ERP SELECTION CRITERIA: THEORETICAL AND PRACTICAL VIEWS

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Abstract. *This article deals with the problems of Enterprise Resource Planning (ERP) system selection as the initial and vital phase of ERP system implementation.*

Firstly, the paper presents an analysis of different classifications of the fundamental criteria for the ERP system selection process, published in scholar sources, and defines two main groups – software-related, and implementation-related ERP selection criteria. Secondly, combining theoretical and practical approaches, the most significant ERP system selection criteria of both groups are identified and reviewed by analyzing and interpreting their definitions and differences. The study is complemented by adding practical/statistical findings produced by different consultancies.

The paper concludes that there is no standard classification of ERP selection criteria. They are classified mostly on the basis of scientists' research interests.

The significance of ERP system functionality as the principal software-related ERP selection criterion is emphasized. Eleven other criteria were defined as important to consider, such as the total costs of the ERP implementation project, vendor reputation, ERP reliability, ease of integration with other systems, technology advance, scalability, upgrading ability, customization / parameterization possibilities; ease of use; flexibility and modularity.

The importance of all-round knowledge for a successful ERP implementation is emphasized, including ERP software functionality, project and change management, business processes, organization of training etc. All these areas are closely connected with implementation-related ERP selection factors: organisational fit, end-user readiness, training, system support quality, and the overall ERP implementation success which is predefined by the complexity of business environment as well as the level of business transformation, defined by technological changes.

Finally, it is stated that for creating a decision support system which would automate the ERP selection process, the quantitative analysis of ERP selection criteria would be required.

Key words: *ERP, ERP implementation, ERP selection, ERP selection criteria, classification of ERP selection criteria*

Introduction

ERP is most often defined as business software which automates the main business processes of an organization, such as manufacturing, logistics, finances, marketing, human resources, etc. For a long time being related to the biggest companies of private and public sectors, now ERP software is suitable for midsize or even small companies.

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ERP implementation is a very complex body of work, which includes several closely related processes (selection, analysis, customization, support) and demands both IT and business knowledge. The problematic of ERP selection as the first ERP system implementation phase could be justified by the large number of research articles on this subject. The majority of them associate ERP implementation failure with an inappropriate choice of business software (Aloini, Dulmin, Mininno, 2007), the decision that encompasses two important subdecisions: the selection of ERP system and the selection of implementation partner.

In the broadest sense, successful ERP implementation is understood as ERP implementation on time and within budget, attaining the majority of functional goals. General research has revealed different rates of success for ERP implementation projects. As much as 50–70% of such projects performed in the USA manufacturing companies, could be considered a partial or complete failure (Davenport, 1998). According to Langenwalter (2000), ERP implementation projects fail in 40–60% of cases. Assessing a ROI of ERP software, the rate of unsuccessful implementations becomes even higher – 60–90% (Ptak, Schragenheim, 2000). The well-known practical research by the Standish group (2009) has resulted in a similar conclusion – 44% of IT implementation projects were completed later than planned or exceeded their budgets. Moreover, in 24% of cases projects were abandoned before completion or the system was not launched at all.

The aim of this study was to define a set of principal criteria for ERP selection. This aim requires analyzing and summarizing the literature on ERP selection, adding practical findings, pointing out and describing the most often cited ERP selection criteria, reviewing classifications and differences among them. The theoretical approach to ERP selection is combined with ERP practical recommendations in order to determine the dominant set of criteria that would provide maximum support for ERP implementation. While preparing this paper, the literature on ERP selection and implementation was complemented by information available in practical articles and surveys. As this topic is rarely discussed in Lithuania, the information used in this study is based mainly on foreign sources.

Classification of ERP selection criteria

In the literature, there is no unique classification of ERP selection criteria Kumar, Kumar and Maheshwari (2002), referring to a practical survey of 20 enterprises in Canada, distinguished four groups of ERP selection criteria. The first group consists of **ERP software-related criteria** (functionality of the system, system reliability, fit with parent/allied organization systems, cross-modular integration, best business practices available in the system). All these criteria were mentioned in more than 50% of cases. The second group includes criteria **related to the implementation project manager** (project management skills, functional experience, experience in IT management). The third

group consists of criteria **related to the implementation partner,** and the last one is associated with **implementation consultants'** criteria (reputation, experience, etc.).

According to Ayağ and Özdemi (2007), ERP selection criteria may be classified in three dimensions. First, **three determinants** are defined with regard to their influence on the company's performance indicators: **competitive advantage, productivity, profitability**. After that, **7 dimensions and 22 criteria** are described. All criteria of one dimension are connected and influence each other either positively or negatively. Competitive advantage is related directly to system costs (licence fee, consultant expenses, maintenance cost, infrastructure cost). Productivity directly correlates with the system support efficiency. Profitability influences more than half (13 out of 22) of the criteria research paper (upgrade possibility, ease of integration, ease of in-house development, functionality, module completion, function fitness, security level, reliability, stability, possibility of recovery, ease of use, ease of operations, ease of learning, technology advance, standardization, integration of legacy systems, easy to maintain).

Bueno and Salmeron (2008) have modeled a practical ERP selection tool and defined the largest set – twenty seven – of ERP selection criteria. Of them 17 are **related to ERP software** and the other 10 **to the organization** where implementation is performed. The further identification of relations among the criteria divided them into another six subgroups. Four of them involve criteria related to ERP software, whereas the last two are related to the organization. ERP selection criteria subgroups related to ERP software features may be sorted in the order of diminishing importance: ERP system reliability and the spectrum of offered services; implementation efficiency; project costs; ERP vendor prestige. In the organizational factors group, the subgroup of organization flexibility strongly outweighs another one – ERP similarity to current IS/IT.

Verville and Halingten (2003), also Wei, Chien and Wang (2005) have highlighted the **importance of choosing a suitable ERP vendor**. Wei draws a clear boundary between ERP selection factors related to the ERP system itself and factors related to the ERP vendor. In the **ERP software selection** process, he suggests to take into account six groups of criteria related to increase in the ERP project efficiency, which are minimized total cost, minimized implementation time, complete functionality, user-friendly interface and operations, excellent system flexibility, high system reliability; also, the vendor reputation, technical capabilities and provision of ongoing services need to be considered in ERP vendor selection process.

From the arguments presented above, it is evident that the diversity of ERP selection factors complicates their classification into standard groups. Most often, system selection criteria are defined regarding the researchers' area of interests and are divided into two, three or four groups. Taking into consideration the nature of criteria in this research, we have split the **ERP selection criteria** into **two groups**: the first group consists of **ERP software-related** criteria and the comprises other one – of **ERP implementation-related** criteria.

Software-related ERP selection criteria

Summarizing research papers about ERP selection, 12 most important software-related ERP selection criteria were identified: ERP functionality, total costs of ERP implementation project, vendor reputation, ERP reliability, ease of integration with other systems, technology advance, scalability, upgrade ability, customization/ parameterization possibilities, ease of use, flexibility and modularity. All of them are discussed in this section.

ERP functionality is one of the most important software-related ERP selection criteria. It could be evaluated taking into account the standard functional power and its suitability to company needs. This factor was mentioned in the research papers of Keil and Tiwana (2006), Kumar, Kumar and Maheshwari (2002, 2003), Liao, Li and Lu (2007), Wei, Chien and Wang (2005), Siriginidi (2000), Chen (2001), Everdingen et al. (2000) and others.

In Kumar's (2003) survey of Canadian companies, functionality has been the most often quoted and the most important ERP selection factor to consider, mentioned in 79% of the cases. Heck (1997) presents a similar opinion, affirming that this criterion has to comprise up to one / third of the final score used for making ERP selection decision. Anderson and Chen (1997) treat ERP functionality as the main ERP selection criterion.

This opinion can be supported by practical findings of the Aberdeen consultancy. In the research performed in the years 2006 and 2007, respectively 1245 and 1680 companies of different size, industries and geographical regions have participated. As a consequence, three most often cited ERP selection factors were defined (Fig. 1). Functionality has been named as the most important criterion (in 69% and 75% of cases, respectively). In 53% of cases, the system price has been mentioned. Ease of use was the third most popular factor, cited in 42% and 51% of cases, respectively.

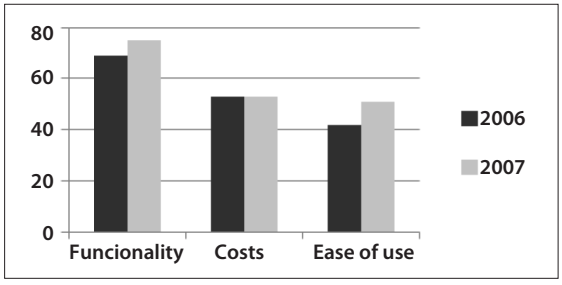

FIG. 1. **The most popular ERP selection criteria (Aberdeen Group, 2006, 2007)**

The surveys performed in the years 2008 and 2009 have evaluated the importance of ERP selection factors on a 5-point scale (5 being the most significant and 1 the least significant). The accumulated results (Fig. 2) have shown the same three most important ERP selection factors as in 2006 and 2007 surveys. Functionality has remained the importance leader with 4.8 points out of 5.

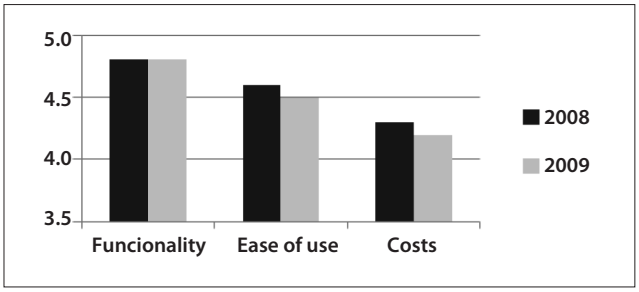

FIG. 2**. The importance of ERP selection criteria (Aberdeen Group, 2008, 2009)**

According to Ayağ and Özdemir (2007), ERP functionality directly affects the company's productivity level and can be assessed considering the complexity of the modules, the suitability of the functions, and the security level of the system. Han (2004) has analyzed ERP functionality as a unique and the main significant ERP selection criterion, separating three levels of system functionality. The first one includes the basic system functionality, the second one – the desirable functionality which could help optimize business processes and lead to an increase in work efficiency, and the third level provides an additional ERP functionality which extends the limits of collected and processed information (for example, ensuring real time communication between customers and suppliers). Such a classification of ERP functionality helps to reduce the number of suitable ERP systems. Keil and Tiwana (2006) are of a similar opinion, defining functionality as a criterion which assesses ERP functional correspondence to the company's requirements. Wei, Chien and Wand (2005) define ERP functionality as a fit between organization and system, including system security and modular complexity.

ERP functionality could be used as a reference point to prioritize the performed functions as one of the principal ERP selection strategies. In accordance with it, attention should be focused on the functional areas that are closest to generating profit, e.g., the supply chain, inventory, or client relationships management. This functionality must work properly and efficiently with an option to extend the system's functional capacity.

Total costs of ERP implementation project. This is the ERP selection criterion which is also mentioned quite often. It has been pointed out by Ayağ and Özdemir (2007), Bueno and Salmeron (2008), Fisher, Fisher and Kiang (2004), Keil and Tiwana (2006), Lall and Teyarachakul (2006), Rao (2000), Umble, Haft and Umble (2003), Wei, Chien and Wang (2005), Yang, Wu and Tsai (2007), Mabert, Soni and Venkatraman (2000), Bernroide, Koch (2001) and others. Most of researchers include un upgraded technical infrastructure, software licenses, ERP implementation and support, and user training into ERP implementation costs. According to Ayağ and Özdemir, system cost or price is a dimension which determines a company's competitive advantage and is calculated as the total amount of expenses related to ERP implementation.

Summarizing different definitions, ERP costs include all ERP implementation and usage costs (both direct and indirect) during the total lifetime of the system. Direct expenses involve hardware, software and implementation costs. Indirect, or hidden, expenses are related to productivity drop during the ERP implementation period when activity outage or stoppage occur. To assign this kind of expenses to the project is much more complicated than to assign direct costs, but in the majority of cases this amount is significant and needs to be given at least an approximate estimate.

ERP practitioners give much attention to an inadequate analysis of ERP implementation cost areas. Most extensively these costs have been analyzed by Leon (2007) who identified eight such areas. These areas could be divided into two groups. The first group includes insufficiently identified costs related to an incorrect calculation of the direct amount of project work: customization, interaction and testing, data conversion, data analysis. The second group is related to interruption possibilities and work efficiency fluctuations of internal staff members during the ERP implementation project: trainings, brain drain (employee turnover), and ongoing maintenance.

Vendor reputation. This criterion has been cited in the research papers of Kumar, Kumar and Maheshwari (2002, 2003), Lall and Teyarachakul (2006), Liao, Li and Lu (2007), Siriginidi (2000), Chen (2001), Bernroide and Koch (2001), Everdingen (2000) and others. After an ERP acquisition, the need of a long-lasting partnership between the organization and the ERP vendor emerges. Therefore, a company with a new ERP system hopes to have a solid and credible ERP vendor and its ecosystem.

This selection factor is of rather social than technical nature and could be evaluated considering the image of the ERP vendor, its financial stability, situation in the market (market share, respectability) as well as a combination of practical achievements (Verveille and Hallingten, 2002) which could be assessed by the number of successful ERP sales, specific industry knowledge, income changes, the technological maturity of offered production or its development. Wei, Chien and Wang (2005) consider that ERP vendor reputation mainly depends on its market share and general financial situation. Meanwhile, Keil and Tiwana (2006) treat this factor as an additional but unconditional ERP vendor production feature, which doesn't have a technical equivalent.

According to the authors, the most sophisticated definition of ERP vendor reputation has been introduced by Verveille and Hallinten (2003), which covers not only the above-mentioned financial stability and market share factors, but also some other criteria, such as an increase of annual turnover, a range of proposed production, its recognition, technological and strategically vision, longevity and experience performing implementation projects to the same size and industry companies, recommendations, possibilities to assure a high service quality independently of client needs and possible changes.

Researchers treat the importance of ERP vendor reputation differently. This factor is defined as one of the four (Chau, 1995) or six (Brown and Stephenson, 1981) most

important non-technical ERP selection criteria. Goldenberg et al. (Goldenberg, 1991, Pivnicny and Carmody, 1994) treat vendor reputation as the only factor that requires considerations. However, all of them hold the opinion that a long-lasting perspective of ERP vendor existence is the prerequisite ensuring and developing the actual ERP functionality from the perspective of new business trends. Bernroider and Koch (2001) have indicated that this factor is more significant for large than for small or mid-size companies.

ERP reliability. This criterion has been mentioned by Ayağ and Özdemir (2007), Bueno and Salmeron (2008), Kumar, V., Kumar, U. and Maheshwari (2002, 2003), Wei (2005), Siriginidi (2000), Everdingen (2000), and others. Wei, Chien and Wang (2005) relate ERP reliability to system stability characteristics as well as to the time of work continuity restoration after technical incidents. Keil and Tiwana (2006) define this criterion as the general ERP feature that supports its proper and stable work.

Each interruption of working process incurs financial and client losses, or even damages the company's reputation. Therefore, IT practitioners consider ERP reliability as one of the most important ERP evaluation and selection factors. The term 24/7 refers to a system's operation availability at all times without interruption. According to Kumar (2003) research findings, ERP reliability is the second most important selection criterion, right after ERP functionality. Shikarpur (1997) and Brewer (2000) also indirectly agree with this statement, highlighting its importance.

Contrary to ERP functionality, ERP reliability is a universal criterion that doesn't depend on the industry where a company does business. Being rather a qualitative factor, it could be expressed quantitatively as well, e.g., considering specific features of the company or identifying critical activity areas and the effect of its divergence from the standards.

Ease of integration with other systems. An implemented ERP system is almost always becoming the core system for information collection and processing, so it needs to integrate data from each organizational level and functional area: manufacturing, distribution, sales, etc. Company size also influences the scope of integration activities. Larger companies use more complex business processes and a more sophisticated software. Today, the functionality of universal and modern ERP systems includes almost all standardized business processes. Therefore, in some cases, the activity area of a company (e.g., public institutions) or specific legal of the country acts (e.g., the case of salary calculations) are unique, so the implementation project is related to integration between ERP and other systems. Consequently, to evaluate ERP software suitability, one has to consider its integration possibilities with software already in use. This kind of opinion is held by Bueno and Salmeron (2008), Fisher and Kiang (2004), Kumar, Maheshwari and Kumar (2002, 2003), Verville and Halingten (2003), Sprott (2000), Everdingen (2000).

Frequently, different manufacturers of ERP software are developing common integrated solutions helping to integrate different systems quickly and cost-efficiently. This kind of partnership is supported by scientists who consider systems' integration as one of the three most problematic areas of ERP implementation (Themistocleous, Irani, O'Keefe and Paul, 2001), strongly related to the success of the whole project (Bingi, Sharma, Godla, 1999).

Most ERP packages are very complex systems, so interfacing with these systems is not an easy task. Most companies will have some system that will not fit into the functionality of ERP packages and which will have to be interfaced with the ERP package. Testing the links between ERP packages and other corporate software links that have to be built on a case-by-case basis is another time-and cost-consuming project task (Leon, 2007).

Advanced technology. It is an important but not crucial ERP selection criterion, useful for the initial reduction of the list of potential ERP systems. This factor is described in detail by Kumar, Maheshwari and Kumar (2002, 2003), Rao (2000). When selecting ERP by this criterion, the ERP technological architecture, its structure, database, programming platform administration possibilities, workflows, document management and report generation tools are evaluated. Ayağ and Özdemir (2007) define this factor as the sum of system standardization, integration with other systems already in use, as well as the ease of its support. Implementation and administration of additional functionality mostly requires special skills related to a specific system support, because the biggest ERP vendors (SAP, Oracle, Microsoft) create solutions using their own platforms – technological linkages between hardware and software (e.g. NetWeaver, C/SIDE). Independent ERP consultants should be rather impartial while assessing their technology level, because ERP vendors or implementation specialists tend to favour their own production features.

Scalability. This criterion is mentioned in research papers of Fisher, Fisher and Kiang (2004), Han (2004), Verville and Halingten (2003), Everdingen (2000). The factor assesses a feature of selected ERP that helps to enlarge functionality already in use, without losses in information processing efficiency.

Evaluating an ERP system by this factor, the expected ERP exploitation period and the use of actual functionality have to be considered to define at least the approximate date for ERP changes.

The easiest way to tentatively define the scalability of a selected ERP is to assess the difference in the number of users in the largest and smallest companies using the same ERP system. The larger it is, the better software functional possibilities are in terms of scalability. Also, it is important to mention that, in this kind of analysis, only companies with the same ERP system, using a standard ERP functionality, could be compared. Only under this condition the system scalability evaluation would be accurate and informative

enough, or the potential ERP system buyer would get a logically reasonable answer about system potential to match company's needs today and in the near future.

Upgrade ability. This indicator characterizes the option provided by the ERP vendor to upgrade the current ERP to a newer version. The criterion is described by Kumar, Maheshwari and Kumar (2002, 2003), Rao (2000), Sprott (2000), Bueno and Salmeron (2008). When considering the possible upgrades of the current ERP system, several issues are important: how easy is the transition to the newest version and what kind of modifications the systems vendors are planning to launch during the next 3–5 years (Hecht, 1997). The definition of upgrade is very often confused with system's update which includes only correction of mistakes in the actual ERP version. In case of system upgrade, a completely new version of business software with new functional possibilities is rolled out.

The cost of ERP upgrades is high (Montgomery, 2004). System upgrade is one of the main jobs of post-implementation and a system support phase (Nah, Faja, Cata, 2001). It helps to extend the duration of the system use as a long-term investment. Since the business environment is constantly changing, some necessary upgrades need to be done during the whole ERP life cycle to ensure the same ERP value for their company. The ERP market leaders constantly upgrade their production quality characteristics with new versions.

According to an AMR consultancy study (Swanton 2004), 55% of upgrades have been voluntary business improvements triggered by the need for a new functionality, expansion or consolidation of systems, 24% of upgrades were initiated by technology changes, 15% of upgrades were induced by the discontinued support of the current version of the software to avoid vendor support termination, and 6% of upgrades were caused by bug fixes or statutory changes.

ERP upgrade should be evaluated as a normal ERP implementation of a smaller scope. Therefore, in order to successfully manage the whole upgrade process, appropriate implementation and planning methodologies should be used to define work size, executed tasks and delegated resources, changes in the organizational structure. The ERP upgrade process incurs costs which are approximately at 25–33% of the initial investment (Carlino et al., 2000). Swanton (2004) has also mentioned that the cost of each upgrade includes 50% of the original software license fee and 20% of the original implementation cost per user.

Customization/parameterization possibilities could be defined as a feature that helps to adjust ERP software to specific organization needs (Keil and Tiwana, 2006). The factor was also mentioned by Berchet and Habchi (2005), Kumar, V., Kumar, U. and Maheshwari (2003), Verville and Halingten (2003), Yang, Wu and Tsai (2007) and others.

Literature review of Mabert et al. (2000) has shown that companies rank this factor as important or as very important. Currently, ERP is becoming a business process

improvement tool (Shikarpur, 1997). Therefore, ERP vendors propose solutions that are parameterized in advance using and classifying the most popular business processes by companies' size or industry. According to Bueno and Salmeron (2008), partly customized solutions significantly decrease the ERP implementation period and system support costs. At the initial phase of ERP implementation, ERP consultants, together with internal company staff, would have to prepare three different lists of functions: the first with the critical, the second with important, and the third with a desirable functionality. If ERP is selected properly, all provided standard functionality have to ensure the fulfillment of at least critical functions. A partial parameterization could be done only within the limits of important or desirable functionality. This type of work is strongly related to end-user satisfaction and to the whole success of ERP implementation because of its support in creating a more attractive IT work environment.

Ease of use. This is an important but very often undervalued ERP selection criterion mentioned by Bueno and Salmeron (2008), Pivnicny and Carmody (1989), Verville and Halingten (2003), Yang, Wu and Tsai (2007), Everdingen (2000). Wei, Chien and Wang (2005) defines it as a measure for the simplicity of training and use. Keil and Tiwana (2006) treat this criterion as a possibility to use software intuitively, without additional specific knowledge. According to Montazemi (1996), ERP has to be simple and easy to understand for the average IT user, because work efficiency with ERP influences the results of the whole organization. Ayağ and Özdemir (2007) also affirm that this factor determines the productivity of organization. Chau (1995) treats the feature of the ease of use as one of the four most important ERP selection criteria of technical nature.

One of the most serious ERP selection mistakes is related to this factor: very often ERP buyers focus on ERP price and its functionality without considering the IT skills of future users. On the one hand, it is recommendable to consider the crucial system functionality aspects and its extension possibilities. On the other hand, the evaluations of user interface with potential ERP users from different company's departments also need a more thorough look. Summarizing the findings of their research, Anderson and Chen (1997) highlight the fact that the importance of the ease of use as one of ERP selection factors increases with the development of ERP functional power. Matthews, while analyzing systems' usability features, emphasizes that a modern information system needs a SOA-based architecture, application service for internal information search, as well as intuitive and understandable web-like navigation for an easy analysis of the sequence and logic of workflows (Matthews, 2008).

Until now, there have been a lot of discussions about the most comfortable user interface logic or menu functions layout. Therefore, the biggest ERP vendors have developed solutions with the possibilities to personalize system screen colours, text sizes, menu structure or report generation display settings. After the top management decision to modernize the company's processes related to information gathering and processing,

the opinion of end users needs to be taken into account. Potential resistance to changes and dissatisfaction of the company's employees about top management decisions could cause the overall failure of the ERP implementation project.

Flexibility. This criterion is widely discussed by ERP theoreticians. According to Ayağ ir Özdemir (2007) and Wei, Chien and Wang (2005), ERP flexibility directly affects a company's profit and could be evaluated by estimating upgrade abilities, simplicity of integration and internal programming work. ERP flexibility as an important factor is recognized by Umble, Haft and Umble (2003), Sprott (2000), Bernroide and Koch (2001), Everdingen (2000). The most sophisticated definition of flexibility is offered by Nelson and Ghods (1998) – the ability to adapt to both incremental and revolutionary changes in the business or business process with minimal time, effort, cost, or performance losses.

ERP is a long-term investment to the business efficiency, so it also needs to be adaptable to the needs of company which changes its organisational structure or size, turnover or work volumes. From another point of view, a too flexible ERP system could reasonably decrease the efficiency of processed information and could provoke an increased use of a nonstandard business process which is difficult to handle. However, ERP vendors are trying to find an optimal system flexibility solution that helps to implement necessary modifications, simultaneously retaining the standard ERP structure.

The evaluation of ERP flexibility by company size has shown that small or middle sized companies tend to give more importance to this factor than the largest ones (Bernroider and Koch, 2001).

Modularity. The factor of ERP modularity is analyzed by Bueno and Salmeron (2008), Kumar, Maheshwari and Kumar (2002, 2003) and others. This feature enables ERP customers from all available functionality to choose modules and functional groups that are necessary for their organization. It helps to decrease significantly ERP implementation time and project costs, paying only for the system features that will be actually used. Before taking a decision which standard and additional modules will be used, an analysis of internal and external business processes should be done (Ziaee, Fathian and Sadjadi, 2006) as well as research of the nature of processed information, user interface, system upgrade abilities and the cost of the project.

As stated above, the usage of standard ERP modules could significantly decrease the system implementation costs. Therefore, in this case, some necessary changes in the areas of work procedures and methods, distribution of tasks, necessary competences or education should be done. On the other hand, the significant functional divergence from the standard functionality could result in a increase of the overall project risk, considering a longer implementation time or a possibly bigger scope of system support, update or upgrade.

Implementation-related ERP selection criteria

Summarizing research papers, five of the most important implementation-related ERP selection criteria were identified: ease and speed of implementation, organizational fit, training quality, end-user readiness, and system support quality. They are discussed in this section.

Ease and speed of implementation. This criterion is cited in the majority of research papers analyzing the ERP selection process. It is mentioned in articles published by Fisher, Fisher and Kiang (2004), Lall and Teyarachakul (2006), Umble, Haft and Umble (2003), Wei, Chie and Wang (2005), Yang, Wu and Tsai (2007), Chen (2001), Everdingen (2000) and others. Bueno and Salmeron (2008) define it referring to the overall implementation efficiency as well as the complexity of system parameters. Keil and Tiwana (2006) suggest to measure this criterion by the time which is needed to prepare and perform ERP implementation. Meanwhile, Verville and Halingten (2003) compare ERP vendors by using this criterion. Their conclusion is that an ERP vendor has to be assessed by the possibility to participate directly in the implementation project, also considering the ERP vendor's and third party partner's accessibility, a work proposal quality, possibility to properly assess organizational needs and to propose the implementation plan and strategy that could maximize the business value. Also, the ease and speed of implementation could be evaluated by the necessary ERP implementation time, the scope of the project, the number of needed consultants and requirements to their qualification.

Because ERP implementation often includes business process reengineering, the business complexity directly affects the project sophistication. For measuring the complexity of a company's business environment, the authors of the above-mentioned research papers propose to consider the following factors: company size, the geographical coverage of business activities (local, regional, national, international), the membership in industrial groups, the presence of branch offices, the level of diversification, and the degree of functional extension.

Business environment-related factors determine the number of implemented modules and functions as well as the complexity of the whole implementation project. The practical research by Bernroider and Koch (2001) has indicated that this factor is more significant for small and mid-size (37%) companies than for large ones (30%).

A project complexity depends also on the degree of the company's transformation planned as consequence of a technological innovation. Venkatraman (1994) classifies five main levels of such a transformation: local automation, internal integration of existing business processes, business process reengineering, business network redesign, redefinition of company's boundaries.

The ease and speed of ERP implementation is influenced not only by the business environment, but also by other factors. With standard configuration ERP, vendors

are trying to meet the requirements of the majority of companies. As a consequence, companies with a specific area of activities (e.g., public companies) need a unique parameterization or a vertical industrial solution.

Organizational fit. This factor is described by Bernroider and Stix (2006), Kumar, Maheshwari and Kumar (2002, 2003), Lall and Teyarachakul (2006), Liao, Li and Lu (2007), Nah and Delgado (2006), Umble, Haft and Umble (2003), Hong and Kim (2002), Goodhue and Thompson, 1995), Kanellis (1999), Everdingen (2000) and others. The criterion is usually defined as a coherent system of ERP and company's technological, organizational, business processes and strategic structure (Fig. 3).

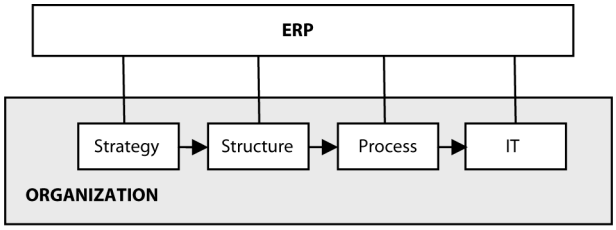

FIG. 3. **The main components of organizational fit**

A theoretical and empirical research on 500 Taiwan companies (Chen, Tsai, Chen, 2009) has shown that ERP implementation success directly correlates with ERP and organizational fit. This conclusion was confirmed by Weill and Olson (1989) in the analysis of scientific essays. In 70% of cases, the statement was accepted that with a good technological, structural and strategically compatibility the results of company activities would be positive.

According to Henderson and Venkatraman (1993), IT investment failures are frequently related to incompatibility between IT and the business strategy. Gattiker and Goodhue (2000) emphasize the fact that the ERP system is a software used for integration business processes in the entire enterprise. When there is a strong relationship between different functional departments of an enterprise, the ERP system will better fit the requirements of the enterprise's general processes. On the other hand, the discrepancy between the processes of each functional department will decrease the compatibility of ERP software and the operational requirements of the enterprise. The research model developed by Hong and Kim (2002) for investigating relations between the organizational fit of the ERP system and the success of ERP implementations disclosed an apparent positive outcome of this kind of dependence for the whole implementation. Generally, according to Kumar (2003), organizational fit as an important ERP selection criterion has been mentioned in 64% of cases.

In practice, this factor is related to the analysis of similarities and differences between business processes of the company and the ERP system. Most often, attention in an ERP

implementation project is focused on business process adaptation (Gattiker, Goodhue, 2000).

There are two different methods to adjust business processes among the organization and the ERP system. The first and, in the opinion of a number of researchers (Hammer and Stanton, 1999, Volkoff, 1999), more attractive method is to adapt the company's business procedures to the processes implemented in ERP. In some cases it is difficult to apply this method because of a great difference between these business process. The second (opposite) business processes adjustment method requires ERP system's modification according to the business processes that are already used in the company. This method is more expensive and requires a sophisticated expertise of business consultants. In general, the importance of business process adaptation could be illustrated by its expenses. According to Al-Mahari (2001), they fall between 30–45% of the total ERP implementation costs.

Training quality. Even during the phase of ERP selection it is useful to take into account the expected ERP training structure, its duration and suitability to the company's personnel. As ERP usually dramatically changes the working methods of acompany staff and their execution processes, according to Fisher, Fisher, Kiang (2004), Verville and Halingten (2003), Yang, Wu and Tsai (2007), Bueno and Salmeron (2008), Everdingen et al. (2000), a successful ERP implementation highly depends on the end-user training efficiency. Therefore, during ERP selection process it is necessary to consider the training structure, duration and suitability for the company employees.

ERP changes the work methods that used to be familiar and understandable for some period of time; therefore, training must be properly organized. Nevertheless, the project implementation team members often reduce the training budget if other project costs are already exceeded. Kimberling (2009), as a ERP practitioner, has suggested six ERP implementation training recommendations: to focus on business processes, not system transactions; to relate new business processes to the existing environment; to leverage a multitude of tools for ERP training; to train the trainer; to allocate plenty of time for ERP implementation training; to reinforce training with more comprehensive organizational change management activities.

It is difficult to produce a quantitative evaluation of ERP user training efficiency. Kirkpatrick's (1994) training programs' evaluation model is one of the most widely used for these purposes. Even if criticized, this four-level model is considered as an industry standard across training communities.

End-user readiness. ERP implementation is a project of both technological and social nature, which forces to change everyday working tools. As a typical ERP consists of more than 20 modules (Aberdeen Group, 2008), to work efficiently its users need not only to get a suitable training, but also to possess an appropriate basic qualification, IT skills, adequate motivation to use the system practically. Even though this criterion as

important is described only in the paper by Bueno and Salmeron (2008), other researchers also mention end-user readiness by associating it to other selection factors such as user training or system support, etc.

The majority of project managers tend to relate ERP implementation failures to technical problems, although actually about 50%. (Albadri, Abdallah, 2009) of these failures depend on system end-users: resistance to changes, not enough training efficiency or a low overall company's culture. The management of organizational culture is one of the main issues, which includes employees' personal values, habits, skills, business processes and the general attitude toward the staff.

According to War (2005), the management of organizational issues is even more difficult than solving technical problems. Researches made by Summer (2000), Wright (2002) also confirm this statement. Most of ERP implementation failures were caused by an inadequate planning and end-user involvement or the lack of professional skills. Many functionally powerful and efficient ERP systems could be less attractive than a simpler solution in cases when employees lack sophisticated IT knowledge.

System support quality. This criterion is often named as the most important ERP selection factor related to the post-implementation process. It includes assessment of the quality of warranty services and is mentioned by Fisher, Fisher and Kiang (2004), Kumar, Maheshwari and Kumar (2002, 2003), Liao, Li and Lu (2007), Rao (2000), Umble, Haft and Umble (2003), Verville and Halingten (2003), Siriginidi (2000), Bernroide and Koch (2001), Everdingen (2000) and others. In spite of the general recognition of the importance of the ERP system support quality, there is no generic description of this criterion. According to Ayağ and Özdemir (2007), the system support is the dimension that determines ERP productivity and could be described by using five related variables such as a good vendor's reputation, consulting performance, R&D capability, a technical support capability, training performance. Meanwhile Wei, Chien and Wang (2005) interpret it as a set of warranted consulting services (e.g., adequate number of experienced consultants), training service (e.g., package of training lessons) and service speed (e.g., well developed problem-solving procedures).

The system support quality could be estimated quantitatively by the number of vendor-certified consultants or the number of granted support cases for system incidents, online help work efficiency, by average reaction time to the incidents, etc.

ERP go-live support is ensured by all three elements of its ecosystem: by the ERP vendor, by the network of ERP implementation partners, and by ERP user companies. External system support providers maintain the actual ERP version (e.g., error corrections, modifications) as well as perform upgrades to the new ERP system releases and versions and ensure a permanent consulting service to their clients.

To ensure all kinds of the above-mentioned services, ERP vendors need to have enough financial resources for research activities or the creation and application of

new technologies. ERP implementation partners also need to constantly develop the consulting knowledge base, improve ERP implementation methodologies and apply them in practice, improving project quality.

It is crucially important that both ERP implementation and system support would be performed by an experienced team that needs to be evaluated during ERP selection. Hereby, an efficient ERP performance could be assured during the whole ERP exploitation period. Therefore, it is strongly advisable to avoid dependence on one ERP vendor or implementation partner and thus to reduce the risk of ERP investment. This kind of risk could be minimized by the alternative consulting providers as well as developing in-house knowledge.

CONCLUSIONS

The analysis of research papers has shown that there is no unique classification of ERP selection criteria. This could be explained by their diversity as well as by differences of scientists' research objects. Mostly, the criteria are only defined and in some cases classified on the basis of the research object. According of the nature of criteria, the authors of this paper separate them into two groups: software-related and implementation-related ERP selection criteria.

According to the majority of research papers and practical investigations, ERP functionality is recognized as the most important and significant ERP selection criterion which is closely related to the whole outcome of the ERP selection process. The significance of other factors may vary depending on the situation in the company – future ERP users' skills, the implementation project's scope, the complexity of business processes, etc. To ensure ERP implementation success, it is necessary to have knowledge of very different areas: ERP software functionality, project and change management, business process, training organization, etc. All these areas are closely associated with implementation-related ERP selection factors: organisational fit, end-users' readiness, training and system support quality and the overall ERP implementation ease and speed predefined by the complexity of the business environment and the level of business transformation conditioned by technological changes. The principal conclusion of this paper is as follows: although the two groups of implementation criteria are interdependent, the software-related criteria are easier to control because of their technical nature, while the implementation-related criteria, being of dominant importance for ERP implementation success, depend more on the human factors and therefore need more effort and attention.

The efficiency of ERP users' training depends not only on their readiness and overall level of IT knowledge, but also on the ability of ERP consultants to combine different methods of training. Combining creative methods and holistic approach, as well as clarifying the advantage of the new system not only to the company's top management

but also to the end users, ERP training could be treated as a tool for delivering a deeper business environment knowledge.

The use of a standard ERP implementation methodology could dramatically decrease ERP implementation costs in all project phases, shorten the overall implementation of duration project and raise the work efficiency.

To ensure the efficiency and impartiality of the ERP selection process, it is necessary to examine the possibility of a quantitative evaluation of the above-mentioned ERP selection criteria.

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