

Critical Success Factors for ERP system upgrades – The Case of a German large-scale Enterprise

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ABSTRACT

The aim of our study was to gain insight into the research field of critical success factors (CSFs) of enterprise resource planning (ERP) projects, especially the post-implementation phase, with specific focus on system upgrades as an essential part of this phase. Therefore, we conducted a systematic literature review in order to update the existing reviews of CSFs. On the basis of that review, we conducted a single case study within a German large-scale enterprise in the service sector. As a result, we could show that all 31 factors found in the literature review also affect the success of ERP system upgrades. Eight of the top 10 CSFs ranked as most important in the literature review also appear in the top 10 for upgrade projects. However, other factors gained or lost importance considerably in comparison to the literature review.

Keywords

Critical success factors, CSF, ERP system, Post-Implementation, System Upgrade.

MOTIVATION

Today's enterprises are faced with the globalization of markets and fast changes in the economy. In order to cope with these conditions, the use of technology and information and communication systems is almost mandatory. Specifically, the adoption of enterprise resource planning (ERP) systems as standardized systems that encompass the actions of entire enterprises has become an important factor for today's businesses. The demand for ERP applications has increased for several reasons, including competitive pressure to become a low cost producer, expectations of revenue growth, and the desire to re-engineer businesses to respond to market challenges. A properly selected and implemented ERP system offers several benefits, such as considerable reductions in inventory costs, raw material costs, lead time for customers, production time, and production costs (Davenport, 2000; Grabski and Leech, 2007; Koh and Simpson, 2005; Somers and Nelson, 2001). Therefore, the majority of enterprises around the world use ERP systems. For example, according to a survey conducted in Germany in 2010/2011, ERP systems are used in more than 92 percent of all German industrial enterprises (Konradin, 2011).

However, to be able to use and consistently benefit from the advantages of an ERP system, continuous adjustments and changes are mandatory throughout the whole life cycle of such a system. These changes can be initiated by the company using the ERP system or by the ERP manufacturers themselves. Changes of a more technical nature include major maintenance updates or upgrades for troubleshooting, feature updates, new modules with advanced functionality for all parts of the company, and/or even the "voiding" of manufacturer support for certain releases (Shepherd, 2007). Economically driven ERP system changes can include corporate takeovers or mergers and/or new or changes in requirements on the basis of governmental regulations. Desire for efficiency or increasing pressure for effectiveness to strengthen the competitiveness of an enterprise the necessity can also create the need to reorganize an ERP system or to consolidate systems from different manufacturers, or even to roll out modules in other parts of the company (Hough, Haines and Giacomo, 2007).

There are many ERP systems with different technologies and philosophies available on the market. This multitude of software manufacturers, vendors, and systems implies that enterprises that use or want to use ERP systems must strive to find the "right" software as well as to be aware of the factors that influence the success of the implementation project. Remembering these so called critical success factors (CSFs) is of high importance whenever a new system is to be adopted and implemented or an active system needs to be upgraded or be replaced (Leyh, 2012). Errors during the selection, implementation, or maintenance of ERP systems, inappropriate implementation approaches, or the adoption of ERP systems that do not fit the requirements of the enterprise can all cause financial setbacks or disasters, perhaps even leading to insolvencies. Several examples of such negative scenarios can be found in the literature (e.g., Barker and Frolick, 2003; Hsu, Sylvestre and Sayed, 2006).

These critical success factors have been considered in numerous scientific publications (e.g., Achanga, Nelde, Roy and Shehab, 2006; Finney and Corbett, 2007; Nah, Zuckerweiler and Lau, 2003; Somers and Nelson, 2001). However, the existing ERP system success factor research has focused in particular on the selection and implementation of ERP systems. Less attention has been paid to the post-implementation phase (Esteves and Bohórquez 2007; Grabski, Leech and Schmidt, 2011; Moon, 2007).

Therefore, the aim of our study was to focus on the post-implementation phase of ERP systems, especially focusing on system upgrades as an essential part of this phase. Prior to this study we conducted a systematic literature review in order to update the existing reviews of CSFs. On basis of the CSFs identified, we conducted a single case study within a German large-scale enterprise operating in the service sector to get initial insights into the similarities and differences in CSFs for system upgrade projects. This case study will offer initial answers to the following research questions:

Q1: What are the critical success factors of ERP system upgrade projects?

Q2: What similarities and difference exist between critical success factors for ERP implementation projects and ERP system upgrade projects?

Therefore, the paper is structured as follows: The next section deals with the results of our literature review. We will point out which factors are the most important and which factors seem to have little influence on the success of an ERP implementation project. Next, our case study design is described before the results of the case study are presented and the research questions are answered. Finally, the paper concludes with a summary of the results and discusses the limitations of the case study conducted.

LITERATURE REVIEW OF CRITICAL SUCCESS FACTORS

A critical success factor for an ERP project is defined according to Finney and Corbett (2007) as reference to any condition or element that is seen necessary in order for the ERP implementation to be successful. In order to identify these factors that affect the success or failure of ERP projects, several case studies, surveys, and literature reviews have already been conducted by a number of researchers (e.g., Esteves and Pastor, 2000; Finny and Corbett, 2007; Nah et al., 2003). Most of the literature reviews cannot be reproduced, because descriptions of the review methods and procedures are lacking. Some researchers have pointed out the limitations of the current literature review articles, specifically noting that they lack methodological rigor (Vom Brocke, Simons, Niehaves, Riemer, Plattfaut and Cleven, 2009). Therefore, in order to update the existing reviews by including current ERP literature, we conducted a literature review by systematically reviewing articles in five different databases as well as papers drawn from several international conference proceedings. The overall procedure for the ERP system review will not be part of this paper. It is described in detail in Leyh (2011) and Leyh (2012).

We identified 185 papers that referred to CSFs of ERP projects. These papers were reviewed again in depth in order to determine the various concepts associated with CSFs. For each paper, the CSFs were captured, along with the publication year, the type of data collection used, and the companies (i.e., the number and size) from which the CSFs were derived.

All 185 papers were published between 1998 and early 2010. Table 1 shows the distribution of the papers by publication year. Most of the papers were published between 2004 and 2009. Starting in 2004, about 20 papers on CSFs were published each year.

Year	2010	2009	2009	2007	2006	2005	2004
Papers	6	29	23	23	25	18	23
Year	2003	2002	2001	2000	1999	1998	
Papers	11	12	5	6	3	1	

Table 1. Paper distribution by year

Overall, 31 factors influencing the success of ERP system implementation were identified. Table 2 shows the results of our review, i.e., the CSFs identified, their ranks and each factor's total number of occurrence in the reviewed papers.

Rank	Factor	Number of instances	Rank	Factor	Number of instances
1	Top management support and involvement	128	17	ERP system acceptance / resistance	42
2	Project management	104	18	Project team leadership / empowered decision makers	41
3	User training	99	19	Vendor's tools and implementation methods	39
4	Change management	86	20	Monitoring and performance measurement	38
5	Balanced project team	85	21	Data accuracy	34
6	Clear goals and objectives	83	22	Available resources	33
7	Communication	78	23	Organizational culture	31
8	Organizational fit of the ERP system	77	24	ERP system tests	23
8	ERP system configuration	77	25	Troubleshooting	22
10	Business process reengineering	73	26	Environment	21
11	Involvement of end-users and stakeholders	68	27	Organizational structure	17
12	External consultants	62	28	Interdepartmental cooperation	16
13	Project champion	53	28	Company's strategy / strategy fit	16
13	IT structure and legacy systems	53	30	Use of a steering committee	15
15	Vendor relationship and support	48	31	Knowledge management	8
16	Skills, knowledge and expertise	47			

Table 2. ERP project CSFs in rank order based on frequency of appearance in analyzed literature

The factors "Top management support and involvement," "Project management," and "User training" are the three most named factors, with each being mentioned in about 100 articles or more. We will not describe each factor and its concepts in detail in this paper. However, to provide a comprehensive understanding of the different CSFs and their concepts, we described all 31 factors in Leyh (2011) as well as the top 8 factors again more detailed in Leyh (2012). Regarding the data collection method, we must note that the papers we analyzed for CSFs were distributed as follows: 95 single or multiple case studies, 55 surveys, and 35 literature reviews or articles in which CSFs are derived from chosen literature.

In most previous literature reviews, the CSFs were grouped without as much attention to detail; therefore, a lower number of CSFs was used (e.g., Finney and Corbett, 2007, Loh and Koh, 2004; Somers and Nelson, 2001). However, we took a different approach in our review. For the 31 factors, we used a larger number of categories than other researchers, as we expected the resulting distribution to offer more insight. If broader definitions for some CSFs might be needed at a later time, further aggregation of the categories is still possible. Comparing these results with other literature reviews (e.g., Finney and Corbett, 2007), the top five factors are obviously similar, with only the ranked positions differing. Due to our large literature base, the total numbers of observed mentions are much higher. Therefore, the differences in the CSF frequencies are much higher as well, making the distinctions in the significance of the factors clearer.

THE CASE OF AN ERP SYSTEM UPGRADE PROJECT

Case Study Design

To gain an initial understanding of possible differences in the CSFs for ERP system upgrades in the post-implementation phase, we conducted an exploratory single case study within a large-scale German enterprise. This company mainly operates in the energy industry and provides energy-related services including electricity, gas, water, and heat. With more than 1 billion € in turnover per year and more than 1500 employees, it runs several major networks and offers its services to private customers as well as business customers. The company also offers IT capacity to surrounding public utilities as a service. ERP clients are administered and maintained along with the company's own system. Therefore, the company's IT department acts as both as an internal IT department as well as an external service provider.

Since the energy sector is strictly regulated in Germany, the company was forced to change some main business processes as a result of changes in governmental regulations. The existing ERP system (SAP ERP 6.0) did not provide all necessary functionalities to fulfill the new regulatory standards. Therefore, a larger system upgrade became necessary. These changes and the connected upgrade affected more than 200 employees in different capacities. To implement the upgrade, a project team was set up consisting of several employees who had more than 10 years experience with ERP projects, since about 10 ERP projects (of different scopes) had been carried out within the company since the early 2000s.

The unit of analysis of our study is their upgrade project, which was carried out from autumn 2010 until autumn 2011. For the data collection, we conducted several interviews with project members to identify the factors that they determined to be relevant for the project's success. All of the interviewees were internal employees since external consultants did not play a major role in this project. The entire project team consisted of close to 50 people. Therefore, it was also essential that the interviewees be chosen from different levels of the project's hierarchy and from only slightly overlapping areas of responsibility. In this regard, Finney and Corbett (2007) mention that it is essential to include members of different hierarchy levels in the data collection in order to gather a broad and balanced collection of lessons learned. Therefore, we interviewed six project members with different tasks and duties. Table 3 gives a short overview.

Interviewee	Description	Tasks within the project
1	Key user	SAP development
2	Manager	Member of the project leadership team, with technical focus on the computer center
3	Key user	Expert from an operating department, key user tests
4	IT expert	Authorization management
5	IT expert	Process and workflow design
6	Key user, manager	Member of the project leadership team, with focus on the process roll-out

Table 3. Interviewees

The interviews were conducted in retrospect to the system upgrade in April and May 2012. The interviews were designed as partially standardized interviews using open to semi-open questions as initial starting points for the conversation. An interview guideline was developed, based on the questions of Nah and Delgado (2006), who conducted a similar study. However, we changed the questions to align with our identified CSFs to ensure that all of the factors were discussed in the interviews. The interview guideline consisted of 41 questions that referred to the 31 identified CSFs. These questions were formulated in an open way so that it would be possible to identify "new" CSFs which were not resulting from the literature review. The complete listing of the formulated questions and their assignment to the success factors will not be part of this paper but will be provided by the first author upon request.

For a better analysis of the results we recorded all interviews (the interviews typically took about 90 minutes) and transcribed them afterwards. As a first step, non-verbal and para-linguistic elements and other elements that were not relevant to the

study were excluded. To evaluate the CSFs, the interviews were analyzed with reference to each CSF question block and the statements of the interviewees were classified according to a three-tier scale (very important, important, and less important).

Results – project specifics

The clear goal and the main driver of the upgrade project was to meet the new governmental regulations within the given deadline. Drivers such as cost reduction in the operation of IT systems, simplification and standardization of information flow to improve efficiency, or better integration of business processes were also part of the decision-making process, but were less important than complying with governmental regulations. Therefore, it was not necessary for the company to set up a detailed business plan since no other alternatives existed to upgrade the ERP systems to fulfill the new requirements. Due to these governmental requirements this case study can be seen as somehow unique compared to other ERP upgrade projects.

It was mandatory (to meet the given deadline) to provide enough resources (employees, budget, equipment ...) for this project. All interviewees said that top management allocated enough human and financial resources for the upgrade project. However, since the upgrade caused not only functional changes within the system but also some changes in the business processes, the departments involved had to actively participate and become involved in the project as well. At the beginning of the project, these departments did not see the necessity of their involvement. This was caused by the low profile of the project within the company. The respective departments (and even the IT department) did not sense that the upcoming changes would be so extensive. Therefore, for example, no additional user trainings were planned to guide users in completing the new functions. However, near the end of the project, as the extent of the upcoming changes became clearer, the departments realized the necessity and the importance of user trainings for the new functionalities. Since then, the user trainings were seen as an important factor for the project's success. However, since these trainings were not included in the schedule from the beginning, additional external consultants had to be hired to do the trainings.

Not only for the user trainings but also throughout the whole project, external consultants with specialized SAP knowledge were hired to counterbalance lack of experience with the new process model or with implementation issues. These consultants had been in contact with the company for a number of years and carried out many other projects within the company. The interviewees characterized the consultants' major contribution as closing the gap between SAP's standard process model and the actual enterprise processes and identifying necessary adjustments.

Since the project management of every ERP project is an important task, the project team was divided into four different subprojects, each with one project leader. Progress was monitored with regular meetings. Additionally, there was a main project leader who led the whole project. The project team used active as well as passive information flows for outward communication. The steering committee as well as the leading key users were updated in regular meetings. Afterwards, written summaries of the meetings were handed out. Additionally, regular status updates were sent to all involved and affected employees. According to the interviewees, the communication and the information flow was seen as very good throughout all involved departments.

From a technical point of view, the project was based on the existing ERP system landscape of the company. The SAP system had been used throughout the enterprise for several years and during those years different changes and adjustments have already been conducted. Therefore, all employees were familiar with the system and "merely" had to learn the new processes and functions. The project impact was localized within the national boundaries. Hence, there were no cross-border issues regarding different languages, value systems, or cultures. No new hardware had to be purchased for the implementation. Six years before, the company had changed to new hardware with a virtualized environment and thereby won great flexibility in infrastructure planning for testing and quality assurance systems. Due to an automated upgrade process from SAP, the data analysis, preparation, and data migration was not difficult. Only some newly implemented processes and some new database tables and additional fields were needed to enhance existing tables.

No fully formalized testing procedure was used for the upgrade project. The key users from the respective departments were responsible for the technical and functional evaluation and were tasked with creating the test cases as well as a schedule for the testing. Afterwards, the new functionalities were evaluated in three process tests. Each took one to three weeks. A developer noted that such long and intensive testing slowed down the adjustment process.

The company did no analyses of alternatives to the upgrade of the existing SAP system. Therefore, no third party vendors who might also be able to implement the new required processes and functions across the existing ERP were considered. This choice allowed the use of most of the SAP standard processes and minimized the tailoring effort. One interviewee stated that approximately 60% of the functionality of the implementation of the processes was completely standard and only 40% had to be adjusted. However, that 40% made up a very large part of the labor-intensive implementation effort.

The support from the SAP provider was in general perceived as good by the interviewees. The vendor and its consultants produced a positive impact on the success of the upgrade project. However, some “error tickets” required a longer response time than expected, which slowed down the progress of the project a bit. The interviewees stated that this could be partly compensated for by the multi-year experience that the consultants had with earlier projects within the company studied. However, the consultants did not play a major role in the project.

Results – CSFs of the system upgrade

For each interview, a ranking of the critical success factors was set up by the authors. A final ranking was created including all interviews and all individual rankings (see Table 4).

Rank	Factor	Rank-difference to the literature review	Rank	Factor	Rank-difference to the literature review
1	Project management	+ 1	17	Project team leadership / empowered decision makers	+ 1
2	Change management	+ 2	18	Monitoring and performance measurement	+ 2
3	User training	+/- 0	19	Data accuracy	+ 2
4	Top management support and involvement	- 3	20	Knowledge management	+ 11
5	Communication	+ 2	21	Business process reengineering	- 11
6	Available resources	+ 16	22	Project champion	- 8
7	ERP system configuration	+ 1	23	Organizational fit of the ERP system	- 15
8	Balanced project team	- 3	24	IT structure and legacy systems	- 11
9	ERP system tests	+ 15	25	Vendor relationship and support	- 10
10	Clear goals and objectives	- 4	26	Interdepartmental cooperation	+ 2
11	Involvement of end-users and stakeholders	+/- 0	27	Organizational structure	+/- 0
12	Troubleshooting	+ 13	28	Organizational culture	- 5
13	ERP system acceptance / resistance	+ 4	29	Company's strategy / strategy fit	- 1
14	Vendor's tools and implementation methods	+ 5	30	Use of a steering committee	+/- 0
15	Skills, knowledge and expertise	+ 1	31	Environment	- 5
16	External consultants	- 4			

Table 4. CSFs of the ERP system upgrade project

According to the interview results, no additional critical success factors were identified. Moreover, all CSFs from the literature review were mentioned in at least one interview. Table 4 also shows the differences in the rankings arrived at through the literature review and the case study. As illustrated, the top four factors remained the same and only shifted a bit in their rankings. However, other factors were ranked much more or much less important.

Most of the top 10 factors from the literature review are still part of the top 10; though some of them have changed their ranks. However, two factors from the top 10 were replaced by other factors; both of these were relegated to the final third of the rankings derived from the literature review. The factor *Available resources* gained considerably in importance, with a rank jump of +16. This was mainly due to the time pressure. It was mandatory to go live in September 2011 due to the governmental regulations. Therefore, the company allocated all the necessary resources and employees to meet this deadline. Also, *ERP system tests*, with a rank jump of +15, became a new member of the top 10. Since in an upgrade an existing ERP system is modified, these changes must be extensively tested to ensure that the system functions correctly even with the adjustments. In addition, the interviewees said that system tests would significantly increase end users' acceptance because they participate extensively in the tests. The increase in the rankings of these two factors was relatively equivalent to the decreases in ranking of the two former top 10 factors that they replaced, *Organizational fit of the ERP system* and *Business process reengineering*. *Organizational fit of the ERP system* was ranked 14 spots lower and thus is far less important during a system upgrade, because a system upgrade is always done to an existing system. There is practically no selection process involved in ERP system upgrades or upgrades of specific functions. Also, the company studied chose an upgrade provided by its system vendor. No third-party software add-ons were considered. However, this is still an alternative solution to upgrading systems. Additionally, *Business process reengineering* (BPR) was ranked 11 spots lower, and is also no longer part of the top 10. For the case study company, BPR has been necessary only for limited processes and therefore, BPR was not seen as a particularly critical factor by the interviewees. The company decided to use the standardized SAP processes to the greatest possible extent. In addition, most new processes were strictly defined by the new governmental regulation and therefore were already included in the upgrade's functions. Only minor BPR was necessary, mainly to adjust interfaces to other processes and functionalities.

CONCLUSION AND LIMITATIONS

The aim of our study was to gain insight into the research field of CSFs for ERP projects, with a focus on ERP system upgrades. Research in the field of ERP system projects and their CSFs provides valuable information that may enhance the degree to which an organization's implementation project succeeds (Finney and Corbett, 2007). As a first step, we carried out a systematic literature review to identify CSFs and to update existing reviews. Our review turned up a variety of papers, i.e., case studies, surveys, and literature reviews, focusing on CSFs. All in all, we identified 185 relevant papers dealing with CSFs of ERP system projects. From these existing studies, we derived 31 different CSFs (see Table 2).

Few studies focusing on ERP system upgrade projects exist. Therefore, as an initial investigation in order to compare the CSFs of ERP upgrades with the CSFs found in the literature review, we conducted a single case study within a German large-scale enterprise in the energy industry that carried out an ERP upgrade of its SAP system. Using a guideline consisting of 41 questions about CSFs, we interviewed six project members of different hierarchy levels. We found that all 31 factors found in the literature review were mentioned by at least one interviewee and therefore, all 31 factors also affect the success of ERP system upgrade projects. Eight of the top 10 ranked CSFs from the literature review are also ranked in the top 10 for upgrade projects. The factors *Available resources* and *ERP system tests* gained more importance within the upgrade projects and replaced the factors *Organizational fit of the ERP system* and *Business process reengineering* in the top 10. As shown in Table 4, other factors also gained or lost importance in comparison to the literature review.

Due to the quick pace of technological evolution, it is becoming more and more important for companies to stay up to date and to keep in touch with the latest developments that may lead them to upgrade their systems. This is also important for smaller and medium-sized companies (SMEs), which evolve much faster than large-scale companies but often lack the human and financial resources to enable their information systems to cope with the changes within the company. Also, to cooperate with larger enterprises with highly developed IT infrastructure, SMEs need to upgrade their information systems and IT infrastructure as well. Therefore, IT upgrade projects must be adapted to the specific needs of SMEs. Here, the importance of certain CSFs might differ depending on the size of the organization. Thus, focusing on ERP upgrade projects and their CSFs in relation to company size or industry sector could be a valuable topic of future research.

A few limitations of our study must be mentioned as well. For our literature review, we are aware that we cannot be certain that we have identified all relevant papers published in journals and conferences since we made a specific selection of five databases and five international conferences. Therefore, journals not included in our databases and the proceedings from

other conferences might also provide relevant articles. Another limitation is the coding of the CSFs. We tried to reduce any subjectivity by formulating coding rules and by discussing the coding of the CSFs with several independent researchers. However, other researchers may code the CSFs in other ways. For the single case study, the interviews conducted and data evaluated represent only an initial investigation of the CSFs of ERP upgrade projects. These results are limited to the specifics of this enterprise. In light of this, we will conduct further case studies and some larger surveys to broaden the results of this investigation.

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