The Impact of Critical Success Factors across the Stages of Enterprise Resource Planning Implementations

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Abstract

This paper describes the impact of Critical Success Factors (CSFs) across the stages of Enterprise Resource Planning (ERP) implementations using the responses from 86 organizations that completed or are in the process of completing an ERP implementation. Our results provide advice to management on how best to utilize their limited resources to choose those CSFs that are most likely to have an impact upon the implementation of the ERP system.

1. Introduction

A recent IT innovation that is enhancing organizational performance through providing end-to-end connectivity is Enterprise Resource Planning (ERP) Systems. ERP software, which attempts to integrate all departments and functions across a company into a single computer system, is one of the fastest growing segments in the software market, and one of the most important developments in information technology in the last decade. A recent survey of 800 U.S. companies showed that ERP was commanding 43% of the companies' application budgets with ERP systems installed in almost half of these companies [1]. Market penetration of ERP varies considerably from industry to industry [58]. With over 60% of the U.S. Fortune 1000 penetrated, major ERP vendors are increasingly targeting small- and medium-sized enterprises (SMEs) to generate new sales. Vendors and users are also moving beyond core applications to extend ERP systems to support Web-based applications, e-commerce, customer-relationship management, and business planning [58].

The growing demand for ERP applications has several reasons, for example, competitive pressures to become a low cost producer, expectations of revenue growth, ability to compete globally, Y2K-related replacements, and the desire to re-engineer the business to respond to market challenges [38]. Benefits of a properly selected and implemented ERP system can be significant leading to considerable reductions in inventory cost, raw material costs, lead time for customers, production time, and production costs [28].

Despite the fact that "the business world's embrace of enterprise systems may in fact be the most important development in the corporate use of information technology in the 1990s" [17], broad-based empirical research in the CSFs that impact implementation are still very limited. For instance, some of the "success factors" identified in four case studies reviewed by Sumner [60] included: support of senior management, redesign of business processes to "fit" what the software will support, investment in user training, avoidance of customization, and use of "business analysts" with both business knowledge and technology knowledge. Bingi, Sharma and Godla [8] identified critical issues believed to impact an ERP implementation. For example, commitment from top management, reengineering of the existing processes, integration of the ERP with other business information systems, selection and management of consultants, and employee training on the new system must be considered to ensure successful implementation. Reel [47] summarized what he believed are essential CSFs in software projects that influence the successful management of a software development effort, and hold true regardless of the design and development methodology, the implementation language, or the application domain. Holland and Light [31] developed a framework that groups the CSFs of the ERP implementation process into strategic and tactical factors. Fitzgerald and O'Kane [23] discuss lessons learned by Motorola's Cellular Infrastructure Group in Cork, Ireland application of the CSF concept to software process improvement program. Willcocks and Sykes [65] found throughout their practical and research experiences that, "in practice, the need to identify and build key in-house IT capabilities before entering into ERP projects emerges as one of the critical and neglected success factors".

The concept of critical success factors in the IS literature is well established for numerous contexts, for example, requirements analysis [49], IS planning [9], and project management [51]. While ERP implementations differ from traditional systems in scale, scope, complexity, organizational changes, project costs, and need for business process re-engineering, the theoretical

development of CSFs in ERP implementations remains embryonic.

The purpose of this paper is to (1) empirically assess which CSFs are most critical in the ERP implementation process, and (2) address the close coupling of the CSFs of ERP systems across the stages of implementation based on a cross-section of medium to large organizations, who reportedly have implemented an ERP system. We examine the implications of the results for research and practice, and describe how they can be used as a communication tool and/or a checklist for consensus building by the stakeholders in their discussions on implementation.

2. Critical success factors of ERP implementation

Critical success factors can be viewed as situated exemplars that help extend the boundaries of process improvement, and whose effect is much richer if viewed within the context of their importance in each stage of the implementation process. Following Cooper and Zmud [15], we view the implementation process as consisting of six phases: initiation, adoption, adaptation, acceptance, routinization, and infusion. A number of factors that may affect the ERP implementation process and the probability of conversion success have been identified in the IT implementation, IT failures, and business process reengineering literatures [3]. Among the more important factors are top management support and involvement [34], the need for a project champion [7], user training [44], technological competence, process delineation, project planning, change management, and project management [27]. In the context of ERP implementation, additional issues include the need to reengineer business processes prior to implementation, the need to communicate effectively and set appropriate expectations, the use of a balanced IS and business team [5], and the avoidance of customization [60].

We propose a comprehensive list of 22 CSFs associated with project/system implementations derived through a process that involved identification and synthesis of those critical requirements for implementation that have been recommended by practitioners and academicians through an extensive review of the literature [55]. Specifically, we carefully reviewed the literature on IT implementation, business process reengineering, project implementations and descriptions, and case studies of ERP implementations of over 110 hundred companies in the popular literature to arrive at our CSFs [available upon request]. Each of the CSFs identified to have an impact on ERP implementations are described next along with relevant literature that supports their influence in project implementations in general.

2.1. Top management support

The commitment of top management to the diffusion of innovations throughout an organization has been well documented [34]. In particular, early in a project's life, no single factor is as predictive of its success as the support of top management [8],[54]. The roles of top management in IT implementations include developing an understanding of the capabilities and limitations of IT, establishing reasonable goals for IT systems, exhibiting strong commitment to the successful introduction of IT, and communicating the corporate IT strategy to all employees [43]. Research on project failures shows that project cancellations occur when senior management delegates progress monitoring and decisions at critical junctures of the project to technical experts [21]. The importance of top management support was instrumental in the successful implementation of a large customized system [26], was the second most important CSF in a study of MRP implementations in Sinagapore [2], and appeared to be the driving force behind a successful ERP implementation at a manufacturing firm in the southern Midwest [13].

2.2 Project champion

The success of technological innovations has often been linked to the presence of a champion who performs the crucial functions of transformational leadership, facilitation, and marketing the project to the users [7], [43]. Project champions should own the role of change champion for the life of the project and understand both the technology as well as the business and organizational context. By appointing an executive level individual with extensive knowledge of the organization's operational processes, senior management can monitor the ERP system implementation, because the champion has direct responsibility for and is held accountable for the project outcome [13]. One advantage of positioning the champion high in the organization is associated with the authority to move large and complicated projects through the transition [43]. Championship is a critical enabling factor if ERP stands a chance of succeeding [65].

2.3. User training and education

The role of training to facilitate software implementation is well documented in the MIS literature [44]. Lack of user training and failure to completely understand how enterprise applications change business processes frequently appear to be responsible for problem ERP implementations and failures [16], [64]. ERP projects appear to have a six-month learning curve at the beginning of the project [14]. At a minimum, everyone

who uses ERP systems needs to be trained on how they work and how they relate to the business process early on in the implementation process. Although many companies use consultants to help during the implementation process, it is important that knowledge is transferred from the consultant to internal employees [18]. Companies should provide opportunities to enhance the skills of the employees by providing training opportunities on a continuous basis to meet the changing needs of the business and employees [8].

2.4. Management of expectations

Information system failure has been defined as "the inability of an IS to meet a specific stakeholder group's expectations" [39, p. 263] and successfully managing user expectations has been found to be related to successful systems implementation [26]. Expectations of a company may exceed the capabilities of the system. ERP systems may fail to meet expectations despite positive contributions to the organization if the systems are "oversold" by the vendor. Careful deliberation of success measurement as well as management of expectations by the implementation manager of ERP projects are important factors [41]. Management of expectations has an impact through all stages of the implementation life cycle [30].

2.5. Vendor/customer partnerships

Vendor/customer partnerships are vitally important to successful ERP projects [57]. Research has shown that a better fit between the software vendor and user organization is positively associated with packaged software implementation success [33] and that organizations should attempt to maximize their compatibility with their vendors [62]. The relationship between the software buyer and vendor should be strategic in nature with the ERP provider enhancing an organization's competitiveness and efficiency. In their study, Willcocks and Sykes [65] identified supplier partnering as an enabling critical factor necessary for ERP success.

2.6. Use of vendors' development tools

There are indications that rapid implementation technologies and programs provided by the vendors can significantly reduce the cost and time of deploying ERP systems. An additional goal of implementation tools is the transfer of knowledge with respect to using the software, understanding the business processes within the organization, and recognizing industry best practices. Accelerators provided by vendors include business-process modeling tools that link business models to the software, templates for industry-specific business practices, and bundling of server hardware with ERP software, or offering combined packages of software, services, and support [25].

2.7. Careful selection of the appropriate package

The choice of the package involves important decisions regarding budgets, timeframes, goals, and deliverables that will shape the entire project. Choosing the right ERP packaged software that best matches the organizational information needs and processes is critical to ensure minimal modification and successful implementation and use [33]. Selecting the wrong software may mean a commitment to architecture and applications that do not fit the organization's strategic goal [48] or business processes.

2.8. Project management

While many in the IS business consider project management an oxymoron, its importance in IT projects is well–documented, and numerous methodologies and management tools exist. Project management activities span the life of the project from initiating the project to closing it [30]. The contingency approach to project management suggests that project planning and control is a function of the project's characteristics such as project size, experiences with the technology, and project structure. The vast combination of hardware and software and the myriad of organizational, human and political issues make many ERP projects huge and inherently complex, requiring new project management skills [50]. Specifically, proper management of scope is critical to avoid schedule and cost overruns and necessitates having a plan and sticking to it. A project scope that is too broad or ambitious can cause severe problems. Customization increases the scope of an ERP project and adds time and cost to an implementation. The minimal customization strategy discussed later, which allows for little if any user-suggested changes and customizations, is an important approach to managing the scope of an ERP project. The high implementation risks of ERP projects imply the need for multiple management tools such as external and internal integration devices and formal planning and results-controls [3].

2.9. Steering committee

To make ERP succeed, it is necessary to form a steering committee or group of "superusers" [60]. A project management structure with a "steering committee" consisting of senior management from across different

corporate functions, project management representatives, and end users who will have daily contact with ERP, is an effective means of ensuring appropriate involvement [11]. A steering committee enables senior management to directly monitor the project team's decision making by having ratification and approval rights on all major decisions, thereby ensuring that there are adequate controls over the team's decision making processes [63].

2.10. Use of consultants

Many organizations use consultants to facilitate the implementation process. Consultants may have experience in specific industries, comprehensive knowledge about certain modules, and may be better able to determine which suite will work best for a given company [46]. Consultants may be involved in various stages of the implementation: performing requirements analysis, recommending a suitable solution, and managing the implementation [62]. While opinions vary with respect to what third parties should be able to control, the company should keep control and accept full responsibility for all phases of the project [14]. A recent study of SAP implementations indicated mixed performance ratings for consultants [14]. A major concern stems from financial ties to the recommended software vendor and lack of expertise and experience in ERP appropriate to the business [46].

2.11. Minimal customization

Minimal customization which involves using the vendor's code as much as possible even if this means sacrificing functionality has been associated with successful ERP implementations [48]. A recent survey of Fortune 1000 companies regarding ERP customization policies indicates that 41% of the companies re-engineer their business to fit the application, 37% of the companies choose applications that fit their business and customize a bit, and only 5% customize the application to fit their business [19]. Because customizations are usually associated with increased information systems costs, longer implementation time, and the inability to benefit from vendor software maintenance and upgrades [33], customization should only be requested when essential [4] or when the competitive advantage derived from using non-standard processing can be clearly demonstrated [20]. Management has the ultimate choice of changing the process to fit the system or the system to fit the process.

2.12. Data analysis and conversion

A fundamental requirement for the effectiveness of ERP systems is the availability and timeliness of accurate data. Data problems can cause serious implementation delays, and as such, the management of data entering the ERP system represents a critical issue throughout the implementation process [36]. Within the company, the challenge lies in finding the proper data to load into the system and converting all those disparate data structures into a single, consistent format. Conversion can be an overwhelming process, especially if companies do not understand what needs to be included in the new systems and what needs to be omitted. In addition, interfaces with other internal and external systems (between departments such as accounting and production, legacy, client/server, other ERP/MRP/MPRII systems, data warehouses, EDI, EFT, and Web) require the ability to handle complex data sources and legacy data types.

2.13. Business process reengineering

One of the problems associated with implementing packaged software is the incompatibility of features with the organization's information needs and business processes [33]. To achieve the greatest benefits provided by an ERP system, it is imperative that the business processes are aligned with the ERP system. Both the reengineering literature [29] and the ERP literature suggest that an ERP system alone cannot improve organizational performance unless an organization restructures its business processes [8]. According to Willcocks and Sykes [65], the new business model and reengineering that drives technology choice is an enabling factor that can contribute to ERP success. In order to maximize the benefits of ERP investments, the supplementary redesign of business processes promises the highest ROI, but also increases the level of complexity, risks and costs [37].

2.14. Defining the architecture

While successful ERP implementation is often determined by business and organization changes, architecture choices deserve thorough consideration during the system procurement phase. Key architectural considerations, which should occur very early in the implementation process, revolve around centralization or decentralization, compatibility of existing tools within the enterprise with the ERP system, and identification of bolt-ons such as data warehouses [56]. Feeny and Willcocks [22] identified architecture planning as a core IT capability and stressed that this cannot be cast aside to ERP suppliers.

2.15. Dedicated resources

An organization's failure to commit the required financial, human and other resources has been found to be a problem in reengineering implementations [27]. Dedicated resources are critical to realize the benefits associated with an ERP package [48]. Resource requirements need to be determined early in the project and often exceed initial estimates and the inability to secure resource commitments up front may doom project efforts [47].

2.16. Project team competence

Another decisive element of ERP implementation success or failure is related to the knowledge, skills, abilities, and experience of the project manager as well as selection of the right team members, which should not only be technologically competent but also understand the company and its business requirements [36]. The skills and knowledge of the project team is important as is the use of consultants to provide expertise in areas where team members lack knowledge [6], [10], [13].

2.17. Change management

Managing change is a primary concern of many involved in ERP implementations. ERP systems introduce large-scale change that can cause resistance, confusion, redundancies, and errors. It is estimated that half of ERP implementations fail to achieve expected benefits because companies "significantly underestimate the efforts involved in change management" [4]. Research has shown that effective change management is critical to successful implementations of technology and business process reengineering [27]. Companies need to adopt a comprehensive approach toward the large-scale process and system changes associated with ERP implementations and make change everyone's first priority [42].

2.18. Clear goals and objectives

Clear goals and objectives were the third most critical success factor in a study of MRP implementations [2]. The initial phase of any project should begin with a conceptualization of the goals and possible ways to accomplish these goals [53]. Goals should be clarified so they are specific and operational, and to indicate the general directions of the project [12]. It is important to set the goals of the project before even seeking top management support [54]. The "triple constraint" of project management specifies three often competing and interrelated goals that need to be met: scope, time, and cost goals [52]. Many ERP installations face scope creep as a result of lacking a clear plan [24], [61].

2.19. Education on new business processes

When considering implementation coupled with business process reengineering, it is imperative for managers to educate and communicate their goals and long-term perspectives in order to win support of all members of the organization affected by the changes [40].

2.20. Interdepartmental communication

Communication is the oil that keeps everything working properly [52]. Slevin and Pinto [54] identified communication as a key component across all ten factors of their Project Implementation Profile and maintained that "communication is essential within the project team, between the team and the rest of the organization, and with the client"(p. 60). Poor communication between reengineering team members and other organizational members was found to be a problem in business process reengineering implementations [27]. Interdepartmental communication represented an important CSF in a study of MRP implementations [2].

2.21. Interdepartmental cooperation

A key factor for the successful implementation of ERP systems requires a corporate culture that emphasizes the value of sharing common goals over individual pursuits and the value of trust between partners, employees, managers and corporations [59]. As ERP systems cross-functional and departmental boundaries, cooperation and involvement of all involved appears to be critical [48]. ERP potential cannot be leveraged without strong coordination of effort and goals across business and IT personnel [65].

2.22. Ongoing vendor support

ERP systems are a way of life and may be a lifelong commitment for many companies [18]. There will always be new modules and versions to install and better fits to be achieved between business and system. Consequently, vendor support represents an important factor with any packaged software including extended technical assistance, emergency maintenance, updates, and special user training.

3. Method and sampling frame

The companies included in this study were randomly drawn from two sources: (1) Fortune 500 firms and, (2) a

random sample of 200 organizations from the *Directory of Top Computer Executives* who indicated the existence of an ERP system. Data were secured by a mail questionnaire. Huber and Powere [32, p. 174] noted that "if only one informant per organization is to be questioned, attempt to identify the person most knowledgeable about the issue of interest". Therefore, having decided to use a single informant from each company, we examined the suitability of various possible informants. The senior IS executive is considered to be the most suitable informant, especially if this executive was also at a senior level in the overall organizational hierarchy [35]. Accordingly, our questionnaire was addressed personally to a senior level IS executive. A short questionnaire, pre-tested during the company interviews to increase the content validity of the research instrument, was mailed to the executive in each company in the sample, accompanied by an informational letter stating the purpose of the research and ensuring confidentiality. The initial company interviews showed that top management from this functional position tended to have the most complete knowledge about the CSFs that were important during their ERP implementations, thereby minimizing some of the problems of the key-informant technique used in our study [45]. Clear, short definitions of the six stages of implementation were included in the questionnaire. Respondents were provided with a list of 22 relevant CSFs drawn from the literature and company interviews, and pre-tested during the pilot stage. They were asked to: (1) identify the degree of importance of each CSF in their ERP implementation overall, using a 5-point scale, ranging from low to critical (including NA=not applicable) and, (2) indicate in which stage of the implementation (i.e., initiation, adoption, adaptation, acceptance, routinization, infusion) the particular CSF was important.

The initial mailing of 700 surveys, resulted in a total response of 86 usable questionnaires (representing a 13.46 percent response rate). Surveys were not completed for several reasons: (1) the most common reason cited was the firm's policy prohibiting completion of academic questionnaires (n=21), (2) some surveys were not deliverable as addressed (n=34) and, (3) a few were returned because the "addressee" left the position or retired (n=6).

4. Results

A wide variety of industries were represented in the responses. The companies classified by industry type and respondents' title are described as shown in Tables 1 and 2. The descriptive statistics suggests that a wide variety of industries were represented and the information was provided by top level IS executives. As can be observed from Table 3, over half (60%) of the organizations reported their ERP implementation was completed last year or over one year ago, 20% were near completion, and 30% were early to mid implementation.

"Table 1. Companies by industry."

Industry	Number of Companies
Education	3
Insurance	6
Retail	8
High Technology	10
Financial Services	10
Manufacturing	20
Utilities	7
Healthcare	13
Government	4
Professional Services	2
Telecommunication	2
Other	1
Total	86

"Table 2. Respondents' titles."

Title of Respondents	Number of Companies
CEO	2
CIO	20
President	5
Senior vice president (e.g., IS, IT, finance)	10
Director of MIS	12
Manager (e.g., MIS, IS, project or implementation)	37
Total	86

"Table 3. Organizations' current stage of ERP installation."

Early to mid implementation	30%
Late implementation/near completion	20%
Implementation completed last year	20%
Implementation completed over a year ago	40%

Table 4 presents the means and standard deviations for the 22 CSFs in descending order of importance (5=critical, 4=very high, 3=high, 2=moderate and 1=low). Top management support was viewed as most important by of our executives. Likewise, among the top ten important CFSs are: project team competence, interdepartmental cooperation, clear goals and objectives, project management, interdepartmental communication management of expectations, project champion, vendor

support and careful selection of package. Surprisingly, use of consultants and use of vendors' tools did not appear to be very important in the implementation process for these companies.

"Table 4. Mean rankings of CSFs by degree of importance in ERP implementation"

Critical success factor	Mean	Std. Dev
1. Top management support	4.29	1.16
2. Project team competence	4.20	1.07
3. Interdepartmental cooperation	4.19	1.20
4. Clear goals and objectives	4.15	1.14
5. Project management	4.13	0.96
6. Interdepartmental communication	4.09	1.33
7. Management of expectations	4.06	1.37
8. Project champion	4.03	1.58
9. Vendor support	4.03	1.60
10. Careful package selection	3.89	1.06
11. Data analysis & conversion	3.83	1.27
12. Dedicated resources	3.81	1.25
13. Use of steering committee	3.79	1.95
14. User training on software	3.79	1.16
15. Education on new business processes	3.76	1.18
16. Business Process Reengineering	3.68	1.26
17. Minimal customization	3.68	1.45
18. Architecture choices	3.44	1.19
19. Change management	3.43	1.34
20. Partnership with vendor	3.39	1.21
21. Use of vendors' tools	3.15	1.57
22. Use of consultants	2.90	1.20

Table 5 lists the top five CSFs, in order of their importance, across the stages of IT implementation. Most important CSFs during initiation are: architecture choices, clear goals and objectives, partnership with vendor, top management support, and careful selection of package. In the adoption phase, when a decision is reached to invest resources necessary for the implementation effort, it is no surprise that top management, project team competence, use of steering committee, partnership with vendor, and dedicated resources are most important to the companies under consideration. Interdepartmental communication and cooperation, project team competence, dedicated resources and use of vendors' tool are the most important CSFs during the adaptation phase, which is the phase in which the application package is installed and becomes available for use in the organization. Again, interdepartmental communication and cooperation, and project team competence are important in the acceptance phase along with top management support, project team competence, and education on new business process. When the ERP application is no longer perceived as something out of the ordinary, interdepartmental communication and cooperation and top management support are still viewed as very important to the implementation. Also, vendor support and user training on software are important CSFs in the routinization phase of

"Table 5. Top CSFs by ERP implementation stage"

Stage: Initiation	Respondents
1. Architecture choices	71%
2. Clear goals and objectives	63%
3. Partnership with vendor	61%
4. Top management support	61%
5. Careful selection of package	60%
Stage: Adoption	
1. Top management support	68%
2. Project team competence	61%
3. Use of steering committee	60%
4. Partnership with vendor	60%
5. Dedicated resources	59%
Stage: Adaptation	
1. Interdepartmental communication	65%
2. Interdepartmental cooperation	63%
3. Project team competence	63%
4. Dedicated resources	60%
5. Use of vendors' tools	60%
Stage: Acceptance	
1. Interdepartmental communication	64%
2. Interdepartmental cooperation	63%
3. Top management support	56%
4. Project team competence	55%
5. Education on new business processes	53%
Stage: Routinization	
1. Interdepartmental communication	51%
2. Top management support	42%
3. Interdepartmental cooperation	41%
4. Vendor support	36%
5. User training on software	36%
Stage: Infusion	
1. Interdepartmental communication	39%
2. Interdepartmental cooperation	35%
3. Top management support	32%
4. Vendor support	28%
5. Partnership with vendor	28%

implementation. Interdepartmental communication and cooperation and top management support are the most important CSFs when the ERP application is used within the organization to its fullest potential along with vendor support and partnership with vendor. Although not among the 5 most important CSFs during the initiation and adoption phases, interdepartmental communication and cooperation were determined important across the adaptation, acceptance, routinization and infusion phases. Top management support appears to be important in all phases, with the exception of the adaptation phase.

5. Managerial implications

Our research not only identified which CSFs are most critical in ERP implementations, but also determined which factors are temporal, i.e. significant in the implementation process for a particular period in time. This information can now be used to identify, anticipate, and allocate time and resources across those factors that need attending to for effective project monitoring [54]. It also provides an understanding of the factors and their importance throughout the various phases of implementation, which in turn can serve as a useful guide for firms in the process of implementing an ERP system. If addressed these factors can improve the likelihood of a successful implementation.

We propose several steps for a successful implementation. For example, as we observed, the most critical part of the ERP implementation project occurs early in the chain of event, in the selection of the software package itself, and in the preparation to make that selection. The best guarantee lies in front end preparation that should focus on building a solid foundation to support the challenges "down the road". This would include securing commitment and cooperation from everyone involved that the work effort will be put forth as it is needed as well as ensuring that adequate knowledge exists to understand the options available (project team competence). Likewise getting people educated/trained and keeping them informed throughout the implementation process must be addressed to achieve the benefits of an ERP system. To accomplish these CFSs, significant effort is required that must be supported by top management involvement to ensure that the implementation receives the resources, time and priority that is necessary.

In addition, although vendor partnership was viewed as important in the initiation phase of the implementation, it should be noted that responsibility for key aspects of the project should not be delegated to software vendors or consultants. These external parties should be viewed as auxiliary resources, not as drivers.

6. Conclusions

ERP implementations represent high-risk projects that need to be managed properly. Organizations must learn how to identify the critical issues that affect the implementation process and know when in the process to address them effectively to ensure that the promised benefits can be realized and potential failures can be avoided.

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