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Measurement of ERP-Project Success: Findings from Germany and Austria

Juergen Alexander Gollner, Ilona Baumane-Vitolina

University of Latvia
19 Raina Blvd., LV-1586, Riga, Latvia
E-mail. gollner@gmx.at, ilona.baumane@lu.lv

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The implementations of Enterprise Resource Planning (ERP) systems have increased rapidly world-wide over the last two decades. ERP projects are long lasting and complex activities, influencing the main internal and external operations of organizations. As companies spend an immense investment on these projects, in the beginning managers are focusing on the most common success factors to reach the main goal of a proper implementation. For evaluating ERP projects in retrospective, an applicable measurement of the whole implementation and its economic effects is essential.
This research paper evaluates the most prominent ERP project success models mentioned in scientific literature and gives an overview of the different approaches. It explores the best fitting model for measuring ERP project success and based on that analysis, the authors created a new model using empirical data.
The study was performed on a sample of medium-sized companies located in Austria and Germany, which implemented ERP software between 2011 and 2013. Based on a newly developed questionnaire completed by over 300 companies' CEOs, factor analysis of the data shows a reduction of dimensions for ERP project success measurement. It indicates that characteristics of success factors can be summoned up to 5 different dimensions, namely project management, user satisfaction, time and budget, ERP system quality and economic value. The results show that some of the dimensions suggested by other authors are coherent and redundant, and, therefore, an extra measurement of these aspects is misleading. The study is designed to make a contribution to management science literature from the perspective of project management requiring effective success evaluation instruments.

Keywords: *ERP, Project, Success, Measurement, ERP Success Model.*

Introduction

In today's fast changing and highly competitive economic environment, organizations are permanently in search for new ways to achieve better business performance and gain advantages through effective distribution of resources and improvement of business processes. To enhance business capacities, companies require an efficient IT system for planning and controlling that synchronizes the important processes across the organization.

One key to competitiveness lies in a solid information system (IS) infrastructure oriented to the core business processes developed for the delivery of high quality products and services to customers within optimal time. These demands have encouraged a lot of organizations to shift their IS strategies from developing in-house information systems to purchasing application software, such as ERP systems, to generate synergies and increase operating efficiency. Generally, a project is considered successful, if it has objectives like profit, punctuality or budget reached or exceeded. In addition to these objectively measurable criteria, the evaluation of the project's success also depends on the position of each stakeholder. This implicates, that an objective survey should be done by people who are not directly involved in the ERP project itself. For many companies, ERP implementations are a large information technology (IT) investment that radically redesigns the entire IT landscape and working processes. ERP projects often imply a radical change in the organizational processes and culture which entails risks to the project and the organizational transformation, which can significantly affect the project's success (Dey *et al.*, 2010).

Currently, the success of an ERP implementation project is often reduced to few facts, namely that the new ERP system is accurate, configured and properly running, the whole project is on time and within budget.

Emphasizing the actuality of the topic, the measurement of enterprise resource planning (ERP) systems' success or effectiveness is critical to our understanding of the value and efficacy of ERP implementation investment, which binds a lot of financial and human resources. Bradford and Sandy (2002) pointed out, that because of the lack of empirically effective evaluation models, more than half of the interviewed companies started no assessments on the performance of ERP systems. As a result, a reliable model for ERP project success measurement is important. Organizations require appropriate methods and tools to evaluate their information systems. New methods for the ex-post evaluation of ERP system examine the organizational performance during the project, and informational and transformational effects that result from the use of the integrated system (Uwizeyemungu, Raymond, 2010). In addition, ERP evaluation methods have to take into account different stakeholders' involvement (Irani *et al.*, 2014).

Despite the significant investments in ERP projects made by organizations around the world, formal efforts to determine their success and the underlying causes have been very limited (Gable *et al.*, 2003). The reason for that could

be the lack of anchoring of ERP know-how in university environment. Until the early 2000 years, ERP was either seen from an economic view in management science or from a technical view in informatics. For the last couple of years, ERP as a subject has been offered in higher education institutes. The necessity of teaching ERP subject matter was discovered particularly for business management students. There do exist some simple instruments for measuring ERP implementation success with ERP consulting companies. This is usually a simple Excel-sheet, which is sent to the implementing companies after the system go-live to evaluate the quality of consulting and customers' satisfaction. But these surveys are neither standardized or confirmed with statistical methods, and are usually kept as an internal secret.

For further access to this topic it is important to differentiate between success criteria / dimension and success factors. Criteria (or dimensions) are used to measure success whilst factors facilitate the achievement of success (Collins & Baccarini, 2004). On the other hand, success factors describe what is necessary to achieve successful ERP projects. Most recently, Zouine and Fenies (2014) conducted a meta-analysis comparing different critical success factors of ERP system projects, and pointed out significant importance based on 32 articles focusing on the ERP system. This perspective is often applied in the advance of a new project. The participating parties are also very broadly seen, as not only the implementing enterprise is in focus of consideration. In these considerations, also culture, environment, ERP consultants and vendors have an important role. Approaches describing success factors of ERP projects are discussed in various economic journals, but will not be discussed in this paper. A previous publication focusing on the measurement of ERP project success by Kronbichler et al. (2010) is also giving an overview on different approaches, but is limited to a theoretical review.

This also reflects the scientific problem, as many of the ERP success measurement approaches were not statistically examined. In most publications, ERP success measurement models are just described in theory, and a functional argumentation is missing. Examples with empirical background are interestingly mainly found in literature from outside of Europe. They focus on specific aspects of the measurement model like service quality of vendors and consultants (Tsai *et al.,* 2009), correlations between groups of dimensions (Chien, Tsaur, 2007) or interrelation of dimensions and its impact on different perspectives (Lin *et al.*, 2006). Tsai *et al.* (2011) conducted an empirical study in Taiwan on how internal or external facilitators impact ERP project success. The used model is consisting of three main success factors, consisting of the service quality of two external facilitators, namely system providers and implementation consultant. In addition, service quality of internal facilitators was described by the achievement level of project management. For each of the three factors, various characteristic items were attached to describe the level of expression. Results mainly show that only project management has a direct positive impact on performance of the new system. The external factors have an indirect effect, as they also improve the level of project management.

Two empirical studies by Dezdar and Ainin on the impact of success of ERP implementations confirmed some of the known impacts of critical success factors. Examining ERP implementation success from a project environment perspective (Dezdar & Ainin, 2011a) showed that as suspected, efficient project management, good team composition and competence have a positive impact. Surprisingly, the effective reengineering of business processes did not result in a significantly more successful project. The analysis of the influence of organizational factors (Dezdar & Ainin, 2011b) mainly proved the positive impact of the companies' top management commitment towards the project and project managements' understandable communication towards the plans and targets as the main success factors. In addition, adequate training and education leads to higher user satisfaction, which results in a positive influence. Besides the focus on these two special aspects, and therefore the absence of a general view on all success factors, these studies also may imply cultural peculiarities, as they were conducted in Iran.

What these researches have in common is that they are not critically reviewing, questioning and testing all different dimensions suggested in the literature. The few empirical studies mentioned here are mostly measuring the impact of various factors on the success of ERP implementation. But they do not examine a comprehensive model for ERP project success measurement itself.

The aim of this research is to propose a new and empirical proven success measurement model for ERP projects, which also can be practically used. To achieve that, qualitative research is used to elaborate a catalogue of items for concrete measurement. And most important, empirical data from over 300 finished ERP projects enables to accomplish a critical statistical analysis of the favored ERP project success model. This can be seen as a novelty, as no publication so far was based on that comprehensive empirical data. Further goal of this study is to examine whether the suggested dimensions of success described in the literature are picturing the clearly separated aspects in reality. Previous studies gave a theoretical classification of different factors, but they did not come up with a concrete survey reflecting them.

Another important facet should be anticipated at this point, the subdivision of ERP project success into project management success and project product success. The combination of both perspectives gives a full assessment for measuring ERP project success. This paper is based on the notion that ERP success depends on both – project management and project product success. Generally, a project is considered successful, if it has its objectives (profit, punctuality, adherence to budget) reached or exceeded. Though, not only the success of the result of the implementation, namely the running ERP system, is relevant. Also an evaluation of the ERP project itself needs to be included into considerations.

Project success can be seen as two separate components, namely project management success and project product success (Baccarini, 1999).

Project Management Success focuses on the successful accomplishment of the project with regards to cost, time and quality (Pinkerton, 2003). It also considers the manner the project management was conducted (Baccarini, 1999), resulting in the quality of project management process. According to Collins and Baccarini (2004), the last success

criterion is satisfying project stakeholders' needs where they relate to the project management process, primarily focusing on project owner and team members.

For Pinkerton (2003) Project Product Success focuses on the effects of the project's final product. That distinction is relevant for practical use of making surveys concerning the evaluation of ERP projects' success.

A research by Ram *et al.* (2013) emphasizes on these two components, as the impact of success factors are empirically tested on the success of the ERP implementation itself and further on the organizational performance, which describes the post-implementation benefits of the product. Interestingly, the four tested key factors, namely project management, training and education, business process re-engineering and system integration manifested mixed results on these two main aspects of ERP project success.

For many companies, ERP implementations are a large IT investment that radically redesigns the entire IT landscape and working processes. Currently and in practice, the success of an ERP implementation project is often reduced to three facts. Firstly, the ERP system is accurate configured and properly running, secondly, the whole project is (more or less) on time, and finally, the whole project is (more or less) within budget. This traditional view on the success of project management usually measures whether a project was within time, budget and specifications (Thomsett, 2002). Globerson and Zwikael (2002) also describe these dimensions as a key criteria to measure ERP project management success.

However, authors of this article are convinced, that these 3 dimension mentioned above are not enough to effectively measure success of project management. Further studies on ERP project success which will be described later in this paper added new criteria like Quality of the Management Process and Project Stakeholder Satisfaction.

The paper is structured as follows: The next chapter evaluates the most important scientific theories developed to measure ERP project success. Then methodology of the current study, used for improving the favored model is explained. Afterwards, the main results are presented and then the preferred approaches are resumed and interpretation to the results of the empirical study is given. In the final chapter, conclusions are drawn up, limitations of the study are mentioned, future research tracks are elaborated and in addition, practical implications from the findings are formulated.

Existing Approaches to ERP Project Success Measurement

In this chapter two separate facets of ERP project success - management process and project product - will be discussed and then various existing ERP project success models will be evaluated.

Project Management Institute's (1996) definition of project management is 'the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from project'. Project stakeholders are individuals and organizations that are actively involved in the project, or whose interests may be affected as a result of project execution or project completion. To satisfy stakeholders, 'the project management team must identify the stakeholders, determine what their needs and expectations are, and then manage and influence those expectation to ensure a successful project.' Baccarini (1999) sees Project stakeholder satisfaction influenced by both project success components - product and project management.

ERP project management success can be defined in terms of delivering the new ERP system on time and within budget with the required functionality (Lech, 2013). This often comes along with benefit realizing organizational changes, which should satisfy users and sponsors. Success of an ERP investment is also dependent whether the organization is able to use it to capture, process, disseminate and analyze directive and predictor indicators on a timely basis (Wier *et al.*, 2007).

Project Management Success is dependent on how efficiently the project has been managed. Criteria like cost and time are measuring effectiveness. Baccarini (1999) points out that these efficiency factors are in fact variables contributing to project management success. Later those factors will be operationalized and measured in a survey addressed to companies CEOs, who valuate the project management process and communication.

An important part of the project management success is project stakeholder satisfaction. For Project Stakeholder Satisfaction, the narrower definition of the term stakeholder is applied, focusing on the influencers and decision makers of a business or technological change, adopting the stakeholder approach to management (Kotter & Heskett, 1992).

ERP project management needs to fully introduce the involved stakeholders. Various researches pointed out that poor project management, along with inappropriate project team composition, are regarded among the most critical failure factors (Amid *et al.*, 2012; Garg & Garg, 2013).

For measuring the success of the project product, even other factors like 'satisfaction of users' or 'added value caused by product' can be added. Pinkerton (2003) notes, that there is not always a straight context between management and product success. For example, a failure in reaching the planned budget for the ERP implementation does not automatically indicate, that the finished product, which is the running ERP software, does not bring net benefits. After an ERP implementation, the most practical and obvious measurements focus is on delivering a functional ERP product within certain economic restrictions. The probability of system success should increase when a new system is accepted to be used (Behrens *et al.*, 2005).

In the past, researchers have published a number of models trying to explain what makes an Information System 'successful'. The beginning of that explicit scientific research field was shortly after the first ERP systems have been used by established companies. Davis's (1989) Technology Acceptance Model (TAM) based on the Theory of Reasoned Action and Theory of Planned Behavior of Fishbein and Ajzen (1975), tried to explain why some Information Systems are more accepted by users than others. Acceptance, however, is not equivalent to success, although acceptance of an information system is a necessary precondition to success (Petter *et al.*, 2008).

It is important to point out that most researches in this field were conducted on the level of Information Systems

(IS). As mentioned before, an enterprise resource planning system (ERP system) is an information system that incorporates enterprise-wide internal and external information systems into a single unified solution. IS is an umbrella term for ERP. In most of the applied literature for project success measurement, these two terms are used synonymous.

Ding and Straub (2007) give concerns that criteria and measures describing the characteristics of an information system, might not capture the intangible or indirect value generated by the according system. The following models for ERP success measurement should give an overview of the existing approaches without an extensive explanation of each framework. To find a fitting method to investigate ERP project success rates, different approaches are analyzed and the best framework needs to be chosen, instrumentalized, statistically proven and possibly improved.

The most prominent model describing ERP project success is the DeLone and McLean I/S Success Model (1999 and 2003), which will be described in detail later in this article. Besides the DeLone and McLean model and its successors, there are other approaches which are worthy being mentioned in this context.

Rosemann and Wiese (1999) suggested the ERP Operation Balanced Scorecard, which evaluates the implementation process. In addition to the four classical perspectives (financial/cost, customer, internal processes, and innovation and learning), a fifth perspective, namely the Project Perspective was added for also evaluating the performance of running ERP software. On the negative side of this approach, there is a lack of empirical studies using Balanced Scorecard in ERP-project. That implicates that main key performance indicators for every perspective have yet to be identified. Additionally, these indicator need to be classified for making a meaningful analysis.

Markus and Tanis (2000) developed 'A Process Theory of Enterprise System Success' described by four different phases for Chartering, Project, Shakedown and Onward/Upward processes. Each phase is characterized by key players, typical activities, characteristic problems, appropriate performance metrics and a range of possible outcomes. A total of 11 critical success factors for ERP implementation have been identified, emphasizing the partnership between implementer and consulting company as the most critical success factor. This approach is lacking measurements of the ERP product success, and in addition, the model was not proven by empirical studies.

The Task-technology fit (TTF) theory by Smyth (2001) summons up 3 dimensions, namely Perceived Usefulness, User Satisfaction and Task-Technology Fit, which is accomplished if the capabilities of ERP system fully enable the tasks the user has to perform. This model is mainly focusing on the advantages ERP users have using the new system, but is leaves out many other aspect measuring the total success of ERP implementations like efficiency, management assessment and economic value.

Stefanou (2001) developed a construct emphasizing an ex-ante evaluation of ERP systems, as the selection of an ERP software is very costly and includes a long time commitment. The model is picturing the ERP implementation and is divided into four phases, namely (1) clarification of the business vision, (2) evaluation of business needs, the company's capabilities and selection of required ERP modules, (3) estimation of costs and benefits caused by the ERP implementation and (4) estimation of the future costs and benefits which arises from operating, maintaining and extending the ERP system with additional functionality. As most scientific studies rely on empirical, ex-post data, this model might not be applicable for academic researches.

The DeLone and McLean model was the first study to bring some order in ERP researchers' multiple choices of success measures (Seddon *et al.* 1999). The original model is based on theoretical and empirical research conducted by a number of researchers in the 1970's and 1980's. To construct the model, over 100 papers containing empirical IS success measures were reviewed, resulting in an integrated view of IS success represented by six dimensions.

System Quality measures the information processing system itself and Information Quality measures the information system output. Information Use measures the consumption of the output of an information system and User Satisfaction measures the users' response to the use of the output of an information system. Finally, Individual Impact measures the effect of information on the users and Organizational Impact measures the effect of information on organizational performance.

Based on their comprehensive research in the early 1990's, DeLone and McLean (2003) published an updated Information System success model. DeLone and McLean described their original model as a temporal, process model. The temporal aspect of the new, extended model implies that an ERP system is first created, then experienced, and afterwards it has organizational impacts. The updated model is in total consisting of 7 different dimensions. The created system is described by dimensions System Quality, Information Quality and Service Quality. Intention to Use, Use and User Satisfaction are describing the aspects of experiencing the new system. And finally, Net Benefits are measuring the operational benefits of an ERP implementation.

The created system contains various functions and exhibits various degrees of system and information quality. Next the experiences of users and managers using these functions are either satisfactory or not. The use of the system and its information impacts and influences collectively result in organizational impacts.

Some changes in the updated model like the addition of Service Quality as an extra dimension to Information Quality and System Quality were conducted. Furthermore, Intention to Use was placed alongside Use, and Individual Impact and Organizational Impact were collapsed into a Net Benefits dimension. In the updated model, also arrows were added to demonstrate proposed associations in a process sense. These arrows do not assume causal relationships between the dimensions.

For every six dimension measuring IT projects' success, a variety of elements were mentioned in researches over the past 20 years. The definitions of the six dimensions are derived from DeLone and McLean (2003). For better understanding, for every dimension describing nouns are mentioned.

The success dimension System Quality constitutes the required characteristics of an ERP and subsumes measures

of the IS itself. These measures typically focus on usability aspects and performance characteristics of the system under examination.

The success dimension Information Quality forms the required characteristics of ERP's output, e.g. information an employee can generate using a company's ERP, such as the latest sales statistics or clearly arranged stock figures. It focuses on usefulness for the user and high quality of the information coming from the system. Information quality is often seen as a key antecedent of user satisfaction and encourages intention to use the system. ERP software standardizes information within the organization, streamlining the data flow between different parts of a business. According to Minahan (1998, p. 113) 'ERP gives all users a single, real-time view of their company's available resources and commitments'. That means data are entered by one department and colleagues in other units immediately have access to the information without having to reenter the information into the system.

The success dimension Service Quality represents the quality of the support that the users receive from the IT department like training and consulting. It also measures the goodness of hotline or helpdesk provided by IT support personnel.

The success dimension Use/Intention to Use represents the degree and manner in which an ERP system is utilized by its users. The measurement of recipient consumption could be done objectively by capturing the frequency of use or functions utilized.

Considered as one of the most important measures of success, the dimension User Satisfaction describes the user's level of satisfaction when utilizing an ERP system. Measuring user satisfaction becomes especially needed, when the use of an ERP system is mandatory, making the amount of use an inappropriate indicator. Seddon and Kiew (1994) were one of the first describing User Satisfaction with in ERP projects with adequacy, effectiveness and efficiency. The term overall satisfaction describing User Satisfaction was also used in further studies by Rai (2002).

Net Benefits, which roughly consist of Individual Impact, describing the measure of the effect of information on the recipient or user, and Organizational Impact, describing measure of the effect of information on organizational performance. In addition, also the value of technology investment measured with quantifiable financial numbers can be applied.

The DeLone and McLean IS model was applied to ERP systems on various occasions. Notable mentions are studies Gable *et al.* (2003), Sedera and Gable (2004), Qian and Bock (2005), Sedera (2006) and Lin *et al.* (2006).

On the basis of the DeLone and McLean construct, Gable *et al.* (2003) build up a new model for ERP system success using the measures Sedera et al. (2003) associated. It has four quadrants, namely individual impact, organizational impact, information and system quality.

The impact dimensions are an assessment of benefits which are caused by the ERP system. Individual impact describes the effects of the system on the individual working with the system, e.g., decision effectiveness or users' productivity. Organizational impact contains the influence of the system on the organization, delivering measures for organizational costs or staff requirements.

The quality dimensions point out the future potential. System quality consists of measures like ease of use, flexibility or data accuracy, whilst information quality describes measures like relevance, importance or timeliness of information.

The Gable et al. model is very good fitting for measuring at a certain point of time. As there is no explicit dimension for user satisfaction, satisfaction is seen as an overall measure of success. Compared to the DeLone and McLean model, it does not reflect a process model of success and omits the construct use.

Based on the model of Gable *et al.* (2003), Ifinedo (2006) extended the dimensions of success for ERP measurement by adding two new dimensions.

Firstly, an external source was introduced with Vendor/Consultant Quality, as competent partners are needed to deal with the very complex challenge of ERP system implementation. It measures the component of external quality on the ERP-systems success. An aspect can be the management of know-how transfer and a good mixture between internal and external staff.

The second added dimension, Workgroup Impact, describes sub-units or functional departments of an organization, partially formed for the purpose of the ERP project. Exemplary measures for this dimension are improvement of interdepartmental communication or organizational-wide communication. Ifinedo pointed out System Quality and Organizational Impact as the two most important dimensions for ERP systems success.

It was already mentioned that to measure the whole ERP project success, project management and project product success needs to be combined. Pinkerton (2003) or Baccarini (1999) emphasized the importance of incorporating a product success component into the definition of project success. Pinkerton (2003, p. 338) describes this need by citing 'using traditional criteria for evaluating project success is like using the time of a single runner to determine whether or not a relay has been successful'. Pinkerton (2003) also points out that presuming ERP project success needs to be seen as addition of project management success and project product success, the extended traditional perspective from project management measuring can be added to the model developed by DeLone and McLean.

The DeLone and McLean model is more focusing on results after go-live of IT-projects, leaving out the criteria of project phase and system introduction itself. That concentration on running ERP systems is not fitting on measuring the whole project success. But a complete picture for the required model is given in addition of the extended traditional approach. Westhuizen and Fitzgerald (2005) merged the dimensions Use and Intention to Use into one aspect, and added five more dimensions to the model.

Within Time is checking whether main milestones and go live were reached in time with predefined specifications. Is also includes the time span of ERP project.

Within Budget is controlling whether project budget within predefined specifications is not exceeded, the budget was used effectively and evaluates expenses for extra requirements.

Within Specifications is testing whether the predefined specifications were achieved for go-live, goals of project were reached and the scope of project was kept.

Project Stakeholders are individuals and organizations that are actively involved in the project, or whose interests may be affected as a result of project execution or project completion. For this criterion, the more narrow definition is used, as the stakeholders are described as managers who have the organizational authority to allocate resources (people, money, services), can set priorities for their own organizations in support of a change, are responsible for profit and loss and finally are dependent on success of ERP implementation.

Quality of Project Management Process is not only evaluating the quality, but also the efficiency and transparency of ERP project management. It also includes the management for escalations and risk management preparing for critical phases. ERP project management includes good scoping, risk management and fitting allocation of resources. A poor execution of these functions may frustrate users, and lead to project failure (Chen *et al.*, 2009). As proven later in this research, Quality of Project Management seems to be a good predictor for the quality of ERP implementation and eventually to project success (Zhu *et al.*, 2010).

Consequently, this more comprehensive 11 dimension model incorporates both, project management and project product success of ERP implementations. It covers all relevant aspects of a comprehensive measurement of ERP project success.

Methodology of the Study

The extended model by Westhuizen and Fitzgerald (2005) with its 11 dimension covers most of ERP project issues. As mentioned in the introduction, the suggested dimensions of success described in the literature need to be checked with the different aspects in ERP project reality. The question is, how the concrete measurement looks like and whether it is possible to rate an ERP project as overall successful. To find out that and to be able to create holistic ERP project success measures, authors designed a study which is covering all critical dimensions surrounding ERP implementations. The authors are equipping the theoretical classification with various items in a concrete survey reflecting them. Some of the dimensions seem to be at least partially synonymous or have a logical correlation. For example, the two dimensions Within Time and Within Budget seem to be connected. If a project consumes less time, it can be assumed it also needs less budget. Thus, method of factor analysis will be later used to check these interrelationships.

Before measures can be created, assigning items for each dimension in a structured questionnaire, certain requirements for defining measures have to be fulfilled (Hoffecker, Goldenberg, 1994). Measurements can be 'controlled', that means indicators can be influenced by stakeholders. For example, a given weakness of ERP cannot be influenced by consultants or users, and should not be in scope of measures. Indicators are 'easy to quantify', that means in best case, the data and key figures for measuring are already available. Measure are 'understandable', that means every project member is able to understand the figures correctly and the same way. And finally, measures must be 'reliable', 'relevant' and as 'accurate' as possible.

Considering these requirements, a comprehensive query was created, with 6 statements assigned to each of the 11 dimensions of ERP project success. For example, one of six statement describing Net Benefits is: 'The new system expands the possibilities of increased sales'. The possible answers were fixed with a 5-level Likert-scale, which ranges from value 1 'strongly disagree to 5 'strongly agree'. To make later statistical analysis easier, all statements were formulated in a positive meaning, which implies 'strongly agree' has a positive valuation of the project success dimension.

Before using it, the ERP project success survey was improved with expert interviews. CEOs from 8 different companies were asked whether all the statements were understandable, save against misinterpretation and fitting for the dimension assigned to. In addition, the average time span for completely filling out the questionnaire was measured.

After this quality check, the queries were sent per mail to CEOs from middle-sized companies from Germany and Austria. The mail included a web link pointing to our online survey measuring ERP project success for each company. The requirement for participation was, that the companies had to have a full ERP implementation, which means the core modules like finance and logistics were included, finished in the years 2011, 2012 or 2013.

An important issue is the perspective of success measurement. CEOs are best fitting for objectively evaluating ERP project success, as they are not directly and daily involved in ERP project implementation, but still have contact with key users in middle sized companies. They are in active exchange with ERP project management, usually taking part in ERP project steering committee and know the most important numbers and milestones being project sponsor. In addition, CEOs are able to access the financial numbers to assess net benefits

In addition to the queries, an explanation for each dimension was added including the descriptions for each dimension from the literature analysis above. This was applicable for the dimensions System Quality, Information Quality, Service Quality, Use / Intention to Use, User Satisfaction and Net Benefits. The five dimensions solely attached to project management success were also explained.

The response on the mailing to CEOs was very good, though a many questions concerning privacy and data security had to be clarified. After deleting all the incomplete and obvious invalid responses on the query, a total of 326 companies validly filled out the survey on ERP project success.

Results

First observation on the results revealed that there could be obvious similarities and correlations between dimensions. As a result, factor analysis has been used to reveal a more accurate underlying dimensionality of ERP project success measurement, in the context of the construct's constitution and major influencing factors.

Additional expert interviews suggested a logical reduction to 5 dimensions. To approve this number, a parallel analysis with O'Connor macro was conducted. The intrinsic value of the fifth component of the random data (1,795) was closest to the fifth component of the used data for measuring ERP project success (1,821).

A principal component factor analysis with Varimax was performed with 66 measurement items, theoretically relating to the 11 original dimensions gathered from the 326 sample elements. The Kaiser-Meyer-Olkin measure of sampling adequacy has been determined with a value of 0,956, which suggests that the sample is factorable. Bartlett's Test of Sphericity was significant with 0,000 ($p < 0,05$), indicating that there are correlations within the data and that factor analysis was appropriate (Backhaus *et al.*, 2008, pp. 323).

Item loadings above 0,4 have been included to the 5 new dimensions and all items generating an acceptable loading stayed in the model.

Cronbach's Alpha has been used as reliability coefficient in assessing the internal consistency of the model. The analysis revealed values ranging between 0,916 and 0,945 (> 0,8) which indicates a very high level of internal consistency of the measurement scale for the particular sample. The detailed result is listed in table 1.

Table 1

ERP Project Success' new 5 Dimensions, Cronbach's Alpha (created by authors)

Dimension	Description	M	SD	Coefficient α
1	Project Management	3,835	0,241	0,945
2	User Satisfaction	3,848	0,195	0,942
3	Time and Budget	3,609	0,305	0,918
4	ERP System Quality	4,159	0,202	0,907
5	Economic value	3,967	0,391	0,916

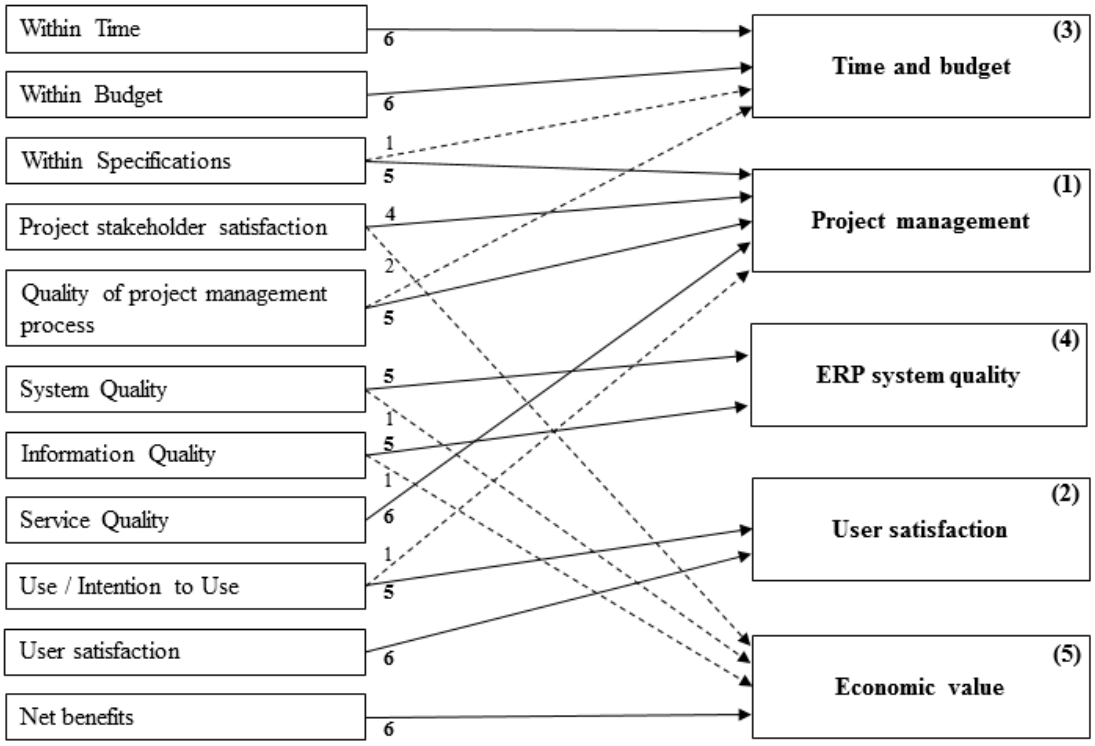

Figure 1. ERP Project Success – Dimension Reduction Through Factor Analysis (created by authors)

Five new main components have been extracted, with given Eigenvalues of the factors above 1, with factor 5 having the lowest value at 1,806. The cumulative value of the five dimensions explain 56,4 % of the total variance. Project management explains the majority of 37,5 %, followed by user satisfaction (8,1 %), time and budget (4,9 %), ERP system quality (3,1 %) and economic value (2,7 %). Dimension reduction for ERP project success is pictured in figure 1.

In most cases, all items from the old dimensions fitted directly with one of the 5 new dimensions. In 4 cases, one item was assigned to different dimensions. In one case, namely Project stakeholder satisfaction, two items moved to new dimension Economic value. When retrospectively looking at these 2 items, the shift was content comprehensible.

Discussion

The DeLone and McLean model (2003) is simple, as it was able to reduce numerous success dimensions to six. The model is also widely accepted, as from 1999 to 2002, the

original model has already been refereed in at least 285 papers. According to contemporary articles, the DeLone and McLean IS Success Model seems to remain the most popular, comprehensive framework for IS success measurement (Kronbichler *et al.,* 2010). Various reasons like simplicity and acceptability are supporting this model.

For further scientific studies, a strong argument for the DeLone and McLean model is that the authors state their intention in the title as the quest for the dependent variable. Project success is undergoing a similar quest for a dependent variable in various researches (Jiang *et al.,* 2002; Linberg, 1999).

By adding the dimensions for Project Management success to the DeLone and McLean model, the approach by Westhuizen and Fitzgerald (2005) provides a comprehensive basis for an instrument to measure the dependent variable, total project success. To prevent too much complexity, the differences in the perceptions of all stakeholders (Seddon *et al.,* 1999) and different system types (Seddon *et al.,* 1999) were not integrated. For instance, relating the eleven dimensions from the extended model to five different stakeholders and six system type dimensions mentioned by Seddon et al. (1999) results in more than 300 combinations. This exponential increase of factors would lead to an unmanageable measuring model.

Empirical data and factor analysis showed that these 11 dimensions can be reduced to five main aspects. As pictured in figure 2, the main construct stayed the same, as ERP project success is mainly a combination of project management success and project product success.

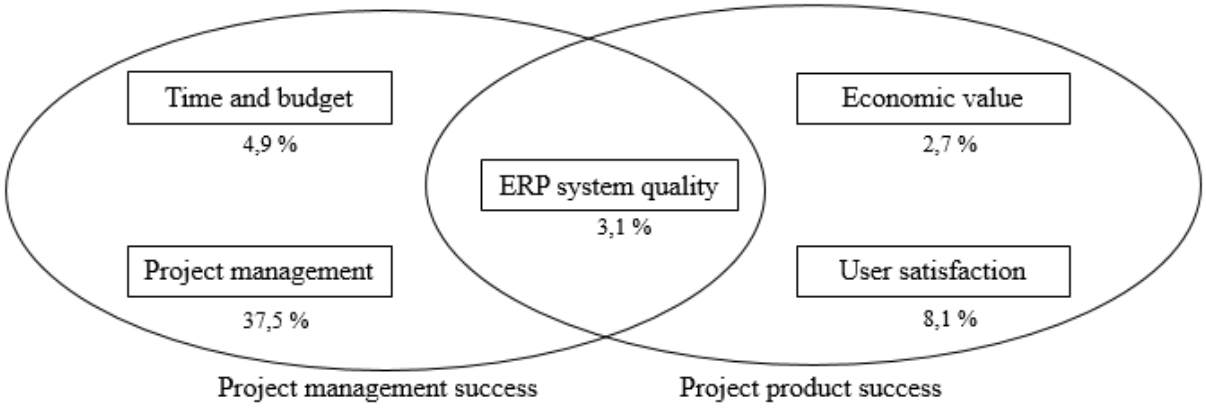

Figure 2. ERP Project Success Measurement with 5 new Dimensions (created by authors)

The numbers implicate, that a big weighting of ERP project success is on the quality of project management during the implementation project. Most of the total success is determined by this dimension. It also suggests that time and budget or even directly derived economic value is not most important evaluating ERP projects.

It also seems to confirm the development of increasing importance of good project managers. A raising number of members is recently counted for professional associations for project managing, more employees strive for project management certification and number of project management offices in companies is also increasing.

Conclusions

The total number of ERP implementation projects for middle sized companies in Germany and Austria per year was not statistically observed in any journal or literature so far. This could be understood as a limitation to this study. To find out the general population, 11 expert interviews with journalists, salesman and researchers of the ERP market were conducted. A mean number of 650 full ERP implementations per year was the result, which means the number for the researched time span is close to 2000. Even though this numbers are not empirically proven and a result of expert estimations, the sample covers at least between 10 and 15% of the total population. Therefore, the achieved sample size can be seen as considerable and fitting for statistical analysis.

Furthermore, a limitation can be a distortion between indicated reality and the actual situation. The fact that the surveys were carried out by people on high managerial level should weaken that restriction. A problem implicated by online surveys is also the missing certainty, that the questionnaire were personally filled out by CEOs, as often managers in that position give away that kind of work to assistants. To lower that risk, the authors were in vital contact with the managing directors. As the target group are middle sized companies, this objection can be seen as less critical, as in companies of that size CEOs are usually more involved in daily business and do more tasks themselves. It can also be assumed that only executive managers with vital interest on the structure and results of this study participated at all, as many responses hinted their curiosity on this topic.

It can be concluded that ERP project success can be measured with five different dimensions, which represent aspects of project management success and project product success. Measurement of ERP project success can be efficiently performed with dimensions of Project Management, Time and Budget, ERP System Quality, User Satisfaction and Economic Value. The dimension of Project Management which includes the quality of project management process, compliance of specifications, satisfaction of project stakeholders and quality of service covers the most considerable dimension.

The practical implication from the findings can be pulled over the reduction of dimensions from 11 to 5. As a consequence, it is useful to develop a new questionnaire which is consisting of less items. A survey with 6 items per

dimension would sum up to 30 items in total, a number which is better to sell to potential participants who have traditionally few time for external issues. Results from factor analysis help choosing the best fit items. In addition, the new questionnaires' understandability also needs to be approved by expert interviews.

According to the research items, the focus of ERP project management quality is emphasized on good scoping, open information policy, effective and rapid escalation paths, transparency, clean risk management and team member support. Badewi and Shehab (2015) claim that project management practice need to be mature, as a routinized approach might not be enough to secure a successful ERP project.

ERP projects should be finished within specifications, that means for reaching these goals project management and management needs to clarify very early a concrete project scope. The goals and scope of a project needs to be communicated to the project team members and even within the whole company for several times. Important information should be communicated openly, especially the status or progress of the ERP implementation. If problems or mayor delays occur, these issues need to be escalated quickly and in full extent. For critical situations, also a transparent risk management is very important. The project management itself should be highly visible and predictable, for example a status of all department needs to be made on regular basis and in writing. It is also important to basically derive subproject plans and work packages from the main project objectives. And finally, the non-bureaucratic support of the project team members by project management is imperative.

The underlying empirical research with its items revealed in this paper should provide a basis for further standardized application of ERP project success measurement. The measured success of ERP implementation can be seen as the dependent variable in further models, as the output can be influenced by various factors during the project.

A running study by the author analyzes the impact of motivation on ERP projects success in mid-sized companies. To assess employees' sources of motivation, the Motivation Sources Inventory (MSI) of Barbuto and Scholl will be applied on finished ERP implementations. This typology has been used in several studies (Barbuto, Scholl, 1998) and was found to be reliable and valid determining different sources of motivation of employees (Barbuto, 2001). A lot of ERP projects do not reach the expected results or even worse, lead to the complete failure of the project. Although some of ERP-project failures arise from technical aspects, the majority of these problems result from management, social and organizational issues within the companies. Management can promote motivation, and motivation is both a social and organizational aspect. For a successful ERP implementation, these issues must be considered because there are multilayered challenges for organizations during ERP projects. A structural model can already be suggested, describing dependencies between motivational sources and ERP-project success. The analysis should critically reflect on the relevance of motivation and discover concrete linkages and correlation between motivation and success. Linear regression analysis could prove a positive impact of different employees' motivation sources on aspects or dimensions of ERP project success. There is actually a lack of knowledge of how to motivate employees during that difficult one or two years. ERP-projects change tasks, processes and ways of working, making a high level of employee motivation absolutely essential.

The results and conclusions can hopefully help to better understand motivators of employees during ERP-implementations, and could also derive some recommendations for project management, leadership styles and organizational activities.

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