference presented in this graph is between the evaluations provided by users of different systems. The total average result of activity managers for both categories is for Danish and Norwegian users 3.4 and 1.6 for Lithuanian users. The highest evaluation for Lithuanian, Danish and Norwegian activity managers was delegated to number of errors on job indicator.

Employee's user type answers, that did not participated in the evaluation of financial performance indicators, is presented below:

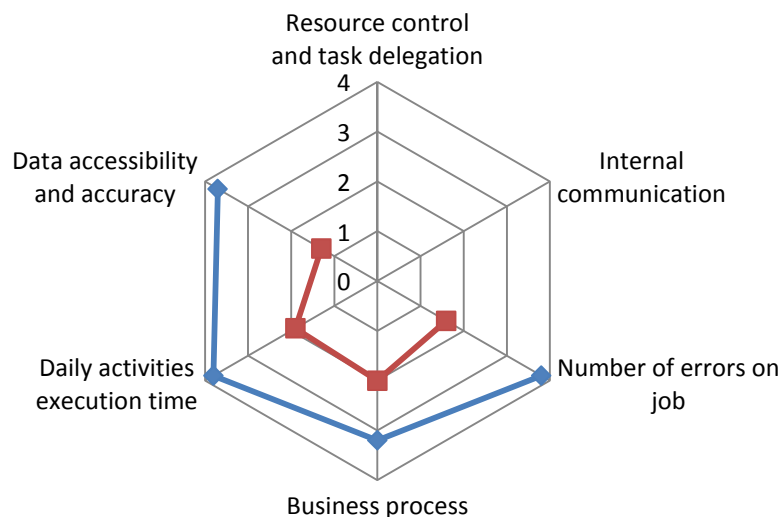


Fig. 21. Employee's evaluation of internal processes performance indexes (created by author)

Employees, not like other users have not been evaluating following indicators among the internal processes performance group: resource control and task delegation and internal

communication. Employees in Lithuania had the second biggest total average evaluation in this group, equal to 1.7, after Heads of the departments. Employees in Denmark and Norway have presented the most positive average evaluation of all indicators in their group, being more than 3.6

The summarised table of gathered results for each of the factors of internal process performance indexes, is presented below:

Table 13. Average evaluation of internal processes performance indicators (created by author)

INDICATOR	HoD (DK, NO)	HoD (LT)	RM (DK, NO)	RM (LT)	PT. M(DK ,NO)	PT. M (LT)	PM (DK, NO)	PM (LT)	AM (DK, NO)	AM (LT)	EMP (DK, NO)	EMP (LT)
Resource control and task delegation	3.2	2	3.8	1	2.8	1.3	3.9	1.5	3.4	1.3		
Internal communication	2.9	2	3.6	1	3.3	1.7	3.6	1.5	3	1.3		
Number of errors on job	2.7	2	3	2	2.7	1.7	3.4	1	3.7	2	3.8	1.6
Business process	3.2	2.5	3.8	2	3.2	1.3	3.7	1.8	3.6	1.8	3.2	2
Daily activities execution time	2.8	2	3.5	1	3.6	2	3.5	1.8	3.3	1.3	3.8	1.9
Data accessibility and accuracy	3.3	2.5	3.5	2	3.4	2	3.3	2	3.6	1.8	3.7	1.3

For further calculations, we will sum up all of the received results per employee category for each indicator and again, will separate results per country. The average evaluation of indicators for internal process performance index calculation for both systems is presented in the table below:

Table 14. Sum of evaluations of internal processes performance indicators (created by author)

INDICATOR	DENMARK AND NORWAY	LITHUANIA
Resource control and task delegation	17.1	7.1
Internal communication	16.4	7.5
Number of errors on job	19.3	10.3

Business process	20.7	11.4
Daily activities execution time	20.5	10
Data accessibility and accuracy	20.8	11.6
Total:	114.8	57.9

The results above show the total average evaluation of each indicator of internal process performance index, made by the users of two systems. Once again we can see a big difference between the results received in two columns for Denmark/Norway and Lithuania. The result is that the more sophisticated information System has a positive impact on business performance.

Information received by now could already be used to make some final judgements on whether the information systems do have an impact on business performance, and what is the amount of that impact. But we would like to proceed with other calculations including the weights that we have identified per indicator and employee group before, to receive more reliable results. This is an important step as we shouldn't treat every indicator equally and we shouldn't assume that the answers of each employee in category has the same weight.

The results for Danish and Norwegian employees evaluation, calculated with weights for Indicators and user groups are presented below:

Table 19. Weighted results of Danish and Norwegian employees (created by author)

INDICATOR		HoD	RM	PT M	PM	AM	EMP
	Weight	0.2	0	0.3	0.4	0.1	0
Finance control	0.3	0.186					
Agreement handling	0.05	0.036					
Follow-up on project/portfolio finances	0.05			0.048	0.074	0.0165	
Project planning and data maintenance	0.15			0.162	0.198		
Project monitoring and follow-up	0.15			0.1485	0.204		
Risk assessment	0.1			0.093	0.132		
External communication	0.05				0.056		
	Weight	0.2	0.15	0.15	0.25	0.15	0.1
Resource control and task delegation	0.1	0.064	0.057	0.042	0.0975	0.051	

Internal communication	0.2	0.116	0.108	0.099	0.18	0.09	
Number of errors on job	0.15	0.081	0.0675	0.06075	0.1275	0.08325	0.057
Business process	0.1	0.064	0.057	0.048	0.0925	0.054	0.032
Daily activities execution time	0.25	0.14	0.13125	0.135	0.21875	0.12375	0.095
Data accessibility and accuracy	0.2	0.132	0.105	0.102	0.165	0.108	0.074

The table above shows the results for both financial performance index and internal process performance index.

The results for Lithuanian employees evaluation, calculated with weights for Indicators and user groups are presented below:

Table 15. Weighted results of Lithuanian employees (created by author)

INDICATOR		HoD	RM	PT M	PM	AM	EMP
	Weight	0.2	0	0.3	0.4	0.1	0
Finance control	0.3	0.09					
Agreement handling	0.05	0.02					
Follow-up on project/portfolio finances	0.05			0.015	0.02	0.009	
Project planning and data maintenance	0.15			0.0765	0.09		
Project monitoring and follow-up	0.15			0.0585	0.078		
Risk assessment	0.1			0.03	0.04		
External communication	0.05				0.02		
	Weight	0.2	0.15	0.15	0.25	0.15	0.1
Resource control and task delegation	0.1	0.04	0.015	0.0195	0.0375	0.0195	
Internal communication	0.2	0.08	0.03	0.051	0.075	0.039	
Number of errors on job	0.15	0.06	0.045	0.03825	0.0375	0.045	0.024
Business process	0.1	0.05	0.03	0.0195	0.045	0.027	0.02
Daily activities execution time	0.25	0.1	0.0375	0.075	0.1125	0.04875	0.0475
Data accessibility and accuracy	0.2	0.1	0.06	0.06	0.1	0.054	0.026

The table above shows the results for both financial performance index and internal process performance index.

After we have received the weighted evaluations for both financial performance indicator and internal process performance indicator, we can calculate the IPPI and FPI indexes as a part of

the evaluation of the System for both Lithuanian and Denmark/Norway. The calculations of IPPI are shown in the following table:

Table 16. Financial performance indicator values (created by author)

SYSTEM (COUNTRY)	FPI VALUE
Denmark/Norway	1.354
Lithuania	0.547

Calculated FPI value for System in Denmark and Norway is equal to 1.354 and is equal to 0.547 to the System used in Lithuania.

The calculations of IPPI are shown in the following table:

Table 17. Internal processes performance indicator values (created by author)

SYSTEM (COUNTRY)	IPPI VALUE
Denmark/Norway	3.25875
Lithuania	1.669

The IPPI value in Denmark/Norway is equal to 3.25875 and the IPPI value for System in Lithuania is 1.669.

After the calculation of IPPI and FPI index, we could place these values on a plot to identify the current position of organization in relation to impact of business performance (internal process performance and financial performance). Based on the score of internal process performance and financial performance we can determine the location of the current information System.

In order to calculate the position of the System, we should take the percentage of the current value from the maximum possible value that would be received, if all recipients would evaluate the System with the highest score. Maximum and current values are shown in the table below:

Table 18. Percentage values of FPI and IPPI (created by the author)

INDEX	DENMARK/NORWAY		LITHUANIA		MAX VALUE	
FPI	1.354	82.56%	0.547	33.35%	1.64	100.00%
IPPI	3.25875	83.99%	1.669	43.02%	3.88	100.00%

The graph for position of the System is based on the following assumption: X-axis shows the percentage of FPI from the maximum values, Y-axis shows the percentage of IPPI from the maximum value. Each System in the graph is shown in different colours and is presented below:

- ◆ Position of System used in Denmark and Norway
- Position of System used in Lithuania

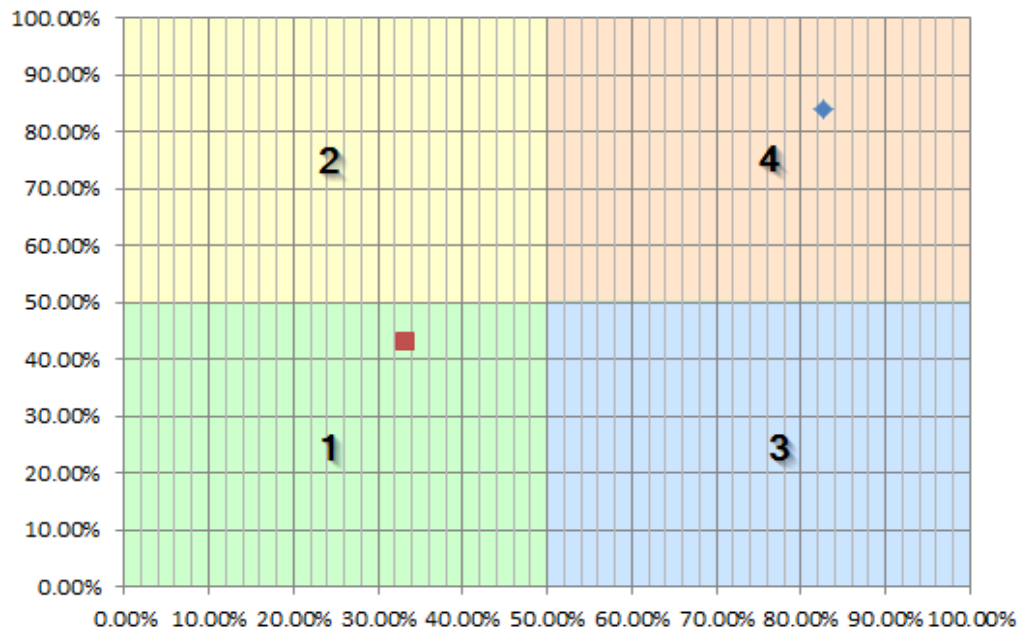


Fig. 22. Position of both systems on the FPI and IPPI plot (created by author)

The numbers of areas presented in the graph have the following meaning:

1. Low financial performance index and low internal process performance.
2. Low financial performance index and high internal process performance.
3. High financial performance index and low internal process performance.
4. High financial performance index and high internal process performance.

From the graph above we can say that the current System used in Denmark and Norway has high financial performance and internal process features, while the System used in Lithuania has low both financial and internal process features.

General business performance could be calculated by taking the IPPI and FPI rates, multiplying calculated values for each country by the weight for IPPI and FPI, that are 0.4 and 0.6 respectively and summing the received values. Calculations of general business performance value are presented below:

Table 19. General business performance values (created by author)

SYSTEM (COUNTRY)	GP VALUE
Denmark/Norway	2.1159
Lithuania	0.9958

After the performed calculations, we have received the general business performance index that is 2.1159 for Denmark/Norway and 0.9958 for Lithuania. On the given example, we can say that the positive impact on business performance that are using more sophisticated and efficient software is twice as much, as the one that could be achieved using the obsolete information

System. What is more important, the System used in Lithuania does not provide the required positive impact on business performance, from the business point of view, and should be changed or upgraded.

CONCLUSIONS

Based on all of the analysis of theoretical aspects of influence of information systems on the business performance that has been made, the following assumptions could be identified.

- Increasing need in information in today's world requires development of information systems. Every enterprise should follow the latest information technology solutions for business management that appear in the market that would improve the way how an enterprise is being managed, improve performance, thus increasing competitive advantage. One of the information technology solutions that improve efficiency of the company is information systems.
- Information systems play crucial role in today's business life. It helps to understand and improve their goals, targets and strategies. Nowadays more and more companies invest money into information systems in order to improve business performance. Investment in information systems helps business to transform business processes and activities so that higher efficiency could be achieved. Production process, customer service, finance and accounting, information processing and other could be improved through implementation of information systems.
- Information systems can be described as the set of components that together are used to collect, store, process and distribute information among different business units thus increasing decision making, planning, control, monitoring efficiency and communication.
- Information systems can help to identify and resolve company's existing problems and weaknesses. It can bring a lot of direct and indirect benefits for the company, thus increasing its financial stability.
- Both financial performance and internal process performance indicators might in one way or another influence the business performance after implementation of enterprise resource planning systems. Evaluation of such benefit is hard enough, because present evaluation models lack of complex evaluation of business processes and doesn't take into account business area specifics.
- Based on the performed calculations under created model, it was identified, that the efficient information system has a huge impact on business performance and can bring different benefits that influence both financial performance and internal process performance. These benefits can have a positive outcome on organizational competitive advantage.
- Performed general performance evaluation showed that the efficient information system index was more than twice bigger, than the one where the obsolete information system were used, 2.1159 and 0.9985 respectively.

- Financial performance index in Denmark and Norway had 82.56 % out of maximum possible value and was equal to 1.354. The same index in Lithuania was equal only to 0.547 that could be counted for 33.35 % out of maximum value.
- Internal performance index in countries with more efficient information system in percentage matters was almost equal to FPI index and counted for 83.99 %. This index in Lithuania was equal to 1.669 that is 43.02 % respectively.
- The percentage of FPI and IPPI index in Denmark and Norway was almost the same, while in Lithuania the difference between these two indexes was almost 10 %. We could state that in Lithuania current information system supports internal processes more, than financial aspects.
- Evaluation performed for the system implemented in three different countries showed, that it could be used for evaluation different companies working under the same business processes and organizational structure, with no influence of geographical location, cultural specifics, etc.
- System used in Denmark and Norway showed to have high financial performance and internal process performance index, while the one used in Lithuania proved to have low financial performance and low internal process performance.
- Evaluation of general business performance in Lithuania did not meet the minimal requirements set in this thesis work before, thus it would be recommended to improve the system or adopt new one with features that could enable processing of different activities using the information technologies.
- For the system used in Denmark and Norway, despite high results in general business performance index and percentage value, it would be recommended to proceed performing continues system improvement and implementation of new features, based on business requirements, to increase the performance level even more.

For further research on value creation through implementation of information systems in the enterprise, such important factor should be taken into account and added to the created model:

- Evaluation criteria. The set of the evaluation criteria might be extended to include more factors, that could provide better performance overview and system evaluation.
- Intangible benefit analysis. There are different benefits that could not be classified under financial performance or internal process performance categories. Evaluation of benefits that deal with intangible indicators might give a more explicit evaluation on what is the impact on the organization.

- Hardware efficiency analysis. By including hardware and performance aspects into consideration, we might identify what areas and business processes doesn't provide the desired results, as sometimes this is the "bottle neck" in increasing the usability and efficiency of the information system.

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APPENDIXES

Appendix A. Scientific article

INFLUENCE OF INFORMATION SYSTEMS ON THE BUSINESS PERFORMANCE

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Abstract. Considering increased competition nowadays, businesses strive to gain competitive advantage, increase their economic indicators, work productivity, work efficiency, reduce costs and get other benefits through implementation of integrated information systems. By improving internal processes and financial performance of the company, the general business performance could be influenced by the deployment of such information system (IS). In order to identify tangible and intangible benefits of IS implementation, influence on business performance, business processes and areas that are being affected, analysis of scientific literature, research synthesis and generalizations have been made.

Keywords: business performance, enterprise resource planning system, information systems, business benefits, ERP.

JEL: M15 – IT Management.

Introduction

In our fast moving and continuously changing world, when the needs and preferences of customers change very fast, only the companies that are able to keep up with innovations and adapt to the situation by making the adjustments in its business processes, can expect to keep their performance on the required level and stay competitive. In recent years the success of any enterprise is directly related to the level and quality of information technologies that are being used in the company and ability to use that information correctly.

The importance of information systems (IS) has dramatically increased during past decade and more and more businesses have realised it (Davidavičienė 2008; Paliulis *et al.* 2012). Modern organization could not be imagined without efficient information system. After lots of researches has been made, no one doubts that implementation of information system in organization can bring a lot of benefits dealing with the internal and external tasks that company may face in day to day operations and long term decisions (Pabedinskaitė 2010).

Continuously technology development that caused an increase of hardware and software performance, lowered the price and caused the higher availability of information systems for most of the business was another factor that caused the spread of computerized systems all over the globe.

Information system integrated to the business processes of the enterprise is one of the major factors that increase the business performance if implemented right (Pabedinskaitė 2009; Yahaya *et al.* 2004; Merkurjev & Tambovcevs 2009), but the benefits, brought by the specific information system could differ from one company to another, operating in the different economic sector and dealing with different business processes.

Define potential benefits that will bring an information system is hard enough, because of the fact that all of the direct and indirect benefits involved, some of which are intangible or tangible.

Main goal of this article is to identify what impact is being made on business by deployment of information system from the theoretical point of view through analysis of scientific literature, comparison and synthesis.

Business performance and IS

Analysis of research made by Awais *et al.* (2012) showed that over the past few decades' companies all over the world started to notice the great need of information systems in the business field. It started to be hard not to pay attention to significance of benefits and possibility to increase business performance through such an investment. The reason is that it was noticed that IS that can help business to save money

also increase the competitive advantage and to improve performance, thus creating more profits.

Increasing business performance through implementation of some information technologies solutions is very common process nowadays. Business performance increase could be expressed as the intermediate step between the information technology and the business strategy. The structure of business performance that lies in between business strategy and information technology in information system is shown in the Figure 1.

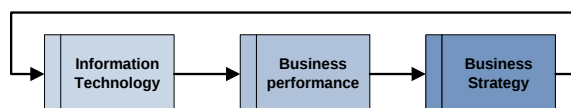


Fig. 1. Business performance position (created by the authors)

The figure could be understood that on the way of reaching business strategic goals through information technology, business performance can be increased. Or in other words saying, information technologies in business could result in impact on business performance, which could help to achieve company's strategic goals.

Research by Sward (2006) supports, that performance is the result of some benefits brought for the business units and the whole organization by the information technology solutions or services related to it, expressed in different parameters. All the improvements in IT or information systems, could result in lower cost of business processes and increase efficiency of activities performed by the workers. These solutions mentioned above improve the monitoring and coordination inside of organization (Hendershott 2006). So we could state that the overall impact on business performance could be defined by analysis of benefits, both tangible and intangible, that were received after implementation of information system. This is the common economic challenge for all kind of investments, not especially in IT, but in other resources (Paliulis & Uturytė-Vrubliauskienė 2012). It is an issue because it's not that simple to evaluate effects of investment on the way how the business performs its activities. Research by Silvius (2006) states that those effects should firstly be understood and after that financially calculated.

Investment in design and implementation of information systems, according to Merkurjev & Tambovcevs (2009), might be very important strategy

for the company. This could help to achieve competitive advantage and improve quality of service provided and increase performance in relation to the company's strategy.

In order to better understand the influence of information systems on the business performance the definition, components and types of Information systems should be set first.

Types of information systems

Information systems could be defined as a set of components that help to collect process and share the information and data in with the help of software, hardware, core ware and organ ware. According to Nikjoo *et al.* (2011), these kinds of systems are the fundamental principles for economic development of any size of business, both small and large.

Awais *et al.* (2012) provides few other definitions of information systems, by defining information systems as a combination of information technology and human resources, whose actions using these technologies help to perform some actions to support business processes. These could also be named as application landscape. Term Information systems could also be used to describe interaction between users, algorithmic processes, information and technology. Also information system could be understood as semi-formal language that enables better decision making process and supports other actions. Information system's main function is to process (collect, transfer, store, process, and share) information.

There might be a lot of different terms for information systems as these might be reviewed from different points of view but they all refer to the systems, that are commonly grouped into five categories, that are shown in the Figure 2 (Molla & Heeks 2003; Nowduri 2010; Awais *et al.* 2012; Reddy *et al.* 2009; Chichernea 2009):

- Office Information System (OIS)
- Transaction Processing System (TPS)
- Management Information System (MIS)
- Decision Support System (DSS)
- Executive Support System (ES)

These groups of systems are interrelated among each other in the data and information flow. The arrows show the information transfer that goes from one system to other shows what is being analysed in

each of the category. Executive support systems get the information from the management information system and decision support system. Management information system is using data from the office information system, transaction processing system and decision support system. Decision support system uses data from the management information system, transaction processing system and office information system. Office information system is supported by the management information system. Transaction processing system is the only system in the following network that serves as an information “provider”, and not the “consumer”.

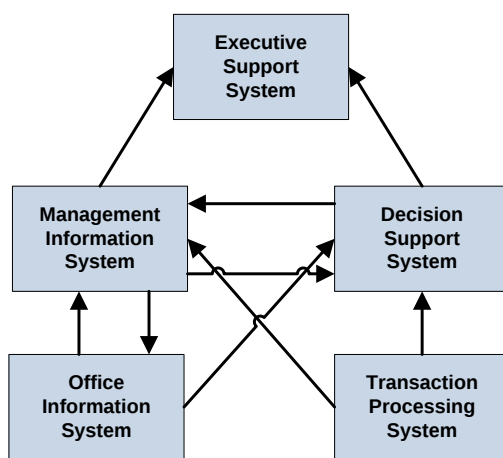


Fig. 2. Classification of information systems (source: Awais *et al.* 2012)

There are different descriptions provided in various scientific sources on purpose of systems provided above, how do they work and what are the main areas covered by each of them. In order to get a better understanding on the information systems, how they influence improvement of business performance, the most relevant explanations of every system is provided.

Office Information System (OIS) is an information system that enhances business processes and makes communication between users easier through use of hardware, software and networks. Using the computers and other electronic devices, employees perform most of the task automatically instead of manual work (Awais *et al.* 2012). Study of Molla & Heeks (2003) stated, that Transaction Processing System (TPS) is an information system that collect, store and process information that is collected over the day by the company from the everyday transactions. These systems help to answer the routine questions of the business. Reddy *et al.* (2009)

explained that Management Information System (MIS) is an information system that is concerned with the collection, processing, storing and transferring important information to help managers to perform activities in any enterprise. Management information system provides relevant and timely information that is used in the decision making process and help the managers to plan operations and control them to be performed in the most efficient way. Research by Nowduri (2010) illustrated, that Decision Support System (DSS) is an information system that helps to analyse the helpful for business information and present it in a suitable for decision making way for the users of this system. This helps to make decisions in a more efficiently way. Chichemea (2009) claimed that Executive Support System (ESS) is an information system that is mostly used as reporting software where you can transform company's data and information into summarized reports. These reports are mainly used by executive level managers, that can be used for long term planning and scheduling.

As every of these systems are covering specific business areas and supports only specific business processes it is wise to have them integrated and connected among each other so that one information system would be able to meet business needs for processes to be made in an electronical way. For these purposes enterprise resource planning systems, as an example of integrated information system, covering various application level is presented and analysed further in this article.

Enterprise Resource Planning (ERP) system

According to Framinan (2008), enterprise resource planning systems are held to be one of the best business information technology solutions in the last few decades for most of the large (and lots of medium and small-sized companies) businesses that have implemented enterprise resource planning systems.

ERP systems were also analysed by Chung & Skibniewski (2007), where it was stated that these kinds of systems are created to process the information, enterprise transactions and foster integrated production, planning and customer feedback. Enterprise resource planning designed to combine all systems of different departments of the

company to one system, to one integrated programme that runs one database in such a way that different departments and business units can freely share information with other users and communicate more. Optimization of information and materials flow in organization among different parts of business could be reached only if the system is integrated. That is considered to be the most important in enterprise resource planning system (Nikjoo *et al.* 2011).

Merkuryev & Tambovcevs (2009) have analysed, that enterprise resource planning systems are fully integrated and cover all the activities in the company. It might consist of several modules, such as finance and accounting, human resources management, quality management, sales and distribution, production management, purchasing management, marketing, planning and material management modules. Different modules and the structure of ERP system are presented in the Figure 3. Next to the traditional modules that were mentioned, extensions like supply chain management, business data warehouse and customer relationship management (CRM), could be installed.

Usually, enterprise resource planning system consists of four levels: network level, resource level, application level and decision level. The whole scheme of enterprise resource planning system's structure is presented in the Figure 3 (Merkuryev & Tambovcevs 2009).

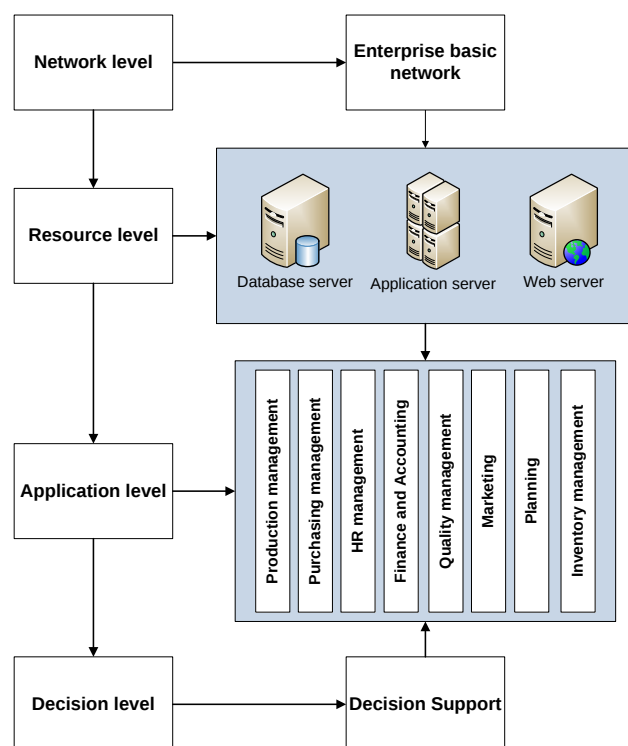


Fig. 3. Four level ERP system structure (source: Merkuryev & Tambovcevs 2009)

In order to have a better understanding of the ERP system, the description of the four levels of enterprise resource planning systems are presented.

Network level: this level is responsible for smooth flow of internal and external information in the company. Infrastructure of the system is based on this level.

Resources level: this level stores all the software, hardware and data required for ERP. Database servers, application servers and web servers are stored here.

Application level: subsystems that are used by users from different business units for the performance of different tasks are held here. Managers by using these subsystems fill enterprise resource planning system with information or obtain information required.

Decision support level: resources, such as data, information are processed for decision making on this level. Models and methods for decision making also are employed here.

The main goal of an enterprise resource planning system is to combine in one integrated system as much functions and

capabilities as possible, that would work using one database, so that all the business units could easily get the required information and communicate between each other. This method can cause a huge payback if the information system is implemented successfully (Davidavičienė & Raudeliūnienė 2010; Merkuryev & Tambovcevs 2009). If implemented right, system will also combine all the part of organization in an integrated system and give Access for the clear and common data (Yahaya *et al.* 2004).

ERP system improves productivity by creating transaction structure in the enterprise that integrates main functions of different business groups within enterprise resource planning system platform (Merkuryev & Tambovcevs 2009). Business managers can make decisions based on information retrieved from the information system. Ordinary workers can gain access to information, thus increasing delegation of authority for more efficient interaction with customers and production decisions (O'Leary 2000).

The research made by Merkuryev & Tambovcevs (2009) showed, that by implementing these systems, companies can achieve competitive advantage. Over the last few years, big amount of companies have invested money in ERP systems and this number is increasing constantly.

Business performance through ERP implementation

There are no doubts already that the ERP implementation fosters productivity and efficiency increase. By providing different benefits, that could be easily visible and evaluated or could be just assumed performance increase could be reached (Bingi *et al.* 1999; Cronin *et al.* 1994; Koushik & Pete 2000). For example research, that an ERP system brings numerous competitive advantages to enterprises, including the reduction of business cost, quick response to customers, and the acceleration of corporate connections, among others has been made by Cronin *et al.* (1994)

and Koushik & Pete (2000). Bingi *et al.* (1999) in their paper stated that it helps simplify work processes, hasten corporate responses, increase validity and timeliness of data, and reduce secretarial work processes. While the Dykeman (1997) said, that it can also improve output sales value and lower inventory turnover rate.

When the value chain of the Internet is applied to marketing and product-related research, an ERP system may effectively increase an enterprise's market share, reduce marginal cost, and boost customer satisfaction (Cronin *et al.* 1994).

Tsaia *et al.* (2011) have managed to classify all the benefits into two categories so that all effects contribute to the performance of a business. The scheme of business performance could be expressed as the Figure 4.

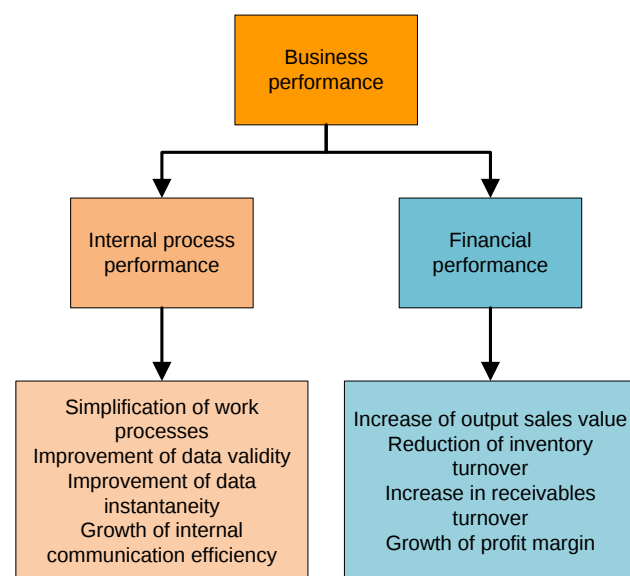


Fig. 4. Business performance groups (source: Tsaia *et al.* 2011)

The figure expresses that there are mainly two indicators that might show how the business performance was changed after implementation of information system. They are internal process performance and financial performance improvements. Tsaia *et al.* (2011) in their work explained the meaning of these two categories. In essence, internal process performance refers to the simplification of work processes,

improvement of data validity and instantaneity, and the growth of internal communication efficiency. Financial performance refers to the increase of output sales value, reduction of inventory turnover, increase of receivables turnover, and growth of profit margin.

The potential benefits that might be obtained after implementation of ERP are huge and may vary from improved information management to reduced operational and other costs. (Davenport 2000). Actually, all those benefits do not happen immediately or just with the purchase or instalment of information system. Soh & Markus (1995) stated that the benefits might arise only the whole organization start using IT assets that were bought or created in the effective way. This shows that this is a long process which requires a lot of resources, such as financial, people, time.

Information systems through better information management can help persons or groups of persons in the enterprise, or even among customers or suppliers, perform their duties in more efficient manner, that would lead to the emerge of benefits (Davenport *et al.* 2000; Marchand *et al.* 2000). It is also was noticed by Peppard *et al.* (2007), that only managers of the company and users that will be using the system both directly or indirectly, could release benefits. In order to justify the money spent on implementation of IS, benefits should be identified and that is sometimes can be hard to do because of several of reasons (Chand *et al.* 2005). Some of the researches managed to identify different groups, according to which, benefits could be defined in an easier way, thus helping managers to identify the value of this decision for the company (Shang & Seddon 2000; Gattiker & Goodhue 2002; Nafeeseh & Al-Mudimigh 2011; Murphy & Simon 2001).

Research that was made by Shang & Seddon (2000) has found that the benefits of IS can be grouped into five categories: operational, managerial, strategic, IT infrastructure and organisational benefits.

It may take some time in order to fully observe all the benefits brought by the implementation of the system, thus analysis of them have to be done during the implementation and post-implementation periods (Kim 2009).

Business performance could be increased only after when it will be defined in details. The task is to express benefits of information systems in terms that would be easily understood by the managers of the company (Gammelgård *et al.* 2006). These researches emphasize the importance of managerial staff in the success of IS implementation process and further use.

Another proposition was to group ERP benefits into four categories: those, that improve information flow between business units, thus improving communication and coordination among the employees, that enable centralized administrative activities, that reduce maintenance costs of information systems and creates new possibilities to deploy new functionality of systems and those, that provide tools for business to move from inefficient business processes and move towards best of practice processes (Gattiker & Goodhue 2002).

But usually, benefits are categorised into two groups: tangible benefits and intangible benefits. Tangible benefits are those that could be quantitatively measured (Nafeeseh & Al-Mudimigh 2011). In this article tangible and intangible benefits that influence business performance will be analysed so that the inicial factors that make changes would be analysed.

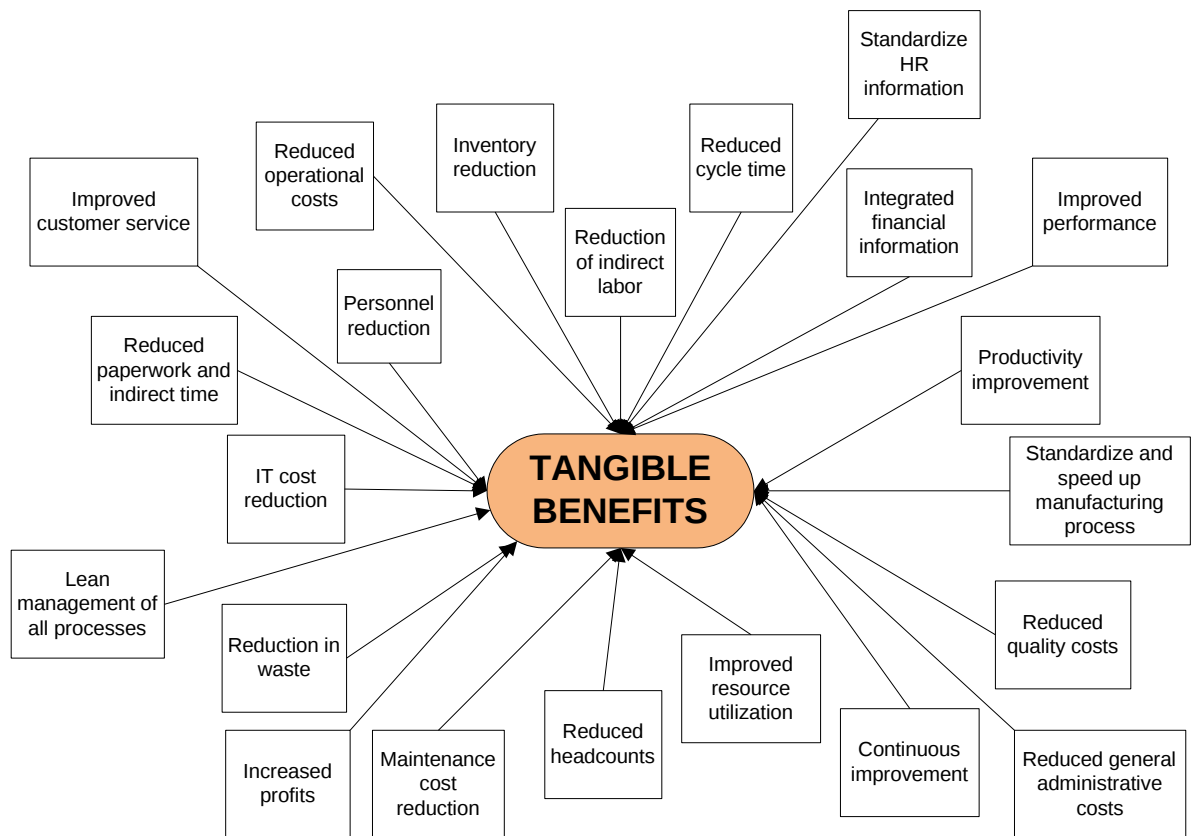


Fig. 6. Tangible benefits of an ERP system. (source: Dustin 2010; Jutras 2009; Murphy & Simon 2001)

The business enterprises that are planning to invest money in ERP information systems could expect to have such tangible benefits that are shown in Figure 5. They are: inventory reduction, reduction in indirect labour, reduced cycle time, standardize HR information, integrated financial information, improved performance, improved

productivity, standardized and faster manufacturing process, reduced quality costs, reduced general administrative costs, continuous improvement possibility, improved resource utilization, reduced headcounts, reduced maintenance costs, increased profits, reduced waste, IT cost reduction, lean management possibility of all

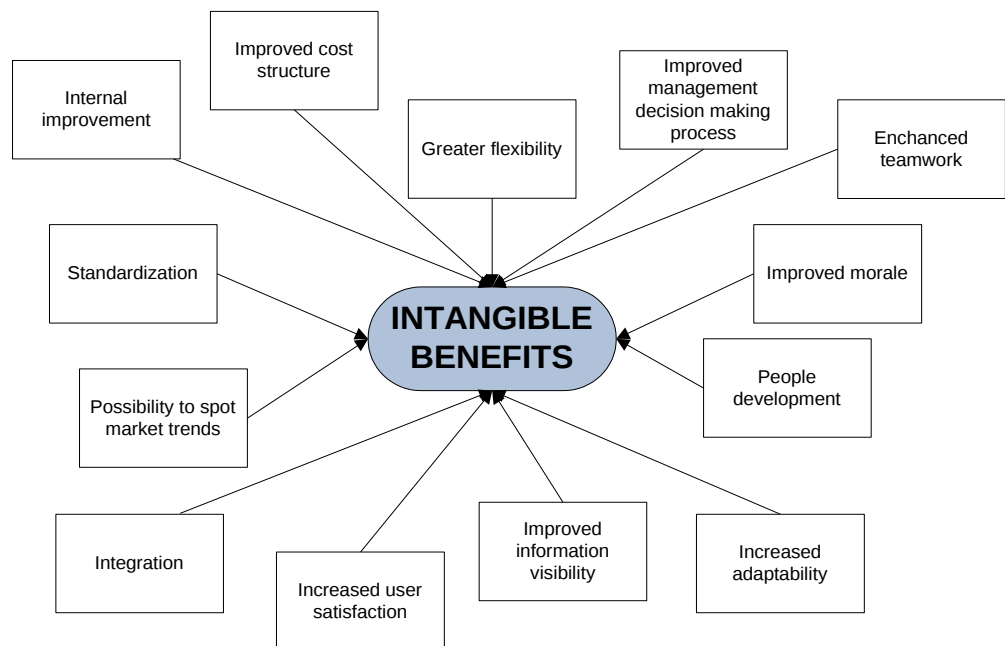


Fig. 5. Intangible benefits of an ERP system (Dustin 2010; Hares & Royle 1994; Murphy & Simon 2002)

processes, reduced paperwork and indirect time, personnel reduction, improved customer service, reduced operational costs.

Intangible benefits caused by IT investments are usually grouped into two categories: internal improvements and the benefits related to the customers of the company (Hares & Royle 1994).

Murphy & Simon (2001) have offered to define intangible benefits as the opposite to the tangible benefits in terms of ease of measure and could not be quantitatively evaluated in the same way. In other words saying, these are the benefits that could not be reformed into quantitative value or to a business value.

Intangible benefits could also be the outcome of successful implementation of ERP system and are shown in Figure 6. These could be following: greater flexibility, improved management decision making process, enhanced teamwork, improved morale, people development, greater adaptability, improved information visibility, increased user satisfaction, integration, possibility to spot market trends, standardization, internal improvement, improved cost structure.

Conclusions

Based on all of the analysis of theoretical aspects of influence of information systems on the business performance that has been made, the following conclusions were made:

- Increasing need in information in today's world requires development of information systems. Every enterprise should follow the latest information technology solutions for business management that appear in the market that would improve the way how an enterprise is being managed, improve productivity, thus increasing competitive advantage. One of the information technology solutions that improve efficiency of the company is information systems.
- Information systems play crucial role in today's business life. It helps to improve

their goals, targets and strategies. Nowadays more and more companies invest money into information systems in order to improve business performance. Investment in information systems helps business to transform business processes and activities so that higher efficiency could be achieved. Production process, customer service, finance and accounting, information processing and other could be improved through implementation of information systems.

- Information systems can help to identify and resolve company's existing problems and weaknesses. It can bring a lot of direct and indirect benefits for the company, thus increasing its financial stability. Both tangible and intangible benefits might in one way or another influence the business performance after implementation of enterprise resource planning systems. Identification of such benefits is hard enough, because still not so much researches were made on the distinction of these factors, so the identification should be made before the impact could be fully evaluated.

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INFORMACINIŲ SISTEMŲ ĮTAKA ĮMONĖS VEIKLOS REZULTATAMS

Dmitrij Lipaj, Vida Davidavičienė

Santrauka.

Atsižvelgdamos į šiais laikais padidėjusią konkurenciją, įmonės siekia įgyti konkurencinį pranašumą, padidinti ekonominius rodiklius, pagerinti darbo produktyvumą ir efektyvumą, sumažinti išlaidas ir gauti kitokią naudą, diegiant

integruotas informacines sistemas (IS). Gerindami vidinių procesų efektyvumą ir finansinius rodiklius, bendras įmonės efektyvumas gali būti pasiektas diegiant tokias sistemas. Siekiant apibrėžti informacinių sistemų diegimo įtakos verslo veiklos efektyvumo aspektus, buvo atlikta mokslinės literatūros analizė, sintezė ir apibendrinimas.

Reikšminiai žodžiai: įmonės veiklos rezultatai, įmonės išteklių planavimo sistema, informacinė sistema, verslo nauda, ERP.