Evaluating ERP as a composition of different functionalities from key stakeholder perspectives

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Abstract. The field of evaluation of information systems (IS) success has a long and established history. However, models in the field usually evaluate success on the level of the whole IS while neglecting the differences in impacts of specific IS functionalities on IS success. Moreover, evaluation models often focus only on technological or only on social perspective neglecting that IS should be considered a socio-technical system and that all key stakeholders' perspectives should be evaluated. Thus, three main perspectives of IS evaluation have to be recognized, namely user/social, technological and managerial perspectives. In this paper we present a novel model for evaluation of ERP success considering all key stakeholder perspectives. The proposed model provides the evaluation of individual functionalities from these perspectives in contrast to established models that consider system as a whole. The model has been tested in a case study in a company from the nautical industry. The results confirmed the usefulness of the evaluation model, especially its ability to provide specific new information to management on the influence of the individual functionalities on ERP success.

1 Introduction

Since the mid-nineties, many organizations have decided to implement Enterprise Resource Planning (ERP) systems in order to improve business efficiency, lower the costs of production, shorten the throughput times, expand their services, provide more reliable delivery dates and improve the coordination of global demand, supply and production. Due to the complexity of these solutions and the need to adapt business processes to selected software solutions, their introduction is challenging, relatively lengthy and typically exceeds the budget. Despite the high investments, many companies are not successful in implementation of ERP system and 70% of implementation projects do not achieve their goals [1]. Investments in enterprise information systems, of which ERP systems are a key component, are a heavy financial burden, so they are under increasing scrutiny and pressure to justify their value and contribution to the productivity, quality, and competitiveness of organizations [2].

Even though the above-described reasons demonstrate a strong need for a systematic evaluation of the ERP systems, it turns out that in practice, information systems in general and ERP systems in particular are seldom systematically evaluated after the implementation [3]. Besides the lack of time, the reasons for this situation are: the benefits

of ERP systems are mostly indirect thus making the evaluation of direct financial benefits difficult; the system is used by a multitude of stakeholders who have different views on when an information system is successful.

These stakeholders typically have multiple and often conflicting interests and rarely agree on a set of common aims [4]. Therefore, the management has to realize that social aspects have to be considered as well as those of the non-human parts of the system [34] which means that the system will deliver the expected benefits to the enterprises only if and when the users accept the new technology are aware of its importance for the organization, using it conscientiously.

The aim of our research is to present a new model that enables management to evaluate ERP systems from the point of view of all key stakeholders in the enterprise, thus gaining a complete evaluation of their ERP system from the user, managerial and technological perspective. Fulfilling this aim poses real challenges since ERP systems are notoriously complex, perform a multitude of tasks and usually have a high number of specific functionalities. For this reason, the basic element of our evaluation model is an individual functionality of ERP. This allows the evaluators to highlight the good and bad parts of the ERP system without being forced to give the average score for the entire system. Critical functionalities can be identified by comparing the scores to each other, which can be easily accomplished by displaying the results on the scatter plot. This enables the organization to take appropriate action by preparing necessary improvements.

2 Literature review

In this section we review the relevant literature that studies the main three dimensions of ERP system implementation success: the user perspective, managerial perspective and technological perspective.

2.1 User perspective

The user perspective studies one of the key success factors of the implementation of the new system; the desired level of its use. Use of the system is a reflection of the technology acceptance by users. Acceptance, however, is not equivalent to success, although acceptance of an information system is a necessary precondition for success [6].

Researchers have derived a number of models [7] to measure technology acceptance. Among them, we should mention Rogers' Theory of diffusion of innovation [8], which tries to explain why, how and at what speed certain innovations spread among potential users, while others do not. As new technology is seen as a novelty in terms of future users, its adoption can be considered the same as adoption of an innovation.

The most renowned of the models explaining technology acceptance is Davis' TAM model [9], which is based on the Theory of reasoned action (TRA) [10]. TAM states that perceived usefulness and perceived ease of use are key factors of technology acceptance. The core of TAM is behavioural intention to use, but this is not an appropriate

measure if usage is mandated by the organization [13], [14], [15]. TAM2 [16] was developed in response to this situation. Delone and McLean propose that the variable 'use' should be upgraded in terms of the nature of use, as even when use is required, variability in the quality and intensity of use is likely to have a significant impact on the realization of the system benefits [17].

Urbach and Müller say that when the use of IS is required, measuring user satisfaction becomes especially useful [18]. This measure is proposed for evaluation of various IS by many other authors as well [19], [20], [21], [22], [23].

User satisfaction is considered as one of the most important measures of IS success [18], [24]. It is generally assumed that satisfied users are more likely to use the system fully and properly [15], which is a prerequisite for success of IS, while unsatisfied users often change technically successful system into a complete failure [25].

The most used among the models for measuring user satisfaction is the one by Bailey and Pearson [26], from which less extensive version of the model was derived [20] which was tested and approved as suitable for ERP systems.

User satisfaction is also one of the dimensions of a widely recognized and frequently used model of Delone and McLean [17] on the basis of which the model, designed to measure the success of ERP systems was developed [2]. This model emphasizes the importance of the quality of the system, the quality of information and the quality of support. These three variables are described as the one having an important impact on user satisfaction. This claim was confirmed in several empirical studies [17].

2.2 Managerial perspective

Management is primarily interested in the net benefits of the implemented system for the organization. Measuring the net benefits by financial performance indicators has proved to be inadequate [2], [3], [18]. Martinsons et al. [27] therefore propose to adapt the Balanced Scorecard (BSC) [28], on the basis of which Chand et al. [11] developed a special system of indicators for evaluating the ERP systems.

Shang and Seddon [21] propose a comprehensive framework for assessing the benefits of the ERP on five different levels - operational, managerial, strategic, IT infrastructure, organizational. Net benefits are also one of the dimensions of the Delone and McLean model [17] and combine the individual impact and organizational impact [14].

Urbach [18] summarizes the measures of the organizational impact of various studies: change in business processes, competitive advantage, reduced costs, improved communication and cooperation, strengthened coordination, improved output, better decision-making, improved performance, overall productivity, quality, customer satisfaction, management control. One can notice that traditional financial indicators do not play an important role in these models.

2.3 Technological perspective

The above-mentioned models relate to either user or managerial perspective of the success of IS. An important aspect of the system is also its technological sophistication.

Shang and Seddon [21] describe IT infrastructure as one of the dimensions of the benefits of implementing an ERP system by improving business flexibility, reducing IT costs and increasing capacity. Seddera, Gable and Chan [4] refer to the technical staff (IT professionals) as one of the stakeholders of ERP systems.

Usually, technologically sophisticated solutions are those, which comply with the standards and use latest technologies. Key features of quality software are described by ISO / IEC 25010: 2011 standard [29]. Quality ERP system should therefore have these qualities, but non-compliance with the above standards does not necessarily mean that the system in inadequate for the organization.

The models studying the technological perspective of ERP success typically focus only on the evaluation of IS as a whole, which forces users to deliver average ratings and prevents the identification of critical parts of the system. Gefen and Ragowsky highlighted the importance of the evaluation of the ERP system by parts in their study [30]. They proposed evaluation of the individual modules, as these are consistent with the business activities/functions, which are mutually different. The nature of each activity should also have a significant impact on the perceived value of the module.

For a comprehensive evaluation of the IS system we therefore have to consider the system as a multitude of diverse components used by the stakeholders with very different interests.

Such "per partes" approach to the evaluation already exists in the field of software development methodologies (SDM). The SDM model, proposed by Vavpotič and Bajec [31] simultaneously addresses both the aspect of user acceptance as well as the aspect of technological efficiency of methodologies. The model was later additionally improved by adding a dimension which measures the impact of SDM on the organization [32].

3 The Proposed Model

The proposed model was designed taking into account the two key features of ERP systems. These two features are: a variety of business functions to be supported by the ERP system and a multitude of stakeholders of the system. The purpose of the model is to enable the organization to easily recognize the critical functionalities of the system that need improvement and to identify the satisfaction of all key stakeholders with key functionalities.

In the proposed approach, the ERP system is simultaneously evaluated from three perspectives of success, each representing a view of a key stakeholder: user, managerial and technological perspective. Since each user typically does not use the majority of functionalities offered within a single ERP module, we increase the granularity of the evaluation from the level of individual modules as suggested by the literature to the level of individual functionalities which support individual business processes. We speculate that such approach will significantly increase the accuracy and exactness of the evaluation, since it will enable users to accurately identify the good and bad functionalities of each module. Thus the model enables managers to gain detailed and systematic insights into the strengths and weaknesses of all the functionalities of the ERP

system, without being forced to rely on average assessment for the entire module or system when making decisions concerning the ERP system.

End-users evaluate the functionalities from the user perspective, middle management from managerial perspective and IT employees (IT experts) from technological perspective.

After completing the evaluation, functions are divided into eight groups in relation to the ratings in each perspective (U -user, T - technological, M - managerial), which may be lower (low - L) or higher (high - H) than the mean value of a perspective. The eight groups are presented in Table 1.

Table 1. Improvement strategies based on evaluation of the three perspectives

U	T	M	Proposed actions and strategies
L	L	L	With functionalities that have below mean values in all measured perspectives of ERP success, we must consider whether they are necessary to deploy at all and if investing in them is justified or can they be replaced with a more appropriate solution.
L	L	H	Because these functionalities have in the opinion of management an above mean impact on net benefits, we need to improve the user satisfaction of these features and perform appropriate technology updates.
H	L	L	Such functionalities should be modified in a way that they will be technologically more suitable or replaced with functionalities that provide a similar user satisfaction (e.g. are not demanding to use), but are technologically suitable. Prior to this, we have to check whether the changes are economically justified, given that the functionality does not provide above-average net benefits to the enterprise.
L	H	L	We must make these functionalities more user friendly while also considering whether the changes are economically justified, given that the functionality does not provide above-average net benefits.
H	L	H	Modifications or replacement of such functionalities should be considered so that they become technologically suitable while providing a similar user experience (e.g. are not demanding to learn and use for user already familiar to older functionalities).
L	H	H	With these functionalities it is necessary to find the reasons for the dissatisfaction of end users. This may be due to the fact that users do not have sufficient knowledge and experience in using the selected functionality, so we must provide them assistance and training, and present to them the benefits arising from the use of these functionalities.
H	H	L	We should analyse if functionalities that do not deliver important net benefits to the enterprise must remain in use. Such functionalities are often administrative functionalities that must be used regardless of the fact that they do not bring a significant economic benefit.
H	H	H	It is necessary to ensure that these functionalities remain in this group. Technological suitability can be provided by updates but the updates should not reduce user satisfaction.

3.1 Characteristics of perspectives

Since the use of the ERP system is mandatory, we decided to measure user satisfaction instead of adoption in order to evaluate the system from user perspective. Based on existing studies [2], [6], [17] we defined the characteristics of the **user/social perspective** as follows. Satisfaction with information - satisfaction with the outputs (on-screen displays and various reports) generated by the ERP system and their value in terms of usability and relevance to the user [4]. We define features of information quality in line with the relevant literature [2], [14], [26]. Satisfaction with the system - satisfaction with the system from a technical and design point of view [4] and also from the perspective of system quality [14]. Satisfaction with the support - satisfaction with the support provided to the users by the IT department and external collaborators who are responsible for support [14]. Impact on the user - how the system affects the individual user [4] in terms of efficiency, productivity, performance and simplification of work.

The **managerial perspective** focuses on alignment with the business strategy and business processes. Regarding the alignment with the business strategy the evaluation focuses mainly on how the system under evaluation affects the costs in case of cost leadership strategy and the improvement of the quality of products in case of differentiation strategy [12], [21]. The evaluation of the alignment with business processes focuses on how well the system under assessment supports specific business processes and if it introduces any advanced solutions from the perspective of business processes.

The basis for the assessment of the ERP system from the **technological perspective** is its technological suitability [29] for: the organization, employees and their way of working. We measure technological suitability of ERP for each of the functionalities and consequently the business process, which the functionality supports.

4 Case study

4.1 Methodology and case description

To test the proposed evaluation model we followed the case study research protocol as defined by Yin [33]. We developed three different questionnaires, each covering a different perspective and intended for different group of survey participants: ERP users, IT experts and management (see Appendix A). All questions used a seven-point Likert scale between 7 (strongly agree) and 1 (strongly disagree), where 4 meant neither agreement or disagreement with the statement. The results of the survey were analysed and discussed with the management.

The case study was carried out in a Slovenian company, which is engaged in designing concepts, plans and tools for serial manufacturers of sailboats and motor yachts as well as its own production of vessels. In 2013, the company employed around 150 people and sold 110 hybrid vessels. The company started with implementation of ERP system based on MS technologies in 2009. The system replaced the existing system, from which the data was transferred.

The first step was to identify the functionalities provided by the system within different modules, and to identify the users of these functionalities who can evaluate them.

We have identified 42 functionalities within seven modules - Financial management (10), Sales and marketing (5), Supply chain management (5), Warehouse management (4), Manufacturing (5), Human resource management (10), Administration (3).

The proposed model was used to evaluate the above 42 functionalities. The 24 employees who use the system have evaluated it from the user perspective. Each user evaluated only the functionalities that he actually uses. Heads of departments further evaluated functionalities from the managerial point of view. There were 10 evaluators and they evaluated the functionalities that are part of the module which is dominantly used in the department they run. Head of IT evaluated all of the functionalities from technological perspective.

4.2 Results and discussion

Average evaluation scores were the highest for the user dimension as presented in Table 2. Satisfaction with support received the best average score. Managerial and technological dimension received a slightly lower average score, but still higher than 4, which represents a neutral level. A high standard deviation in the managerial aspect is due to low evaluation scores of functionalities within module Sales and marketing. Only the answer to the question about the alignment with the business processes was taken into account, as the manager was not able to respond adequately to the two other questions.

Table 2. Average values and standard deviations

Perspective	Characteristic	Average value		Standard deviation		Cronbach alpha
user	Satisfaction with information	5.122	5.255	1.083	0.881	0.843
	Satisfaction with the system	5.122		1.136		
	Satisfaction with the support	5.564		0.701		
	Impact on the individual	5.212		1.270		
managerial	Impact on quality of products	5.090	4.655	1.343	1.830	0.967
	Impact on lower costs	5.131		1.428		
	Business process alignment	4.722		1.827		
technological	Technological suitability	4.191	4.191	1.065	1.065	-

Evaluation scores for user and managerial perspective of the functionalities are shown on scatter plot in Figure 1. The figure shows that the evaluation on the level of

the individual functionalities instead of modules proved to be adequate, as the functionalities of a particular module are distributed over the entire plot, which means that their evaluation scores vary considerably.

The majority of the evaluated functionalities are in the first quadrant, which means that they are suitable both from a user perspective (users are satisfied with functionalities), as well as from the managerial perspective (managers estimate that the functionalities help increase competitive advantage and support business process well). A good score does not mean that they should no longer be monitored, as it is crucial for these functionalities to stay where they are, or ideally to move further towards the top right corner of the plot.

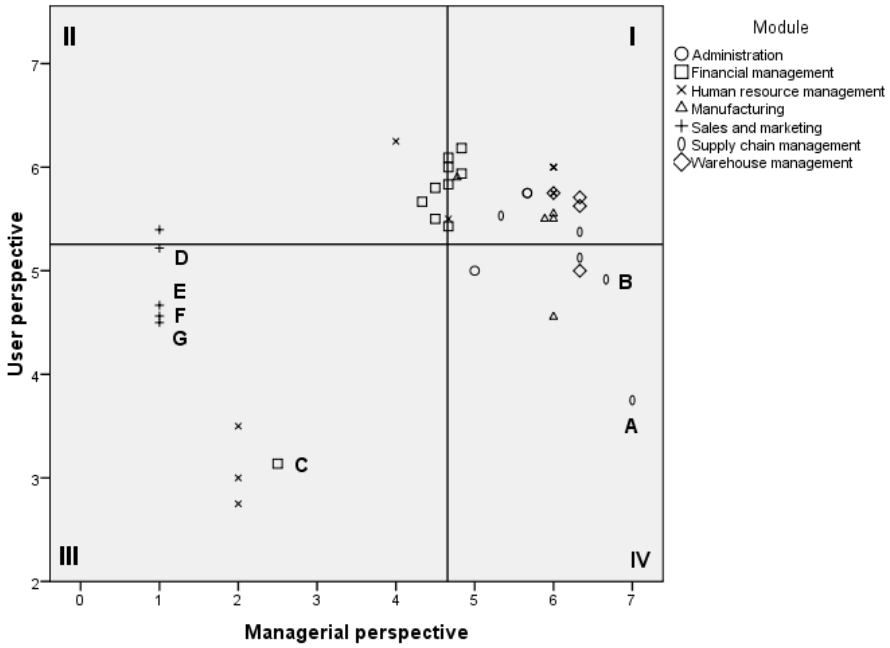

Fig. 1. Scatter plot showing the results of the evaluation

In the third quadrant are the functionalities which neither users nor managers are satisfied with. The score of the Inventory management from the Financial management module (C) is especially interesting. This functionality deviates significantly from the others in this module, with which users are extremely satisfied and management evaluates them as economically beneficial. According to the comments of the evaluators, low score is arising from difficulties in the recording of unfinished production, which is not tailored sufficiently enough to the nature of production. Users also highlight that the calculation of the value of unfinished production is very complex and incomprehensible to the users. The fact that three out of four functionalities of the Sales and marketing module are in the third quadrant (D, E, F, G) is worrying, since the sales

process is one of the most important for company performance. Users here exposed the inadequacy of the ERP system for the nautical industry and its inability to deal with widely different contracts that often significantly change after they are signed. For these reasons, the use of Sales and marketing module is limited and employees are forced to use other tools to support the sales process.

Second and fourth quadrant are particularly interesting for the analysis, as they include functionalities with which users are satisfied, but management evaluates that they do not bring much to the competitive advantage (second quadrant) or vice versa (fourth quadrant). Most functionalities in the second quadrant are related to the supporting processes (Financial management and Human resource management modules). Therefore, lower evaluation score regarding the economic benefits was anticipated.
The fourth quadrant contains functionalities, which significantly contribute to the added value created, however users are dissatisfied with them and are reluctant to use them. These are mostly the functionalities which support some of the core business processes. The functionality which stands out the most is Stock from the Supply chain management module (A), which was given the highest rating by the management, while having relatively low user rating. User dissatisfaction with Stock (A) as well as with Procurement planning (B) is due to the fact that it takes a lot of manual work even though the system allows planning of materials. The effective application of MRP proved to be very challenging because of the specific field and way of work. Since the production is not serial, automatic data processing and creation of orders depending on the state of stock is very difficult. The bill of materials (BOM) cannot be defined in advance as each product is customized. The key for the proper functioning of the MRP is the integrity, accuracy and timeliness of the input data and a close cooperation of production, purchase, storage and sales department. One of the evaluators pointed out that users usually expect more from the system, than they are willing to invest in it. All functionalities from the Manufacturing module were evaluated as technologically inadequate. They are intended namely for the needs of the classical serial production, and are thus functionally inadequate. One of the end users said that it is important to know from the beginning exactly what we expect from the system as any subsequent changes of the settings represent a major undertaking from both the financial and time perspective. The functionality associated with the stocks and their valuation (control) also received low evaluation score for the technological perspective. This is due to the complexity of operations and big amount of data in the database which is causing slow performance of the entire system when in use, so we can conclude that their implementation is ineffective. Use of this functionality is therefore only possible when other employees do not use the system, otherwise other users are not able to work normally due to the unresponsiveness of the system. Occasional unresponsiveness was exposed as a weakness and the source of dissatisfaction by the end-users as well.

Non-compliance with the process is the reason for the low technological scores in the functionalities from the Sales and marketing module. Furthermore, the problem is the lack of portability of the system. The system only works on Microsoft Windows operating systems.

Other features of quality software are realized in line with the needs of the company. The system is compatible (allows export to other tools for editing), useful, which was

also exposed by the end-users, reliable and safe. Modular structure of the system allows simple maintenance and testing in the special testing environment.

4.3 Discussion of the results with management

We turned to the director of the company for the commentary of the results of the evaluation. He said that the results confirmed his fears about the areas that represent the greatest difficulty in utilization of the system, while he was surprised by the relatively high user satisfaction scores. This new information led him to rethink his position that the system is being underutilized according to the possibilities that it offers by the users. He will push technical management to increase the number of opportunities for ERP use. He believes that the use of the MRP would not be so difficult if they would take better care of the accuracy of the input data, as we have already mentioned in the analysis of the results. He presumes that the mistake they made was entering the data into the system even during the development of the product instead of after the completion of the development, when the greater part of the BOM is already defined. To allow customization of products, but not cause problems because of changes in BOM, he proposes the introduction of a fundamental, base BOM, and optional BOMs for the predefined packages of equipment that the customer can select. As essential he also points out the definition of the timeline and all the steps in the production process.

He sees the evaluation as highly beneficial providing important managerial information. The results will be used before the implementation of the upgraded system at the new location. The results will help them avoid making the mistakes they made in the past as well as knowing which functionalities they must be vigilant about when educating users.

5 Conclusion

Nowadays, the work in the majority of organizations is supported by information systems (IS) to such an extent that the organizations' performance depends on the IS. This demonstrates a strong need for a systematic evaluation of the ERP systems. Since each user typically does not use the majority of functionalities offered within a single ERP module, we increased the granularity of the evaluation from the level of individual modules as suggested by the literature to the level of individual functionalities which support individual business processes. We show that such approach significantly improves the accuracy and exactness of the evaluation, since it enables users to accurately identify the good and bad functionalities of each module. Thus the model enables managers to gain detailed and systematic insights into the strengths and weaknesses of all the functionalities of the ERP system, without being forced to rely on average assessment for the entire module or system when making decisions concerning the ERP system. The results confirmed the usefulness of the evaluation model, especially its ability to provide specific new information to management on the influence of the individual functionalities on ERP success.

Limitations of the paper are as follows. A single case study was conducted thus caution is needed when generalizing its results. Other organizational settings, such as bigger enterprises might pose additional limitations for the proposed model as it might become necessary to conduct the evaluation in several steps due to large number of functionalities and large number of users. Additional research on these issues would be valuable. Additionally, the interrelation of the three perspectives should be considered as a possible extension of the proposed model in further research.

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Appendix A

User perspective

1. **Satisfaction with information provided:**
   The information that I get when using <*functionality*> are relevant (complete and useful), concise, accurate and easy to understand.

2. **Satisfaction with the system:**
   <*functionality*> is reliable, accessible, flexible and easy to use.

3. **Satisfaction with the support:**
   IT department and external consultants are accessible and responsive, their support for <*functionality*> is reliable and easy to understand.

4. **Impact on the individual:**
   The use of <*functionality*> facilitates my work and improves my work performance and productivity.

Managerial perspective

1. **Impact on the quality of products:**
   <*functionality*> significantly contributes to the added value created through increasing the quality of products.

2. **Impact on lower costs:**
   <*functionality*> significantly contributes to the added value created through cost reduction.

3. **Business process alignment:**
   <*functionality*> supports business processes well and introduces advanced solutions.

Technological perspective

1. **Technological suitability:**
   <*functionality*> is technologically suitable for the company