Critical Success Factors in ERP Implementation in Finland

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ABSTRACT

Organizations look to enterprise resource planning (ERP) as a significant strategic tool of competition. ERP plays an important role in today's enterprise management and is beginning to be the backbone of organizations. Although ERP has been recognized as a useful tool, in practice, there are many difficulties in compelling people to implement it effectively. In this case, how to help ERP's future effective implementation has already attracted some researchers' attention. The core research developed is focused on critical success factors of ERP implementation.

In this paper, six general accepted critical success factors (CSF) are identified based on the relevant literature: top management support, effective project management, business process reengineering, the suitability of software and hardware, education and training, and user involvement. A survey of ERP implementation in Finnish firms was conducted concerned with critical success factors and other firm issues.

Data analysis shows that CSF is vital to ERP implementation. CSF may keep the implementation on schedule, within budget, satisfactory to the user, and so on.

KEY WORDS

Critical successful factors (CSF); Enterprise resource planning (ERP); Questionnaire survey; Finland.

CONTENTS

1.Introduction

1.1 Background

Since the latter part of 1990s firms have rushed to implement enterprise resource planning systems (ERP). One study found more than 60 percent of Fortune 500 companies had adopted of ERP systems (G. Stewart et al 2000). The appeal of the ERP systems is clear. Although most organizations typically have software systems that performed much of the component functions of ERP, the standardized and integrated ERP software environment provides a degree of interoperability that was difficult and expensive to achieve with stand-alone, custom-built systems (M. Wheatley 2000, G. Stewart et al., 2000).

ERP systems hold the promise of improving processes and decreasing costs. Furthermore, two important new frontiers for ERP are electronic business (e-business) and supply-chain management (Wang and Nah, 2001). The systems can connect with suppliers, distributors, and customers, facilitating the flow the product and information.

In reality, ERP implementation is costly and complex. In many cases, ERP is the largest single investment in any corporate-wide project. The software is expensive, and the consulting costs even more. Meta Group found that the average ERP implementation takes 23 months with total owners' cost of $12 million (G. Stewart 2000). The ERP implementation is the process where business process and ERP system match each other. Usually the firm has to change the business process per ERP systems. Sometimes most positions have to be redesigned according to the ERP systems. Thus the difficulties and high failure rate in implementing ERP systems have been widely cited in the literature (Davenport, 1998), The failure percentage of ERP systems was determined by one study as ranging from 40 to 60 percent and from another study as between 60 and 90 percent (G. Langernwalter 2000, C. Ptak and E. Schragenheim 2000).

With the development of ERP, it becomes more and more powerful with high risk. All of the vendors, users and academic researchers wish to find some successful experience or mode. The success factors are critical to generalize the experience. With this background, some research on critical success factors (CSFs) in ERP implementation presents itself. The study of CSF is beneficial in all aspects, which is the reason why I study the subject.

1.2 Research objective

The object of the thesis is to use the data of Finnish firms to evaluate some CSFs and determine the inherent relations among these factors. The interesting relation between CSFs and a company's characteristics is also researched.

2. ERP

2.1 Definition

ERP has been defined by various authors but with few differences. Kumar et al (2000) define enterprise resource planning (ERP) systems as "configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization"

The basic architecture of an ERP system builds on one database, one application, and a unified interface across the entire enterprise. According to O'Leary (2000), ERP systems have the following characteristics:

1. ERP systems are packaged software designed for a client server environment, whether traditional or web-based.
2. ERP systems integrate the majority of a business's process.
3. ERP systems process a large majority of an organization's transactions.
4. ERP systems use an enterprise-wide database that typically stores each piece of data

once.

5. ERP systems allow access to the data in real time.

In some cases, ERP calls for an integration of transaction processing and planning activities (e.g., production planning)

- Support for multiple currencies and languages (critical for multinational companies)
- Support for specific industries (e.g., SAP supports a wide range of industries, including oil and gas, health care, chemicals, and banking)
- Ability to customize without programming

2.2 ERP evolution

In order to satisfy customer demand and stay competitive companies in 1960s retained large amount of inventory while at the time the organizational systems focused on inventory control. Most software packages (usually customized) were designed to handle inventory based on traditional inventory concepts.

In the 1970s more and more companies realized that large volumes of inventory was a luxury and unaffordable. This led to the introduction of material requirements planning (MRP) systems. MRP had been a great improvement in the materials planning process. The computer can be used to calculate gross material requirements, since there is a master production schedule, supported by a bill of material file that identified the specific materials need to produce each finished item. In MRP net material requirement can be determined by accurate inventory record files, the available quantity of on-hand or scheduled-to-arrive materials, which prompted further improvements in, for instance, new order placement, canceling of existing orders, or modifying the existing order. The ability of the planning system to systematically and efficiently schedule all parts was a tremendous step forward for productivity and quality.

With the passage of time, capacity planning was included into the basic MRP systems,

since traditional production priorities and materials planning are only part of the problem in manufacturing. Some new tools were developed such as sales and operations planning, master production scheduling, and demand management. These developments resulted in the next evolutional stage that became known as closed-loop MRP (H.Oden et al 1993).

In the 1980s more affordable and available technology was coming. Companies coupled the movement of inventory with the coincident financial activity. Manufacturing resources planning (MRPII) systems is a method of planning all resources for a manufacturer. MPR II was expected to incorporate all resource planning for the entire enterprise. For instance order processing as in MRP, business planning, sales and operations planning, and production planning. This gives companies the ability to have a more integrated business system that derived the material and capacity requirement associated with a desired operations plan, allowed input of detailed activities, translated all this to a financial statement, and suggested a course of action to address those items that were not in balance wit the desired plan (C. Ptak et al 2000).

In the early 1990s the contribution of technology improvement permitted more and more areas to be included into MRPII, such as product design, information warehousing, materials planning, capacity planning, communication systems, human resources, finance, and project management. There is a tendency within the operations management field to consider ERP as a natural extension of MRP II. Manetti gave the American Production Inventory Control Society (APICS) definition of ERP as “a method for effective planning and control of all resources needed to take, make, ship, and account for customer order” (J. Manetti).

But ERP systems benefit more than manufacturing companies; it is practical in any company that wants to compete, including chemical facilities and universities.

2.3 ERP implementation

The basic elements of an ERP implementation include the core transaction system, packaged decision support applications provided by the ERP vendor, in-house or third party extended application, and a collection of tools for managing various aspects of the system.

Markus and Fenema et al. (2000) found five ways to arrange relationship among business units, four ways to configure software, and two ways to accomplish execution of an ERP system in multisided implementation as the following table:

Table2.1 Multi-site ERP implementation Areas and Options

Control strategy	Software Configuration	Technical Platform	Management Execution
Total local autonomy	Single financial/single operation	Centralized	Big bang
Headquarters control-financial only	Single financial/ multiple operation	Distributed	Phased rollout
Headquarters coordination	Multiple financial/ single operation		
Network coordination	Multiple financial/ multiple operations		
Total centralization			

There are some ways to execute ERP systems. One extreme is the big-bang deployment where at once all the old systems are upgraded to the new one. A classic example, Quantum Corp., closed its operation worldwide for eight days to switch systems. The other extreme is phased rollout where the system component is brought on-line serially and operated and observed before moving on to implementation of the next phase. For example BICC Cables which took a lengthy process to build it s global operation.

Both Big Bang and Phased implementation have advantages and disadvantages (O'Leary 2000). Please see the generalized factors in table 2.2.

Big Bang	Phased
Advantage	Advantage
● No need for temporary interfaces	● Peak resource requirements are less than with Big Bang
● Limited need to maintain and change legacy software	● More resource can be devoted to a particular module
● Low risks	● Lower risks
● Functionality linkage	● Legacy system can be returned
● No going back	● Personnel gain knowledge in each phase
● Shorter implementation time	● Project manager can demonstrate a working system
● Cost-low	● Time between development and use is reduced
Disadvantage	Disadvantage
● Huge peak resources may be required	● Heavy use of temporary interface
● Fewer resources will be available in particular module	● Need to maintain and revise legacy software
● The risk of total system failure may be higher	● Higher risk of uninvolved and uncoordinated personnel
● Cannot readily go back to legacy systems	● Higher risk of losing personnel to turnover
● Personnel have fewer hands-on opportunities to gain knowledge	● May not be enough modules implemented to achieve functionality
● Project managers can't show that it works until the system is entirely installed	● Operative legacy system constitutes fallback position which my derail new

implementation	
● Time between development and implementation may be longer	● Longer duration to install ● Higher total cost

Table 2.2 the advantage and disadvantage of Big Bang and Phased implementation

V. M. Marber et al. (2000) believed that although the big bang method is dangerous it made sense in the context of ERP. The alternative, phased rollout, makes sense for larger groups, and it is also widely used in this data. The time span varies greatly depending on the installation strategy. A rollout strategy lasts longer. The duration is also related to the company size. The smaller companies are likely to take big-bang approach which require less time.

2.4 Why EPR implementation's success is critical

The definition and measurement of success are thorny matters. First, success depends on the point of view from which one measures it. Even within a single company people will have different ideas. For example, implementation specialists (e.g. project managers and implementation consultants) often define success in terms of completing the project plan on time and within budget while the user and adopter tend to focus on the transition from old systems and stable operation. Of course, the business objectives should be met such as inventory reduction and more decision support capabilities.

Briefly, ERP systems are commercial software packages that enable the integration of transactions-oriented data and business process throughout an organization. Beginning with the manufacturing and financial systems, ERP systems may eventually allow for integration of inter-organizational supply chains. Because these systems touch so many aspects of a company's internal and external operations their successful deployment and use are critical to organizational performance and survival. (Markus and Tanis, 2000)

Implementing an ERP system is not an inexpensive or risk-free venture. In fact, 65% of executives believe that ERP systems have at least a moderate chance of hurting their business because of the potential for implementation problems (S.Cliffe, 1999).

Most organizations have extensive experience managing traditional MIS projects but these new ERP projects may represent new challenges and present new risk factors that must be handled differently.

3. Literature review

Critical Success factors have been cited in IT research. There are a great number of articles on CSF. In this literature review section the only focus is on the CSF in ERP implementation. The difficulties and high failure rate in implementing ERP systems have been widely cited in the literature (Davenport, 1998), but research on critical success factors (CSFs) in ERP implementation efficiency is still fragmented. Most literature combines the CSFs with different ERP characteristics. Here I choose some classic literature examples and review them by chronology.

Larsen and Myers (1997) found that an ERP experience could be an early success and a later failure. This result is supported by a case study - a BPR project involved redesigning the main accounting process within one organization in the New Zealand financial services industry. The following two factors would lead to failure:

1. Inappropriately cutting project scope
2. Cutting end-user training

Their finding show the different measures of success are appropriate at different points in the ERP experience cycle and that the outcomes measured at one point in time are only loosely related to outcomes measured later. This occurs because the experience cycle is a process (actually a set of processes) and not a mechanical connection between starting conditions and final results. Some suggestions on implementation are proposed

such as the decomposition of the project into manageable parts, the level of budget to be allocated to the project and shakedown phases of each part, an appropriate project leader and/or implementation partner, and so forth.

Bancroft et al. (1998) provided critical success factors for ERP implementation including top management support, the presence of a champion, good communication with shareholders, and effective project management. This is derived from discussions with 20 practitioners and from studies of three multinational company implementation projects.

Before implementing ERP it is important to develop key IT capabilities. According to Feeny and Willcocks (1998) there are nine core IT capabilities required for successful ERP implementation.

Table 3.1 Core IT Capabilities Needed for ERP implementation Success

Capability	Impact
IT leadership	Develop strategy, structures, processes, and staff
Business systems thinking	Adopt systems view
Relationship building	Cooperate with business user
Architecture planning	Create needed technical platform
Technology fixing	Troubleshoot
Informed buying	Compare vendor sources
Contract facilitation	Coordinate efforts
Contract monitoring	Hold suppliers accountable
Supplier development	Explore long-term mutual benefits

A competent internal IT group is established along with a systems view of organization. This view makes it easy to understand BPR. These core capabilities are based on skilled employees. Willcocks and Sykes recommend hiring the required skills rather than

relying on long-term consultant relationships unless the need is very short-term.

Parr et al. (1999) observed that ERP systems are more complex than packages because users are involved in the re-engineering process and factors associated with project success from the literature (management support and a champion) are important because of the substantial re-engineering which take place.

Holland and Light (1999a) performed their research by a company case, although they did not mention CSFs directly, when the analyzed the case. Elements include IT legacy, business legacy, IT strategic review, project management strategy, business process reengineering strategy, and IT strategy. In their paper, besides the previous business and management factors, the IT factors are emphasized, though these IT factors are different from later researchers' views. Since Holland and Light only noticed that the legacy system are no longer efficient, the systems are fragments and need to be combined and improved to meet new business necessary. They did not comment on the impact of legacy system to implement new ERP systems. Later Holland and Light (1999b) design a model to group the CSFs into strategic and tactical factors as shown in this figure.

ERP implementation process

Strategic	**Tactical**
• Legacy systems	• Client consultation
• Business vision	• Personnel
• ERP strategy	• BPC and software configuration
• Top management support	• Monitoring and feedback
• Project schedule and plans	• Communication
	• Trouble shooting

BPC: Business Process Change

Figure 3.1 a critical success factors model with strategic and tactical factors

They also emphasized that most implementation models ignore legacy systems and

underestimate their importance on the choice of ERP strategy. Although the focus is on legacy systems, BPC is also analyzed in this model. In actuality, there is no difference between BPC and BPR. Several detailed approaches are added to the model, such as Troubleshooting.

Sumner (2000) held an interview with the senior project managers responsible for planning and implementing enterprise-wide ERP systems in seven large organizations with sales ranging from $1 billion to $15 billion annually. The interview questions cover several aspects of project. His study shows that IT management is regarded as one important risk of enterprise-wide/ERP projects. The unique challenge in ERP implementation lies in acquiring the necessary skills. Insufficient training and skill of the IT workforce in new ERP technology, without enough ‘internal’ expertise, and failure to combine internal and external expertise will lead to ERP failure. The writer recommends investing more in recruiting and retraining IT professionals who combine technology and business skills which keeps the professionals from moving to consulting firms with higher salaries.

Willcocks and Sykes (2000) propose several scenarios and use cases to prove these scenarios. Unlike the development of new simple software applications the main target of ERP is to fulfill BPR (business process reengineering). Many companies failed on this aspect of ERP implementation. This failure was driven by the need for major change in human, culture, and organization relationships. The following table displays three factors associated with ERP failure.

Table3.2 Factors in ERP implementation failure

Scenario	CIO/IT focus	Typical Outcome
Technological determinism	Technical	Failure to gain business benefits
Supplier/consultant driven	Disregarded	Cost overruns
Outdated relationships & capabilities	Insufficient talent	Chaos

Willcocks and Sykes emphasize Feeny and Willcocks (1998) nine core IT capabilities and believe these nine core IT capacities must be retained in-house, since in come cases the companies have to outsource human resources to work closely with the in-house team and ensure that a transfer of learning takes place. In order to obtain necessary IT capabilities, Willcocks and Sykes suggested some strategies to manage the ERP implementation:

1. User versus technology

   With business requirements changing rapidly, further learning and innovation is required. As IT becomes more organizationally pervasive, development will not rely on IT specialists or external IT suppliers. Users themselves will approach IT through multifunctional teamwork, personal relationship, and business goals.

2. Governance and staffing

   Effective business innovation requires high-level support and a project champion. An efficient team combination is recommended including:

   - Full-time, high-performing users
   - In-house IT specialists
   - People with bridge-building interpersonal skills
   - Fill-in external IT staff and knowledgeable users/managers

3. Time-box philosophy

   They recommend decomposing implementation into smaller projects. This approach can help reduce project risk. This is also known as converting “whales” (large unmanageable projects) into “dolphins” (smaller and more manageable projects).

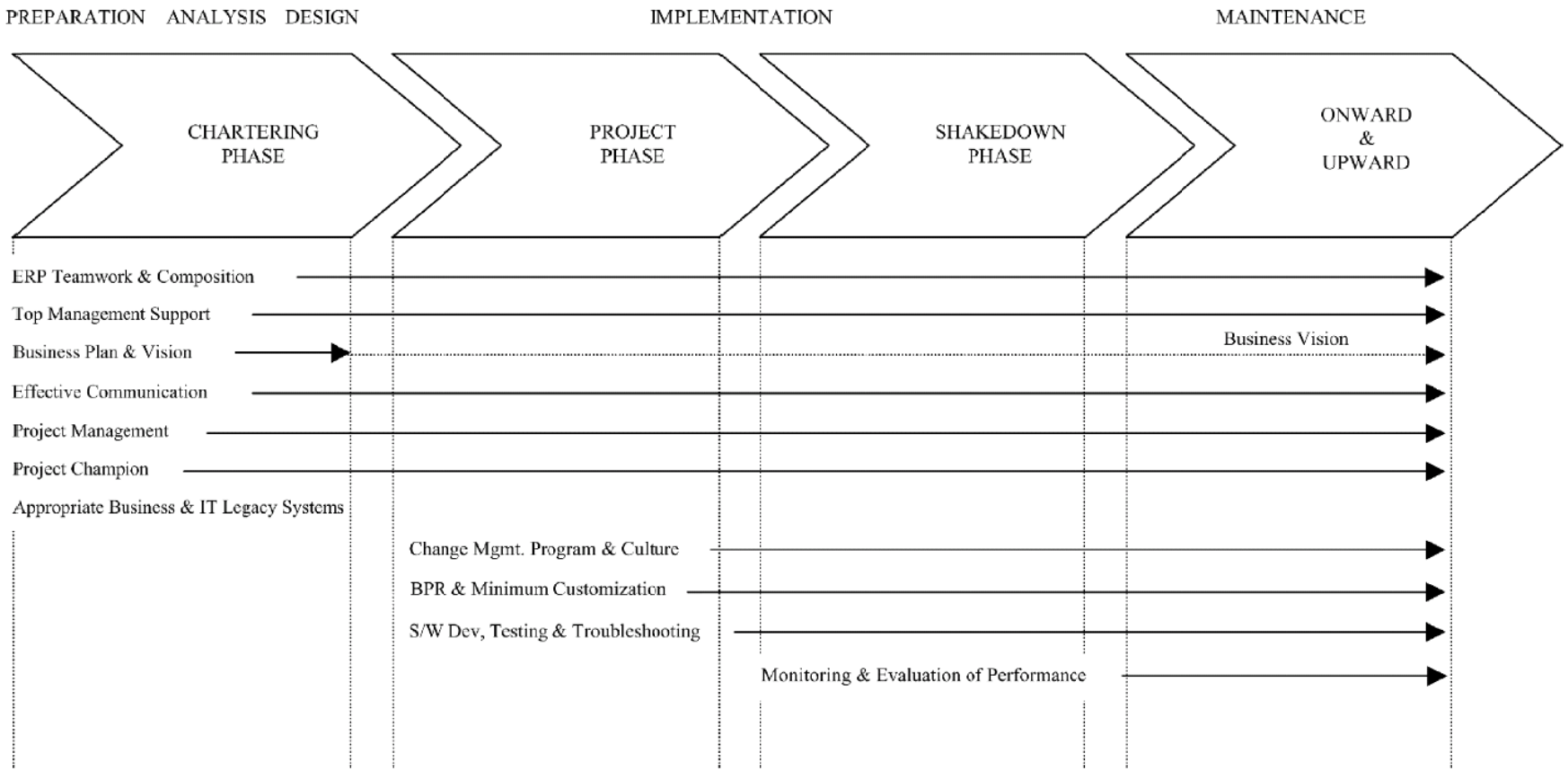
4. Supplier/ consultant role in ERP

   First, consultants fill in the in-house shortage of skills. Secondly, the company may choose to outsource the entire IT project to decrease the risks.

Nah, Fiona Fui-Hoon, et al. (2001) propose 11 factors as being critical to ERP

implementation success: ERP teamwork and composition, a change in management program and culture, top management support, business plan and vision, business process reengineering with minimum customization, project management, monitoring and evaluation of performance, effective communication, software development, testing and troubleshooting, project champion, appropriate business and IT legacy systems (see Figure 3.1).

Figure 3.1 Classification of CSFs of ERP implementation into Markus and Tanis' (2000) process –oriented ERP life cycle model.


PREPARATION ANALYSIS DESIGN
IMPLEMENTATION
MAINTENANCE
CHARTERING PHASE
PROJECT PHASE
SHAKEDOWN PHASE
ONWARD & UPWARD
ERP Teamwork & Composition
Top Management Support
Business Plan & Vision
Effective Communication
Project Management
Project Champion
Appropriate Business & IT Legacy Systems
Business Vision
Change Mgmt. Program & Culture
BPR & Minimum Customization
S/W Dev, Testing & Troubleshooting
Monitoring & Evaluation of Performance

They classify these factors into their respective phases (chartering, project, shakedown, onward and upward) in Markus and Tanis' ERP five-cycle model. According to Markus and Tanis (2000), there are four phases in an ERP life cycle.

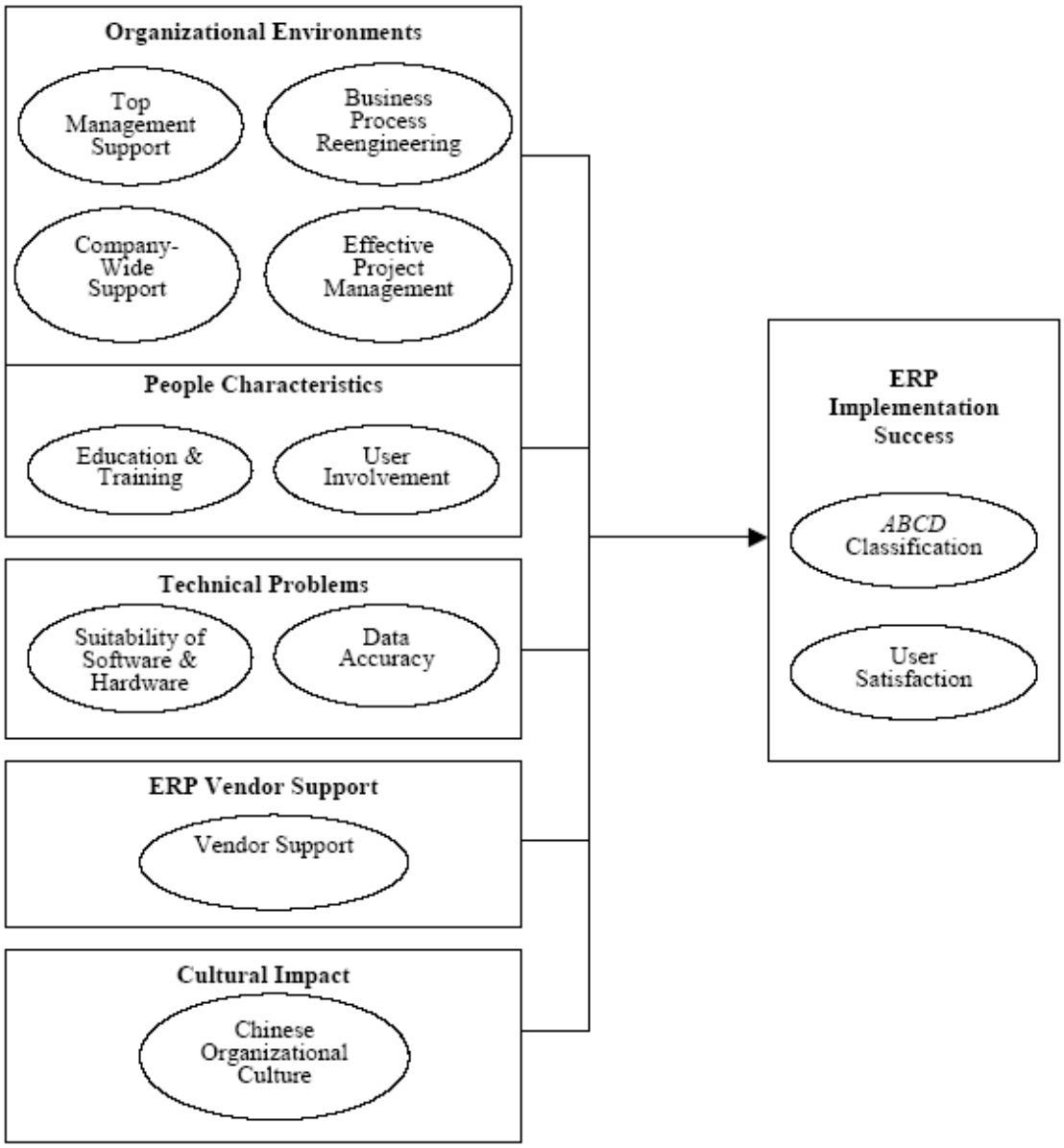
1. Chartering – making decisions defining the business case and solution constraints
2. Project - getting the system and end users performing
3. Shakedown - stabilizing, eliminating "bugs", returning to normal operations
4. Onward and upward - maintaining systems, supporting users, getting results, upgrading, system extensions.

Nah, Fiona Fui-Hoon, et al. believe teamwork and composition is a key factor for CSFs in the ERP implementer-vendor-consultant partnership. There should be good communication and coordination between implementation partners. Since a wide range of functional areas are included in ERP it is necessary to have a cross functional ERP core team. ERP requires changing management programs and culture. If the employees are open to sharing common values and goals and accept the change, it will be likely successful. Furthermore, user training, education and support should be available and highly encouraged.

In order to measure ERP implementation success, there are two indicators of the dependent variable. From Delone & McLean (1992) the success model includes six dimension or categories of information systems success: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. While this approach has some disadvantages when use of the systems is mandatory, the measure of system quality, information quality, and use become less useful. Whether the system is good or not, and whether the user likes it or not, there is no choice. Conclusions about individual impact and organizational impact are also difficult to determine. User satisfaction was a widely accepted measure until now, since it is more obvious and direct, but Zhang L. et al (2002) use user satisfaction and White's ABCD classification method to judge whether an ERP system implementation is a success or failure.

The researcher classified the hypothesized factors into five categories: organizational environments, people characteristics, technical problems, ERP vendor commitment, and cultural impact (see Figure 3.2)

Figure 3.2**.** Conceptual research model of ERP implementation success in China



Organizational culture becomes a CSF here. It is emphasized that the researcher's study occurred in another country, China, whose culture is different from traditional ERP implementers. Most ERP vendors come from Europe and America. The difference of

cultures between Western countries where the ERP systems are developed and China makes culture an important factor.

Their empirical data analysis has shown that top management support, business process reengineering, effective project management, education and training, suitability of software and hardware, and data accuracy has a significant impact on ABCD classification. Business process reengineering has the biggest positive impact.

Majed Al-Mashari, et al (2003) discuss the theoretical basis of ERP systems in relation to the benefits realization process. This paper presents a novel taxonomy of the CSFs in ERP implementation process. Set-up, implementation and evaluation are the three main phases. Figure 3.3 shows the inter-relationship between core business strategy aspects and the role of IT and associated systems.

Figure 3.3 Taxonomy for ERP critical factors

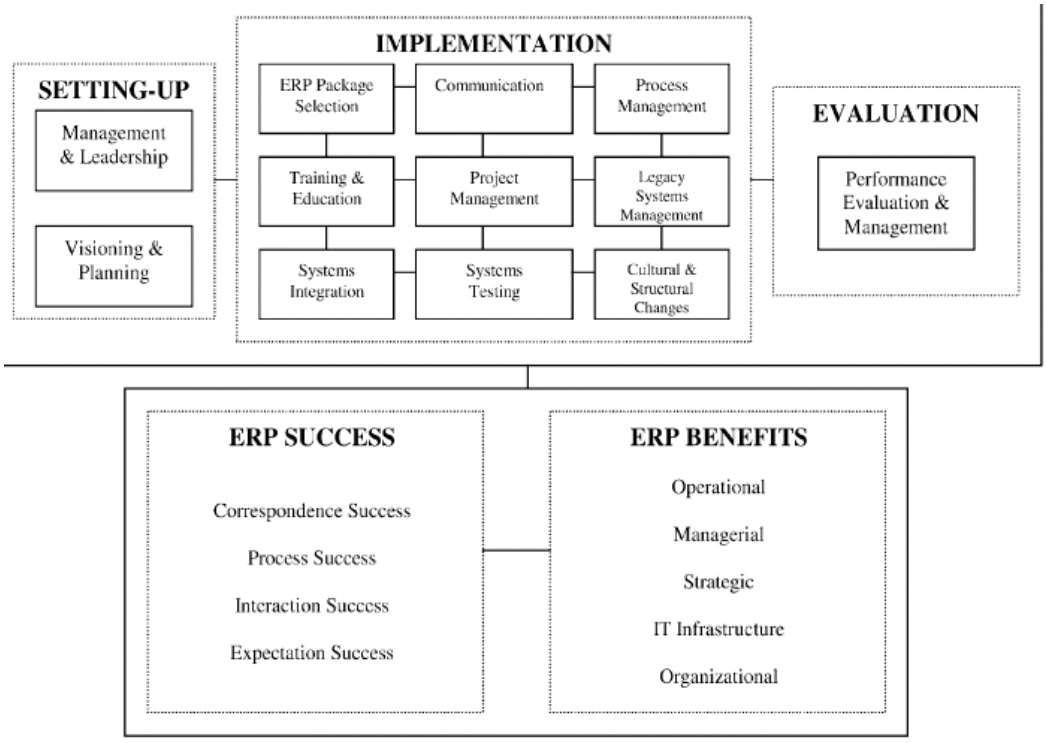


Fig. 1. Taxonomy for ERP critical factors.

In this model the evaluation is attractive. In order to measure and improve ERP systems

several techniques have been developed to calculate the cost. McKinnon and Brus (1992) have suggested that management accountants should have responsibility to measure the performance. Kaplan and Norton (1992) propose a “Blanced Scorecard” with five perspectives: strategic planning, financial, customer, internal business, and innovation and learning. This approach become more popular and spread all over the world. According to Majed Al-Mashari, et al the measuring and evaluation of performance are very critical factors in ensuring the success of any organization. It is suggested in the taxonomy that measurement take place in a balanced perspective and for the purpose of proving useful information that can facilitate the decision making process, deliver the corporate objectives and forward the business competitively. To obtain this system, the authors advise that regular auditing and benchmarking should be considered for optimization of the potential available to all aspects of business. Furthermore, external benchmarking may bring new ideas, knowledge and better practices on dealing with deficiencies in ERP systems, de-bottlenecking, streamlining the processes, optimizing and redesigning for more extensive benefits (Al-Mashari, 2002)

Elisabeth J. Umble, et al (2003) point out that commercially available software packages promise seamless integration of all information flows in the company-financial and accounting information, human resource information, supply chain information, and customer information. However, managers have struggled, at great expense and with great frustration, with incompatible information systems and inconsistent operating practices.

They divide CSFs into 10 categories:

1. Clear understanding of strategic goals.
2. Commitment by top management
3. Excellent implementation project management
4. Great implementation team
5. Successfully coping with technical issues

6. Organizational commitment to change
7. Extensive education and training
8. Data accuracy
9. Focused performance measures
10. Multisite issues resolved

4. Critical success factors in ERP implementation

A critical success factor is something that the organization must do well to succeed. In terms of information system projects, a critical success factor is what a system must do to accomplish what it was designed to do. The proposed methodology of studying CSFs behind ERP implementations is very similar to the approach used in a variety of studies in Information Technology (IT) implementation research. Some of these proposed factors are the one that have been found to be significant in other IT implementations.
Three factors consistently appear as critical success factors for information systems projects: top management support, client consultation (user involvement), and clear project objectives (Olson, 2001).

Referring to the previous research, I generalize 6 CSFs into 3 categories: strategic factors, tactical factors, and operational factors.

A. Strategic factors:

- Top management support – earlier studies (Sumner (1999), Mabert et al (2001)) have shown that the ERP implementation was in general a top-down decision, and the success of such an implementation depended on the alignment of the ERP adoption with strategic business goals.

B. Tactical factors:

- Effective project management – in order to successfully accomplish the decision to implement an ERP system, the effective project management comes into play

to plan, coordinate and control such an intricate project

- Re-engineering business processes – it is very important to consider the extent to which the company needs to re-engineer its current business processes in order to be compatible with the ERP software.
- Suitability of software and hardware – management must make a careful choice of an ERP package that best matches the legacy systems, e.g. the hardware platform, databases and operating systems.

C.Operational factors:

- Education and training – when the ERP system is up and running it is very important that the users be capable to use it, hence they should be aware of the ERP logic and concepts and should be familiar with the system's features.
- User involvement – participating in the system development and implementation, the users go through a transition period that gives them time to better understand the project's consequences.

A. Top management support

Duchessi, et al. (1989) concludes that commitment from top management and adequate training are critical success factors for implementation.

The commitment of top management should be emphasized throughout an organization. In particular, no more important factor than the support of the management is critical in the project's life. The roles of top management in IT implementation 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 (McKersie and Walton 1991). Senior management must be involved, including the required people and appropriate time to finish and allocate valuable resources to the implementation effort.

The shared vision of the organization and role of the new system and structures should be communicated between managers and employees. Policies made by the manager will come with the new systems in the company. In case of conflict, the proper mediation will be based on that standard (Carol Brown and Iris Vessey 1999).

Two types of top management support roles have been associated with systems implementation projects (Martin et al. 1999):

1. The project sponsor
2. The project champion roles

The project sponsor is responsible for budgetary support and ensuring that key business representatives play a role on the project team. The project champion may or may not be a formal member of the project team, but can pay a key role in change.

B1. Project management

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Project management is accomplished through the use of the processes such as initiating, planning, executing, controlling, and closing (PMBOK Guide 2000).

Project management goes beyond one single factor because management is required through all the implementation. If we look at the ERP as a large project, we have some areas that we should consider, such as integration/plan, scope, time, cost, quality, human resource, communication, risk, and procurement. Usually if we balance and control all the factors correctly, the project will be successful.

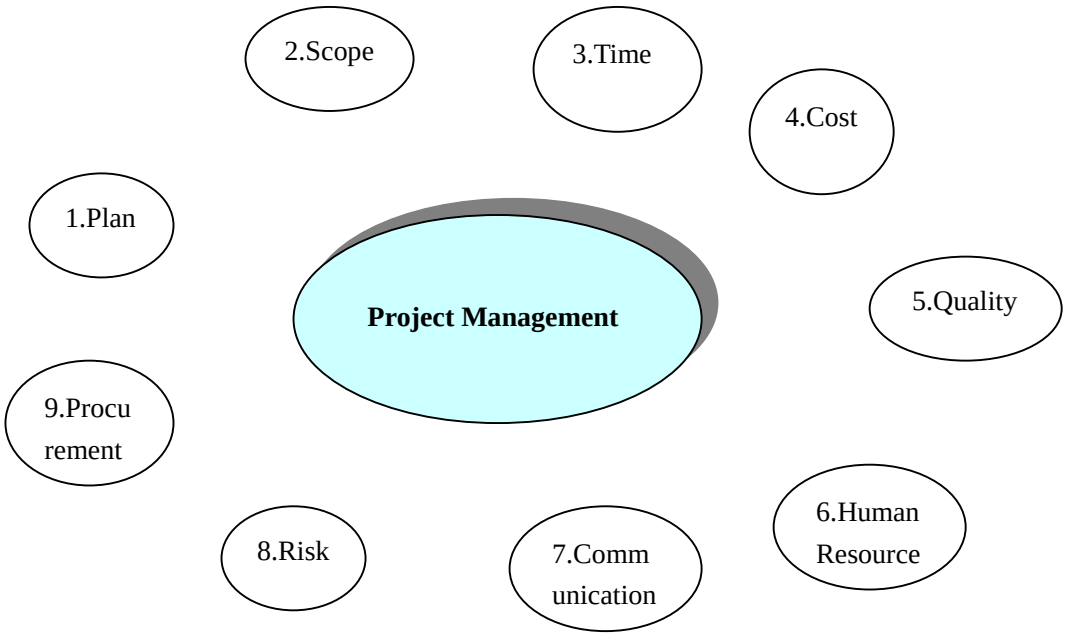


Figure 4.1 the areas of Project Management

Project management activities span the life of the project from initiating the project to losing it (J.A. offer, 1998). One expert or a group of experts should be assigned to manage the project and drive success throughout project management.

A plan with goals and objectives is the initial phase of any ERP project. Sometimes the ERP fails since it is unable to meet the stakeholder groups' expectations. When proposing the goal, this expectation should be carefully thought-out to guarantee this expectation is within the ERP's ability. In order for the ERP system to progress it is critical to clarify the ERP project's and every participators' scope and ensure consideration of all the required work. The schedule and cost budget cause trouble for most implementing firms. These are two contrary factors since more investment in resources such as consultants can propel the progress, but this also leads to extra expense. People always wish the ERP implementation could be finished sooner while maintaining a limited budget. In fact this time and cost may be estimated during the beginning plan phase. The control of time and cost budget depends on the project management. Human Resources is always vital for the implementation. The company

must express their requirements to the implementing consultants clearly and timely in every step. On the contrary, the consultants also inform the company of their situation and ability. Particularly in BPR communication is quite necessary among different aspects of the project.

B2. Business process reengineering (BPR)

A process is a logical set of related activities taking input, adding value through doing things, and creating an output (H.J. Harrington et al, 1997)**.** There are many ways to complete the job in business. Information systems are significant in collecting data, storing it efficiently, generating useful report to the management, and archiving data for future reference. There are two kinds of business process: operational and infrastructure. Operational processes help accomplish typical business functions including product development, order management, and customer support. Infrastructure processes are more administrative such as establishing and implementing strategy and managing many aspects of the organization including human resources, physical assets, and information systems (Olson, 2004).

Business process re-engineering (BPR) is defined by Hammer and Champy (2001) as “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed”. BPR analyzes the process of an organization’s business in order to identify the best way of doing things.

BPR came earlier than the popularization of ERP. In the 1980s firms hoped to find a more efficient way to do business. Re-engineering has continually reduced workforce size and other created other short-term cost saving, with less impact on developing computer-based automation. It is ERP that rescues the idea of BPR and forces the company to redefine and design work flows to fit the new software.

BPR has some implicit risks. Sutcliffe (1999) proposes the following difficulty of implementing BPR:

- Employee resistance to change
- Inadequate attention to employee concerns.
- Inadequate and inappropriate staffing
- Inadequate developer and user tools
- Mismatch of strategies used and goals.
- Lack of oversight
- Failure in leadership commitment

O'Leary (2000) offers two kinds of basic way to implement reengineering: clean slate and technology-enabled BPR. They are extreme concepts of implement possibilities.

(1) Clean Slate Reengineering

As the name of the approach, in clean slate reengineering everything is designed from scratch. After selecting software which best supports the new system design the firm can identify the organization's needs and requirements. This approach is the most likely to create the optimal system for the organization; however, this approach is more expensive than technology-enabled reengineering. It is also slower and harder to apply than the technology-enabled approach to implementation. This approach can involve significant changes in the way the organization does business, but the previous business practices may also remain, so the impact may be less than the technology-enabled approach.

(2) Technology-Enabled Reengineering

O'Leary refers to this approach as constrained reengineering, which means the reengineering process is constrained by the selected systems. Since the systems are ready and it is not necessary to change them, this approach is faster and cheaper than clean slate reengineering, and is the most dominant in practice now. On the negative

side, it also requires a lot of change and training within the organization.

Generally speaking O'Leary believes that the clean slate reengineering fits for large firms with enough funds. These large firms, which can draw on their own business experience, hold a strategic advantage. Firms that have budget or time constraints can use the technology-enabled reengineering.

Almost every analyst of the ERP implementation process strongly advises companies to avoid modifying the software. Companies are advised to maintain existing ERP functionality and to change their procedures to adapt to it (M.Lynne Markus et al 2000). To gain full benefit of ERP systems, it is imperative that business processes are aligned with the ERP systems, since both reengineering literature and the ERP implementing literature have proven that the ERP itself can not improve the firm's performance unless the firm reengineers the business process per ERP systems. Modification of the software causes problems, such as code errors and difficulty upgrading to new versions. Each company needs customized software, but the organization must keep customization to a minimum, since any modification will lead to higher related cost.

B3. The Suitability of Software and Hardware

Today there are many ERP vendors in this market, including traditional large vendors called the BOPSE group (the initial letters of the five vendors). Now BOSPE has become BOS, since Peoplesoft recently acquired J.D. Edwards, and was then merged into Oracle.

Table 4.1 Major ERP vendors in today's market

Vendor	Origin	Comment
BAAN	Holland	An early ERP vendor
Oracle (Peoplesoft, J.D. Edwards)	United States	A newcomer, but gaining a market share quickly
SAP	Germany	The pioneer and largest vendor

Besides these giants, there are more and more newcomers who fit better for certain countries and cultures, since they would have to think about localization problems when dealing with a multinational company wanting to implement an ERP system. A complex software package, ERP systems integrate all information processing to support business. The following table shows us the business function modules in SAP R/3.

Financial Applications	Human Resources Applications	Logistics Applications	Cross Application Modules
FI: Financial accounting	PA: Personnel administration	LO: General logistics	SAP Business Workflow
CO: Controlling	PD: Personnel development	MM. Materials management	SAP Office
EC: Enterprise controlling		PM. Plant maintenance	SAP Archive Link
IM: Capital investment management		PP. Production planning	
TR: Treasury		PS: Project systems	
		QM: Quality management	
		SD: Sales and distribution	

Table 4.2 Business module of SAP R/3

Finding a suitable software package is a vital step for ERP implementation. Since they do not have enough professional expertise or experience in developing ERP systems in-house, many companies opt to buy off-the-shelf systems. Today's vendors can supply very complex software packages like the above SAP R/3 package, while the off-the-shelf systems cannot meet the company's requirements fully, especially when

the company's business process itself is unique. Some vendors provide very specific solutions to niche industries based on the characteristics of the operations environment (i.e. process and business) and enterprise size. For instance, an ERP vendor can offer decision support functionality for supply, manufacturing, and distribution planning at all enterprise levels.

Most vendors will also offer add-ons. The implementing firm can forego the functionality of standard ERP and change to a new function, one developed either in-house or procured from third party software vendors. Lucas, et al. (1988) suggested that package implementation is different from customer implementation because the user may have to change procedures in order to work with the package, but the user is likely to want to change some programs in the package to fit the company's unique needs, at which point the user becomes dependent upon the vendor for assistance and updates. In this way, the company has to consider the synchronization between systems and the software package. Different ERP vendors use different hardware platforms, databases, and operating systems, and certain ERP packages are compatible only with some company's databases and operating systems. Although most vendors do not like to offer connections with other vendors, sharing is becoming a new trend.

Which one should be changed more, the business processes or the ERP software?
This question troubles most companies. The probability of success is higher when there is only a minimal need to change business processes and ERP software. This does not mean the company should choose the software with least required change, but they should choose the software such that implementation is most likely to be successful. If many changes happen in organizational process, then some risks arise, such as the lack of organizational adaptability, incorrect choice of the appropriate practices to implement, or a resistance to change among other factors. Alternatively the most changes can be made in the software, but often the organization has no ability to implement such large IT projects, which leads to failed implementation. Finally, large changes in both the

organizational process and the software can strongly affect the probability of success. See related (O'Leary 2000).

Extent of Change to Organizational Processes			
	Extensive	Potential Project Failure because of Process Changes	Potential Project failure because of Process Changes and IT Changes to Software
	Minimal	Highest Probability of Successful Implementation	Potential Project Failure because of IT Changes to Software

Figure 4.2 Change to software and change to organization

Below is a model of the ERP acquisition process known as MERPAP put forth by Jacques, et al (2003). The MERPAP model consists of six distinct and iterative processes: planning, information search, selection, evaluation, choice, and negotiation.

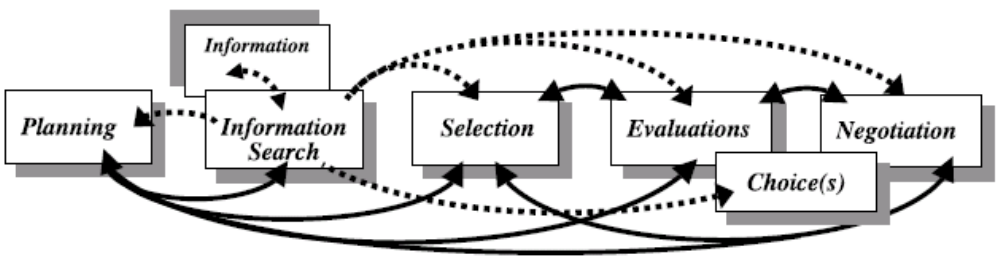


Figure 4.3 MERPAP

The structure is as follows:

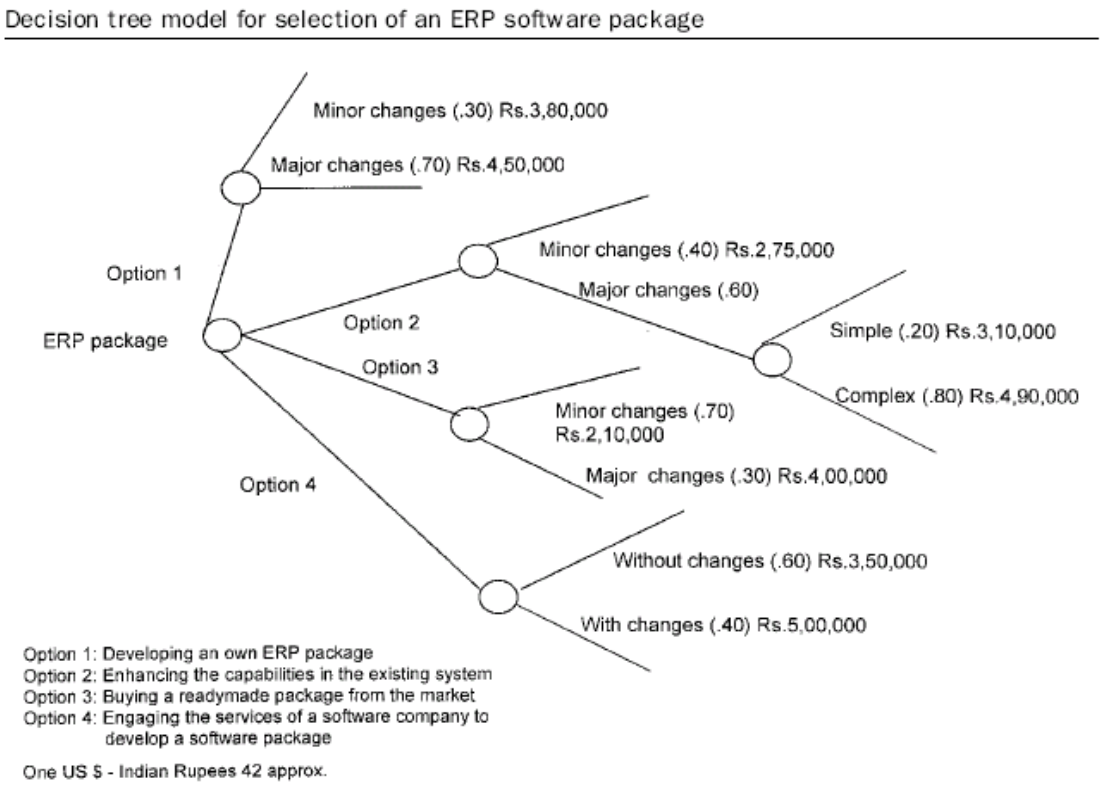
1. MERPAP begins with planning

2. MERPAP ends with negotiations
3. MERPAP is nonlinear
4. Some of the processes are done concurrently
5. Some of processes are embedded
6. All of the processes with the exception of “choice” are iterative
7. All of the processes with the exception of “choice” are recursive
8. Each process is causal and results in products (deliverables) that are used by another process.

In this diagram, the dotted lines indicate the flow of information during the process. The solid recursive arrows between planning and the other processes indicate the ongoing nature of activity, feedback, adjustment, and input between them. Like other models, the MERPAP is not perfect, but it gives a company a kind of reference when selecting ERP software packages.

Rao (Rao, S. 2000) uses a decision tree model as a guide for selecting suitable ERP systems. For small and medium companies, Rao chooses five criteria important for selecting an ERP package including affordability, domain knowledge of suppliers, level of local support, and ease of software upgrades and use of latest technology.

Figure 4.4 Decision tree model for selection of an ERP software package



C1. Education and Training

In ERP implementation process many projects fail in the end despite of millions of dollars and hundreds of hours due to lack of proper training. Usually the end-user can get used to the ERP system within one year. One of the earlier researchers, Ang, et al. (1994) found that lack of training led to difficulties in MRP systems implementation. A thorough training program is necessary to make the user comfortable with the system. This factor is too often ignored. It is a challenge for a company implementing such a system to find an appropriate plan for the training and education of the end-user. In most cases, consultants are included during implementation process, and while all the aspects of the system should be explained and transferred the end-users, the main goal of ERP training is that the users understand the various business processes behind the ERP application (Majed Al-Mashari, et al 2003).

Generally speaking new employees of company may find ERP implementation easier.

Employees with many years of experience may need more time to change their habits. Another problem is time limit. Sometimes firms rush to finish the ERP project within a certain time period, and have no time to completely change the organization's culture.

Training new users of the ERP system also has some difficulties, including the diversity of the users, the complexity of the new systems, and the variety of training methods available. New ERP systems change nearly all of the organizational business processes, meaning all kinds of users in all aspects of the business will be impacted. Since all kinds of factors should be considered, the training fee can be quite expensive, ranging from 10 to 20 percent of the total implementation cost (Mabert, et al 2001). More and more companies are joining in the ERP training market. Basic training forms are as follows (Olson 2004):

- Web-based virtual training
- Computer-based training
- Video courses
- Self-study books
- Pop-up help screens

Most universities and training institutions use case studies and models to teach complex situations and analyze relevant scenarios. This approach focuses on specific questions. The students are asked to analyze the situation and find the internal relationship among various factors. Based on these factors and constrains, trainees develop a sound solution or plan of action. However, the limits of case studies are obvious here, as planning is only part of management responsibility. Implementing the solution and monitoring the implementation are equally important parts of the process. Unfortunately, the dynamic nature of the implementation process is rarely evident in case studies. In other words, cases are static and real situations change over time.

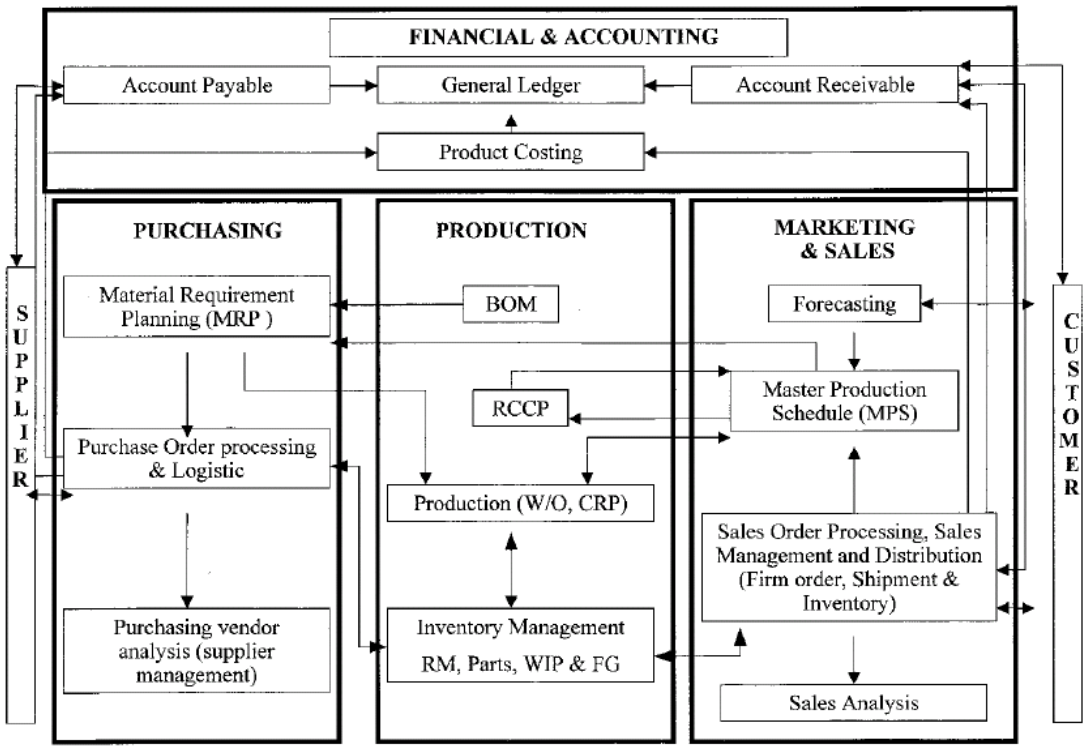
An alternative approach involves modeling real problems based on simplified

assumptions, analyzing the models, and identifying appropriate solutions. This approach is a cornerstone of operations research. However, in ERP implementation the problems and factors are usually outside the model's scope, since these factors are dynamic.

ERP, a complex software system, includes functions which touch upon almost all aspects of business processes throughout the organization. It supports data drill down and harmonizes functions in the entire supply chain. To demonstrate this function, some training institutions utilize real systems, specifically the installation of a commercial ERP system. This is a workable option, especially for users with only basic needs. This approach is an ideal way for the end-user to begin using the ERP system.

Avraham Shtub (2001) proposes a training framework which includes the Operations Trainer (OT) as an important part. The OT is a teaching aid that integrates the case study and modeling approaches into a dynamic teaching environment. It combines a simulation of a specific process (a scenario or a case study of a specific order fulfillment process) with an ERP-like information system. Different scenarios (or case studies) can be taught with the OT. Chart 4.1 shows the fulfillment process in OT.

Chart 4.1 Operation Trainer (OT)



Not only does the system user need training, but the implement consultant does as well, meaning those in the firm responsible for implementation also must receive appropriate training. This is especially important for those companies that want to implement ERP in-house. Those implementing the ERP system should receive training so that they understand how to design processes and configure the software.

C2. User Involvement

User involvement referrers to participation of the user in the process of ERP implementation. The functions of the ERP system rely on the user to use the system after going live, but the user is also a significant factor in the implementation. There are two areas for user involvement (Zhang, et al. 2002):

1. User involvement in defining the company's ERP system needs and
2. User participation the implementation of ERP systems.

Resistance to new ERP system may be involving the user early on while the project is still being defined, since the user has then also contributed to this decision. By participating in the ERP implementation, the user can understand the new system sooner and give feedback from his or her own point of view. This method can shorten the gap between the old and new systems and make easier for the user to cope with the new system. Since the user understands some of the ideas sooner, the training is more easily accepted. The experienced users who take part in implementation can also communicate with the newcomers. Another benefit of involving some users early on is that it facilitates in-house expert training. In the long-run the company may not be willing or able to rely on consultants or vendors because of the expensive consulting cost. Early users are a good resource if it becomes necessary to train experts in the future.

5. Data and Research Methodology

In order to examine the relationship between the hypothesized CSFs that were collected from previous research, we (Oana Velcu and the author) took a survey of Finnish companies. This survey used mail and email with a website containing a questionnaire. The questionnaire is divided into two major parts: one part collects data regarding the success of certain ERP measures such as time, budget, and the system's functionality, and the second part identifies the respondents' perception of the importance of some critical success factors in the ERP implementation process. The questionnaire does not include questions which could identify the company.

The questionnaire was mailed to a total of 676 companies in Finland, together with separate, prepaid envelopes. The companies' contact information was extracted from the Blue Book's company database. Blue Book is a provider of business contact and marketing information of Finnish companies. The target respondent group is the CFO of the company. For 286 companies, the questionnaire was sent to both the CFO and the CIO. At the beginning of November 2004, the survey with a cover letter and prepaid

return envelope was sent to the 676 selected companies, and 142 responses were received. Because this paper focuses on CSF, 84 useful responses were selected. There was a total response rate of 21 percent. The included cover letter was in Finnish while the questionnaire itself was in English. All the questions were evaluated carefully. We reviewed scholarly literature and then selected the most prominent critical success factors. Furthermore, some basic questions on the company's background were also included in the questionnaire. In this paper I looked for the inherent relationship between the CSFs and related ERP implementation issues, so the most significant related factors were chosen.

Question 11. Top management support refers to the fact that the ERP project needs to receive approval from top management.

This is the first step of ERP implementation. Without top management approval, no further ERP project would progress. Top management support does not solely deal with early approval but also support during and after the ERP implementation. This support can provide time, money and human resources. At the same time, this support is backed by management's understanding of ERP. Sometimes the project is over-budget or behind schedule. When this happens the top manager's attitude is usually significant to the continuation of future work. This attitude may be divided into: very positive (5P), positive (4P), neutral (3P), passive (2P), very passive (1P) and N/A (0). N/A is considered that this factor is unimportant, and this answer will be still counted in calculation in this paper. These are the possible responses corresponding with the questionnaire question. If the active manager understands the status and discovers problems and encourages or invests more, the project may be ahead of schedule or within the budget. On the contrary, a passive attitude will lead to a passive atmosphere throughout the company or implementation team. Employees will hesitate to go along with the ERP implementation. Initially some will reject ERP. When the top managers feel pessimistic, the implementation situation will be much worse.

Based on the above apparent reasons, the factor of top management support is never ignored by research. In this paper you will find interesting relationships between this factor and others.

Question 12. Effective project management refers to the effective planning and execution of the implementation process.

A project is temporary endeavor undertaken to create a unique product or service. A project is a temporary, unique, and progressive elaboration (PMBOK Guide 2000). ERP implementation is very typical project. When working on a project, the management cannot be ignored. In this case it should be managed in the form of project management. As previously mentioned, ERP implementation projects incorporate all aspects. This question focuses on planning and executing of the project. Other aspects such as budget and schedule are asked separately. Communication is also mentioned in other research. In this paper, communication is not listed separately since it is very general and difficult to compare. Some other similar factors in same situation are defining clear goals and objects, project champions, inter-department cooperation, and so on.

Question 13. Business process reengineering (BPR) refers to aligning the company business processes with the ERP software to be implemented.

BPR may be considered the core of ERP implementation. It makes ERP different from other software or MIS. It promotes ERP from a systems level to the management level. ERP gives the company an opportunity to promote BPR. More and more mature experience is added in the ERP systems to guarantee a successful model. In this case the implementation process is also a channel for the company to take advantage of the best practices. Thus BPR is an important issue in ERP implementation since it impacts all

business processes and positions. Then it is not difficult to understand that a failure of BPR will lead disaster in ERP implementation. Change may happen in both software and the company itself. Although depending on the company's specific situation, most organizations greatly re-engineer. There are also some extreme samples where the ERP systems are modeled on the companies' own process. In this study, the survey is based on Finnish mid-size firms. All the companies have the BPR. To some extent, the success of the company's BPR will determine ERP's potential effect. Culture factors have been mentioned in some research papers. Culture, not only among different countries but also different organizations, has to be considered in the BPR. Although the ERP vendors have become increasingly global, solutions are particular to certain geographical and political areas. For example, the accounting system has to obey local accounting principles.

BPR will change the organization's original structure, and the organization has to select the proper module or function carefully. This will be discussed in the next question. We see there are some obvious relationships among these factors.

Question 14. The suitability of software and hardware refers to the fit between the selected ERP system and the hardware.

The suitability of software is significant for many reasons, e.g. BPR. The ERP vendors market has been centralizing due to mergers of the top companies; however, at the same time, there has been an increase in the number of smaller, local vendors. In this survey some unfamiliar smaller vendors have been included as well. Along with the selection of software and hardware, the coordination between software and hardware is also taken into consideration. The software vendor usually makes recommendations of hardware. The organization has to plan for the long run since the software will require upgrades and the organization will theoretically grow in the future. The appropriate hardware needs to be balanced between budget and function to prevent future limitations. Legacy

systems may need to be removed. This factor was noticed several years ago in the research field. O'Leary believes a legacy system is a general technical risk. The company has to decide how much legacy hardware should be kept. Some big ERP vendors can develop special tools to help the firm transfer data from the legacy system to new ERP systems. This confronts the users with new operating systems, and the firm often has insufficient expertise and personnel for the new environment, therefore training is necessary.

Question 15. Education and Training refers to the introduction of the ERP concepts to the future users, and to providing training with regard to the features of the ERP software.

ERP is a completely new concept for its users. Top managerial users are required to master ERP, but for other users the correct general idea will be enough for their position in the firm. Because the ERP systems sometimes make work more complex, some users may not want to accept it, however when users understand where their input data goes and the significance of this data, they will be more cautious with the input. Many researchers emphasize the significance of data accuracy. Once again, training may help solve this problem. Obviously more detailed training is required for certain positions. As previously stated, training enables users to accept new systems more easily and gives a more stable transition from legacy systems. An excellent ERP system without skilled users means nothing. The systems must be well-operated in order to achieve optimum performance. The basis of ERP is still human. Many studies have shown that ERP needs well-performing users and IT specialists. Education and training can back up this need.

Question 16. User Involvement refers to the users participation in the development and implementation of the ERP system.

This approach is very practical. Feedback from users is almost always more exact than that from anyone else. Users' involvement in the early stages of implementation makes it easier to understand the requirements, choose right package and plan the customization. During the implementation users' timely involvement will also help correct mistakes. After implementation the firm needs the users' involvement to modify and upgrade the software package. Because they are involved, the users become accustomed to ERP. The most frequent participants then become experienced users and are easier to train as in-house experts. Questions 15 and 16 cover the human issues in ERP implementation.

The results presented in this section are based on the firms that have implemented or are implementing an ERP system.

The critical success factors to the implementation of ERP were based on a 5-point scale with preset response possibilities. The following list of 6 CSFs have been scored by response. The answers are rated by level of agreement, including irrelevant, and very unimportant (disagree) to very important (agree). The distribution of these weights is given for each aspect. (See Table 5.1). 44 of 84 companies believe "Top management support" is very important or important. 43 of 84 companies hold the same opinion of "The Suitability of Software and Hardware". According to these responses, over half of the companies believe these CSFs are important, as shown in Table 5.1 on the following page.

Table 5.1 Distribution of importance

CSF		Very important (5 points)	Important (4 points)	Neutral (3 points)	Unimportant (2 points)	Very unimportant (1 point)	Irrelevant (0 points)
Top management support	Frequency	8	36	24	11	5	0
	Percentage %	9.52	42.86	28.57	13.10	5.95	0.00
The effective project management	Frequency	9	20	28	15	9	3
	Percentage %	10.71	23.81	33.33	17.86	10.71	3.57
Business process reengineering	Frequency	11	13	30	17	10	3
	Percentage %	13.10	15.48	35.71	20.24	11.90	3.57
The Suitability of Software and Hardware	Frequency	9	34	30	7	4	0
	Percentage %	10.71	40.48	35.71	8.33	4.76	0.00
Education and Training	Frequency	9	17	32	19	5	2
	Percentage %	10.71	20.24	38.10	22.62	5.95	2.38
User Involvement	Frequency	8	26	30	13	6	1
	Percentage %	9.52	30.95	35.71	15.48	7.14	1.19

After calculating the total value and average value of each CSF, the order of importance can be seen in the following table. “The suitability of software” and “Top management support” are the top two CSFs with an average value of 3.80 and a total value of 319. Another commonly cited factor is “User Involvement”. The factor of BPR which was often cited in other research papers is at the end. Differences in the weights attributed to these CSFs are explored in Figure 5.1. This is a general picture; more breakdowns will help us analyze the CSFs from different points of view.

Table 5.2 Total and Average ranking of CSFs by degree of importance in ERP implementation

CSF	Total	Average
1.Top management support	319	3.80
1.The Suitability of Software and Hardware	319	3.80
3.User Involvement	302	3.60
4.Education and Training	282	3.36
5.The effective project management	278	3.31
6.Business process reengineering	259	3.08

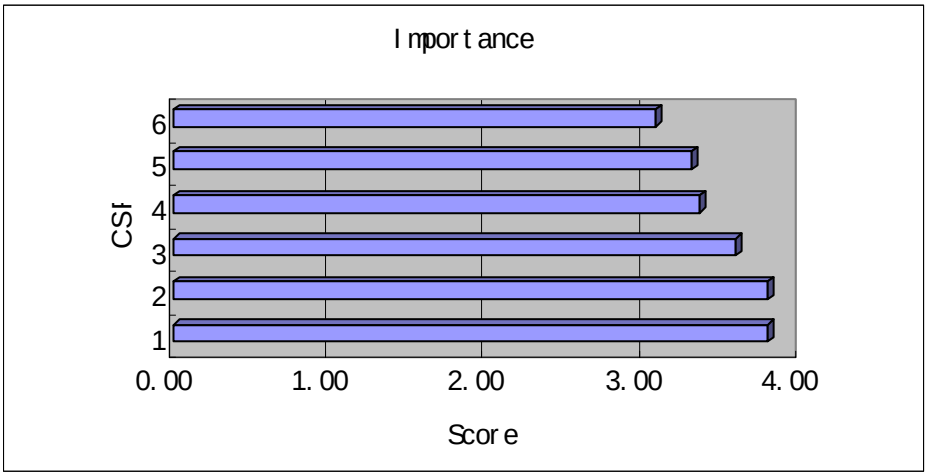


Figure 5.1 Rank of CSF

In Part 4, these CSFs are grouped into strategic, tactical and operational factors. This approach aims to offer some useful direction for ERP implementation. Table 5.3 presents the average of the three groups. The strategic factor is rated higher than other two. We can see that the averages in tactical and operational factors are almost same.

Table 5.3 Average of Strategic, Tactical and Operational Factors

CSF	Class	Average
Top management support	Average in Strategic factors	3.80
The effective project management	Tactical factors	3.31
Business process reengineering	Tactical factors	3.08
The Suitability of Software and Hardware	Tactical factors	3.80
Education and Training	Operational factors	3.36
User Involvement	Operational factors	3.60
	Average in Strategic factors	3.80
	Average in Tactical factors	3.40
	Average in Operational factors	3.48

Table 5.4 presents the average value of the CSFs for each responding company. Out of the 84 answers received, 3 questionnaires (or 3.57%) averaged five points (5P). The largest portion of the remaining questionnaires (36 questionnaires or 42.86%) averaged four points (4P) and 29 (34.52%) companies averaged three points (3P), showing that most companies evaluate these CSFs at a high level.

Table 5.4 Distribution of Importance by Average Value.

Average CSF	5P*	4P*	3P*	2P*	1P*	N/A
Frequency	3	36	29	6	1	8
Percentage %	3.57%	42.86%	34.52%	7.14%	1.19%	9.52%

*Average CSFs represented as integer only

This paper examines whether the degree of CSFs is different among different companies. Previous theory and research evidence indicates that the significance of the CSFs is affected by all kinds of company characteristics. In accordance with this general idea,

detailed hypotheses are further developed in the upcoming section.

Hypothesis 1: Recent (early) implementers of EPR are more aware of the CSFs than later users.

The year 2000 was a significant time for IT. Per previous research, many companies updated their MIS to ERP for fear of the Y2K problem. Here the companies are divided into those who implemented ERP before the year 2000, and those implemented it later. The later users (46%) and early users (52%) are then evaluated separately. From the average weight, the early users believe “The Suitability of Software and Hardware” is the most important CSF, while the later users choose “Top management support”. Unlike the hypothesis, there is relatively little difference in order of CSFs, however, the table (as calculated by ANOVA) shows that the weights of individual CSFs vary a little. These differences have been described by P-values in the table. The P-value of “Top management support” is the weakest. Later uses pay more attention on “Top management support”.

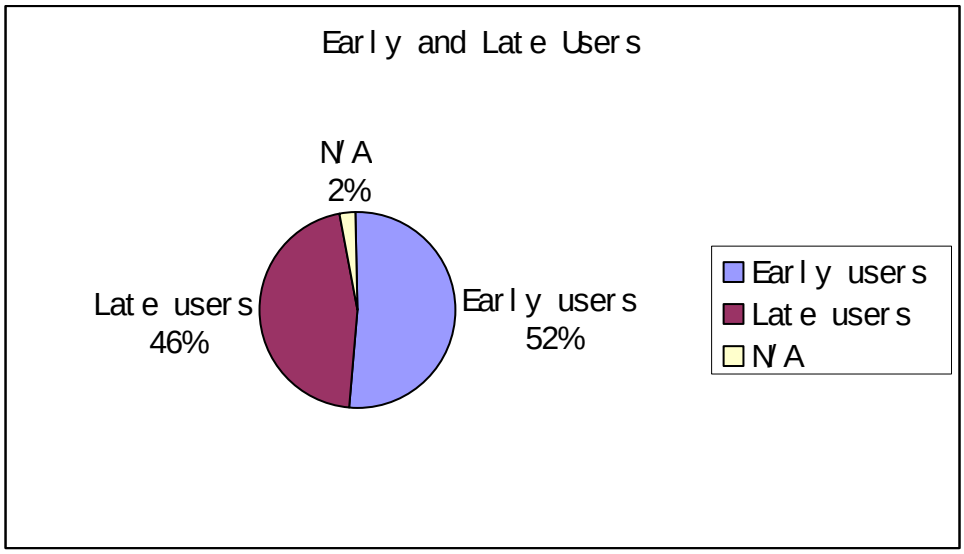


Figure 5.2 Early and Late users

Critical Success Factors	Early	Late	F	P-value	F crit
Top management support	3.63	4.18	3.20	0.08	3.96
The effective project management	3.42	3.36	0.03	0.86	3.96
Business process reengineering	3.28	3.03	0.58	0.45	3.96
The Suitability of Software and Hardware	3.84	3.95	0.12	0.73	3.96
Education and Training	3.47	3.41	0.03	0.86	3.96
User Involvement	3.67	3.69	0.00	0.95	3.96

Table 5.5 CSF on early and late users

Hypothesis 2: A company that implements ERP on-time recognizes CSF more than a company that implements ERP late.

To evaluate the impact of the CSFs, the companies were first separated into two categories, “on-time” and “late”, based on the questions: (1) How many months was the ERP implementation planned to take, and (2) How many months did the implementation actually last. Separating the companies into these categories provides an easy but useful way to determine if there is a relationship between CSF and whether the project was completed on time or late. The results are summarized in Figure 5.3. From the responses, 52% had late implementation and 37% on time implementation; 11% did not answer for various reasons.

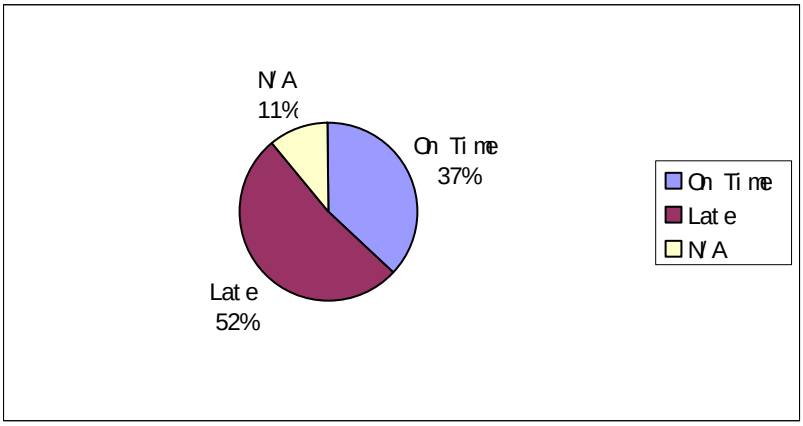


Figure 5.3 Distribution of on time and late

The values of the CSFs differ substantially between on-time and late companies. In Table 5.6 the values for the on-time companies are clearly higher, and there is some positive association in combination with the P-value, and both “The effective project management” and “The Suitability of Software and Hardware” have the weakest P-value of 1%. The on-time companies also recognize “The effective project management” significantly more than late companies. In some sense, this supports the idea that project management is a vital factor in keeping ERP implementation on time. There is one exception; on-time implementation companies did not find “Business process reengineering” to be as important as did late implementation companies. Generally, however, the data supports the hypothesis.

Table 5.6 CSF on on-time and late implementation

CSF	On Time	Late	F	P-value	F crit
Top management support	4.29	3.52	5.31	0.02	3.97
The effective project management	3.87	2.95	7.46	0.01	3.97
Business process reengineering	3.00	3.11	0.10	0.75	3.97
The Suitability of Software and Hardware	4.35	3.43	7.75	0.01	3.97
Education and Training	3.55	3.23	0.93	0.34	3.97
User Involvement	3.94	3.36	3.01	0.09	3.97

Hypothesis 3: Positive correlation between CSF and within-budget implementation

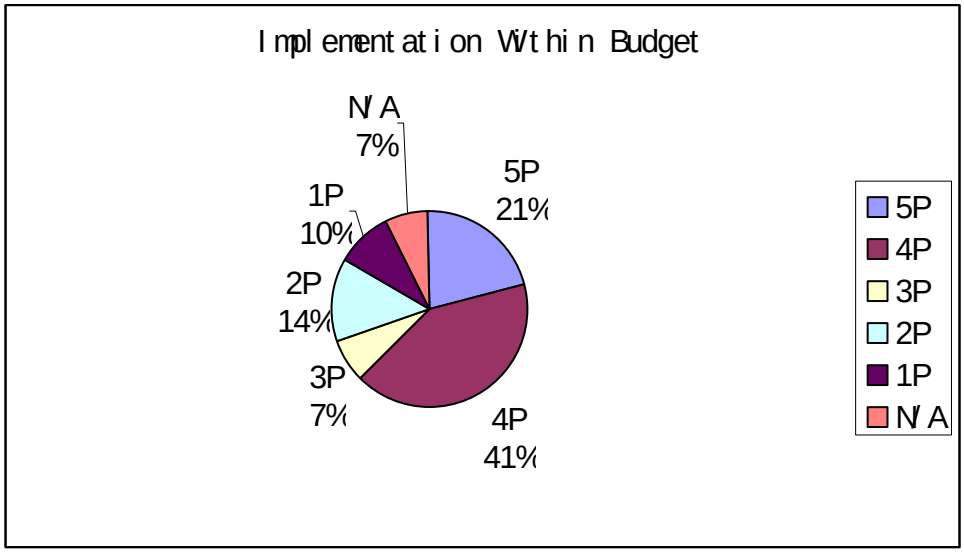


Figure 5.4 Implementation within budget

The results evaluating if the ERP implementation was completed within budget is displayed in above figure. 41% of companies give four points, which is the largest percent of total samples. To probe the relation with CSF, two sample groups are chosen, 18 of 84 with 5P and 26 of 84 with 2P or 1P, according to their response to this question. Separating the companies into these categories provides a useful way to determine if there is relationship between these two factors.

CSF	5P	2P and 1P	F	P-value	F crit
Top management support	4.00	3.45	1.00	0.32	4.11
The effective project management	4.17	2.30	16.35	0.00	4.11
Business process reengineering	3.89	2.60	7.03	0.01	4.11
The Suitability of Software and Hardware	4.39	3.20	5.16	0.03	4.11
Education and Training	4.06	2.80	6.24	0.02	4.11
User Involvement	4.11	2.70	7.72	0.01	4.11

Table 5.7 CSF of two groups by budget

The interpretation of the sample statistics in Table 5.7 is as follows: the companies that were on-budget (5P) grade higher than the others (2P and 1P). Particularly “The

effective project management" shows the difference clearly, especially according to the reported p-value, and it also indicates the positive correlation between CSF and staying within budget. Overall, these results indicate that the companies that are within budget recognize the CSFs more, and they support the hypothesis.

Hypothesis 4: Positive relationship between CSF and current satisfaction

When the sample companies were asked to evaluate if the ERP system is successfully used at the present moment, four and five points accounted for over half of the total samples. This means most companies are satisfied with their ERP utilization generally, but it is not perfect, since four points accounts for 43%, which is the largest percentage. According to the degree of satisfaction, the sample companies were classified into the following groups: five points, four points, three points, two points and N/A. The weight of CSF in these groups has been distributed in Table 5.8.

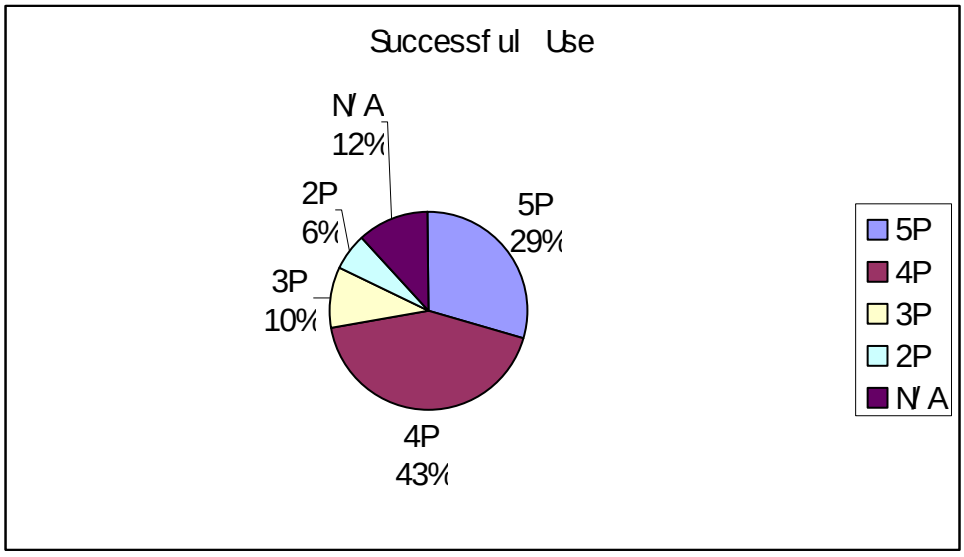


Figure 5.5 Successful Uses

CSF	5P	4P	3P	2P
Top management support	4.60	4.00	3.57	3.50
The effective project management	4.40	3.10	2.43	3.25
Business process reengineering	3.90	3.28	2.29	2.50
The Suitability of Software and Hardware	4.70	4.21	3.00	3.75
Education and Training	4.20	3.59	2.43	3.25
User Involvement	4.30	3.86	2.86	4.00

Table 5.8 CSF on Successful Use

The above table shows something interesting. Companies with more successful ERP implementation recognize the CSFs more. As in the hypothesis, there is a direct ratio between these two factors. A clear trend appears. This conveys the significance of CSFs in ERP implementation. The CSF appears to lead to success directly. However, we have to consider one other situation: unsuccessful or dissatisfied users are disappointed with ERP systems and ignore these CSFs accordingly. Further research may need to be done in this area.

The companies were separated into two groups: very successful ones (five points) and others (three points and two points). The weak p-values indicate the huge difference. All the p-values are below 5%, particularly “The effective project management” and “The Suitability of Software and Hardware”.

CSF	5P	3P and 2P	F	P-value	F crit
Top management support	4.60	3.55	9.73	0.004078	4.18
The effective project management	4.40	2.73	15.57	0.000463	4.18
Business process reengineering	3.90	2.36	11.47	0.002048	4.18
The Suitability of Software and Hardware	4.70	3.27	15.89	0.000415	4.18
Education and Training	4.20	2.73	16.30	0.000361	4.18
User Involvement	4.30	3.27	5.97	0.020877	4.18

Table 5.9 Very Successful Companies (5P) and Others (3P and 2P)

The above results give powerful support to the fourth hypothesis. The success rate rises with the significance of the CSFs. In this classification an obvious gap appears, and it is easy to see that successful users evaluate the CSF higher.

Hypothesis 5: Positive relationship between CSF and fulfillment of ERP function

Figure 5.6 depicts the responses to the question that asked if the required functionality of the ERP system has been fulfilled. 37 percent of the organizations agree that the function of ERP has been fulfilled very well (five points), and 36 percent of companies rate four points, so 73 percent of the total responding companies are pleased with their ERP system. Some companies, however, are not satisfied with how well the ERP system meets the demands, including nine percent of companies who responded that it had not been well fulfilled (under three points).

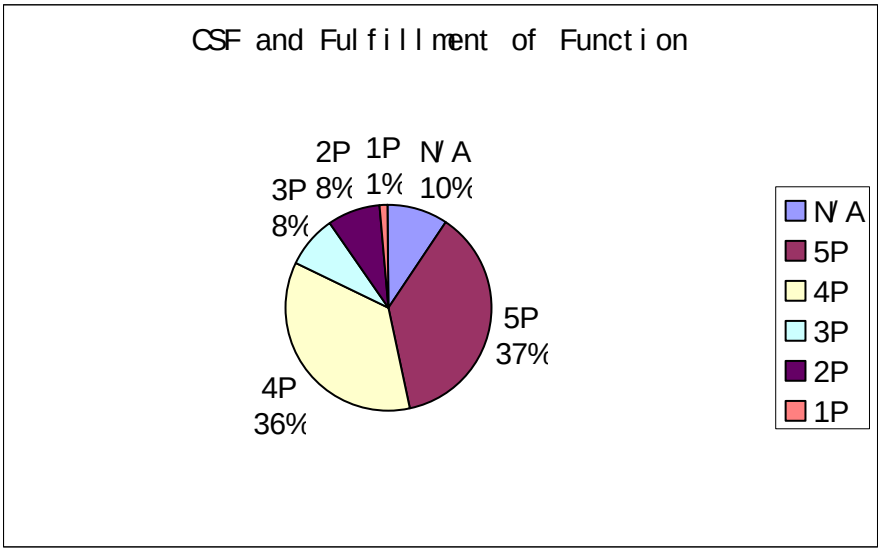


Figure 5.6 Fulfillment of Function

Akin to hypothesis three, higher satisfaction comes with higher value of CSFs. The results for these phenomena are tabulated in Table 5.10.

	5P	4P	3P	2P	1P
Top management support	4.19	4.07	4.14	3.29	3.00
The effective project management	3.87	3.63	2.57	2.14	2.00
Business process reengineering	3.55	3.43	2.29	2.29	2.00
The Suitability of Software and Hardware	4.26	4.13	3.43	3.14	2.00
Education and Training	3.81	3.83	2.71	2.43	1.00
User Involvement	3.97	4.10	3.29	2.71	1.00

Table 5.10 CSF on Fulfillment of Function

The proportions of 4P and 5P are close, 37 percent and 36 percent. However, all P-values are quite high. Overall, the companies with 5P evaluate higher score of CSFs than the ones with 4P. Some extra cases have to be mentioned here, for instance “User Involvement”. The companies with 4P believe “User Involvement” is more important than the companies with 5P and cannot ignore the high P-value (0.65). Another example is “Education and Training”.

CSF	5P	4P	F	P-value	F crit
Top management support	4.19	4.07	0.16	0.69	4.00
The effective project management	3.87	3.63	0.59	0.45	4.00
Business process reengineering	3.55	3.43	0.12	0.73	4.00
The Suitability of Software and Hardware	4.26	4.13	0.17	0.68	4.00
Education and Training	3.81	3.83	0.01	0.92	4.00
User Involvement	3.97	4.10	0.21	0.65	4.00

Table 5.11 5P and 4P

According to the above analysis, hypothesis 5 is reasonable, while it is not very obvious between close groups. Generally, we can find the trend as hypothesis 4.

Hypothesis 6: SAP users have a different view of CSF from others

The data show that many brands of ERP have been implemented in the Finnish market such as SAP, BAAN, SCALA, LEAN, and IFS. A total of 19% of 84 sampled companies are SAP users. SAP has the largest market share. Further analysis will be done to see the different CSF between SAP users and others. From this table, both SAP and other users rate "Top management support" and "The Suitability of Software and Hardware" as the top two CSFs. The smallest P-value is 0.50 on "The Suitability of Software and Hardware." The rate and P-value show that there is not a difference between SAP users and other users. Hypothesis 6 cannot be supported.

CSF	SAP	Others	F	P-value	F crit
Top management support	4.00	3.75	0.35	0.56	3.96
The effective project management	3.44	3.28	0.13	0.72	3.96
Business process reengineering	3.00	3.10	0.06	0.81	3.96
The Suitability of Software and Hardware	3.56	3.85	0.46	0.50	3.96
Education and Training	3.25	3.38	0.10	0.75	3.96
User Involvement	3.50	3.62	0.08	0.78	3.96

Table 5.12 SAP and Others

Hypothesis 7: There is a relationship between "Top management support" and other CSFs

Top management support	5P	4P	3P	2P
The effective project management	4.06	3.42	2.91	1.60
Business process reengineering	3.67	3.46	2.00	2.40
The Suitability of Software and Hardware	4.50	3.96	3.64	3.40
Education and Training	3.97	3.67	2.55	2.60
User Involvement	4.06	4.29	3.09	2.00
P-value	0.004	0.010	0.204	0.516

Table 5.13 Top Management Support

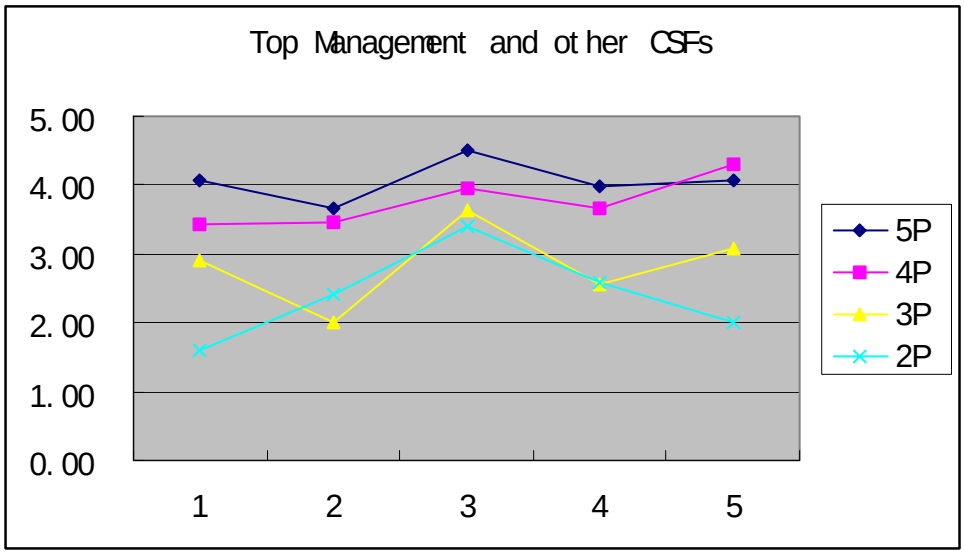


Figure 5.7 Relations between between Top Management and other CSFs

Table 5.13 and Figure 5.7 indicate that there is no direct relation between "Top management support" and other CSFs. However, an interesting phenomenon was noticed: If the responses for "Top management support" was high, the responder offered high scores for the rest of the five CSFs. The almost-horizontal line in Figure 5.7 for 5P is prominent. The remaining responses to CSFs vary greatly, which is demonstrated by the weakest P-value and zigzag line in Figure 5.7.

H8: The average CSF value of each company will impact successful utilization

Table 5.14 Average of CSF and successful use

Class of Average CSF	Average Value of CSF	Successful Use	F	P-value	F crit
5P	5.00	5.00	65535.00	N/A	7.71
4P	4.32	4.03	1.81	0.18	3.98
3P	3.55	3.79	1.60	0.21	4.01
2P	2.58	3.33	4.69	0.06	4.96
1P	1.75	2.50	0.25	0.67	18.51

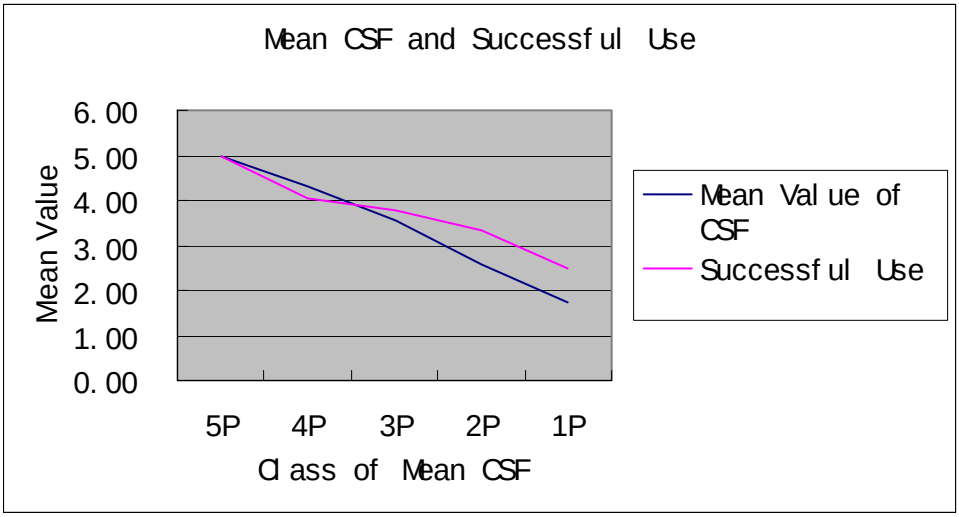


Figure 5.8 Relations between Average CSF and Successful Use

Figure 5.8 shows that there is a clear trend between Average CSF and Successful Use. The data in Table 5.14 give us more exact evidence. Two matched points occur where the two factors almost meet at 5P and 3P. On these two points, the degree of successful use is similar to CSF. This leads to the conclusion that if the responding companies rate CSF highly, they also hold the idea that the ERP systems have been successfully used. In this way, CSFs is directly correlated with ERP's successful use. Both Table 5.14 and Figure 5.8 prove hypothesis 8.

Hypothesis 9: High CSF mean will lead to more satisfied fulfillment

Table 5.15 Average CSF and Fulfillment of Function

Class of Average CSF	Average Value of CSF	Function Fulfillment	F	P-value	F crit
5P	5.00	5.00	65535.00	N/A	7.71
4P	4.32	3.97	2.20	0.143	3.98
3P	3.55	4.14	11.09	0.002	4.01
2P	2.58	3.00	0.63	0.446	4.96
1P	1.83	2.00	0.06	0.827	18.51

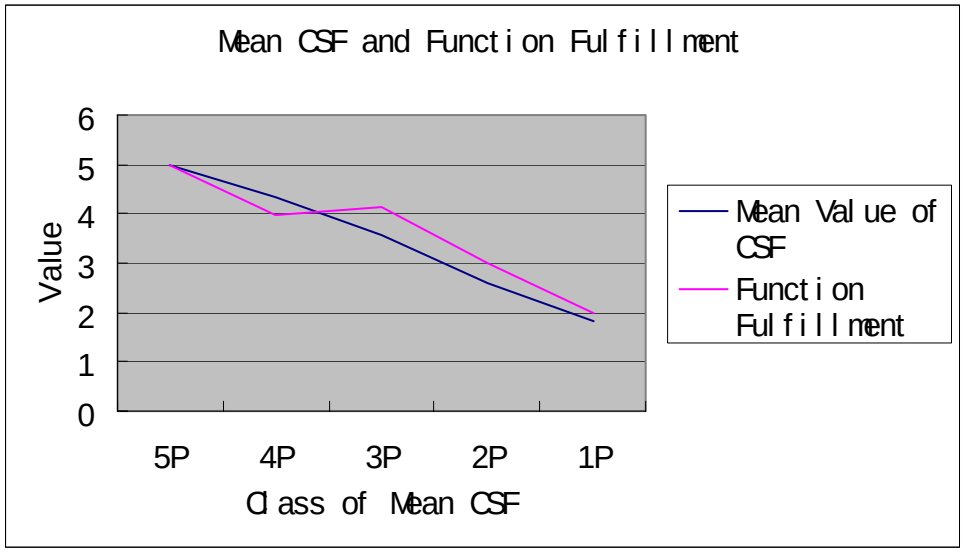


Figure 5.9 Average CSF and Fulfillment of Function

The method used is same as for hypothesis 8. The tendency is also quite similar, except that there is no meeting point between the two factors. Generally speaking a higher CSF average relates to a higher satisfaction of function fulfillment, as expected by hypothesis 8. However, in the class of 3P, the average of CSF is only 3.55. When compared with a function fulfilled value of 4.14, the difference is huge and also has the weakest p-value. Hypothesis 9 is fully supported.

6. Conclusion

This study aims to improve understanding of critical success factors affecting ERP implementation in Finland. Critical success factors may ensure effective ERP implementation and a realization of the promised benefits. Factors affecting ERP implementation are complex and abundant. A total of 6 critical success factors for ERP implementation have been identified based on a review of the related literature. The two variables of “Top management support” and “The Suitability of Software and Hardware” have been proven to be the extremely important factors in ERP implementation in Finland by the empirical data. The results of hypothesis are summarized in Table 6.1.

Table 6.1 Hypotheses

Hypothesis	Supported
H1: Recent (early) implementers of EPR are more aware of the CSFs than later users.	No
H2: The company of On-time implementation recognizes CSF more than will be than one of Late implementation.	Fully
H3: Positive correlation between CSF and within-budget implementation	Fully
H4: Positive relation between CSF and satisfaction of currently use	Fully
H5: Positive relation between CSF and fulfillment of ERP function	Partially
H6: SAP users has different view on CSF from others	No
H7: There is a relationship between “Top management support” and other CSFs	No
H8: The average CSF value of each company will impact successful utilization	Fully
H9: High average of CSFs will lead to more satisfaction of function fulfillment	Fully

The data analysis proves the significance of CSF in ERP implementation. According to the proven hypotheses, CSF can facilitate on-time implementation and keep the implementation within-budget. The data also shows that CSF may lead to satisfaction of use and function fulfillment.

However, due to the small sample size in the survey there are some limitations in the generalizations of the research results. This was due to the necessity of short survey questions and the difficulty of extracting information from the participating organizations. At this point, there are six major critical success factors; however, in the future more CSFs relevant to successful ERP implementation may be determined.

Future research could focus on how these critical success factors differ among various implementation partners such as managers, IT specialists, vendors, and consultants.

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Appendix

1 Summary of Literature Review

Authors	Title	Publication	Research objective	Research method	Database	Contribution on CSF
Larsen, M.A. and Myers, M.D.	BPR success or failure? A business process reengineering model in the financial services industry	In Proceedings of the International Conference on Information Systems 1997	Study the process of BPR, the internal and external "factors" or issues that influenced the process, the outcomes of the process, and participants' evaluations of the project.	Interpretive research, one case study	Interviews and documentary sources. Ten semi-structured interviews were conducted with all of the key players in the BPR project.	Possible to early success and later failure. Vice versa.
Bancroft, N., seip, H. and Sprengel, A.	Implementing SAP R/3	2nd edn (Manning Publications, Greenwich, CT) 1998	N/A	Case study	Discussions with 20 practitioners and from studies of three multinational company implementation projects.	Generalize CSF including top management support, the presence of a champion, good communication with shareholders and effective project management.
C. Holland and B. Light	Global Enterprise Resource Planning	*32nd Annual Hawaii International*	Demonstration of the organizational and	Case study	Top person interviews supplemented by	IT legacy is systems are focused

	Implementation	*Conference on System Sciences*, Maui, Hawaii, 1999	technical complexity of ERP implementation and identifies the factors that determined the total cost of the system		documentary evidence collected over a three-year period.	
C. Holland and B. Light	A Critical Success Factors Model for Enterprise Resource Planning Implementation	7th European Conference on Information Systems ECIS, Copenhagen, Denmark. 1999	Identify the factors needed to ensure a successful ERP project and to explain different project outcomes	Case	Interview business and IT personnel in 8 companies and through project documents, annual reports, and company web sites.	Highlight the critical impact of legacy systems upon the implementation process and offer a CSF model with strategic and tactical factors
Mary Sumner	Risk factors in enterprise-wide/ERP projects	Journal of Information Technology, vol.15 2000	Develop a better understanding of the major risk factors associated with enterprise-wide/ERP projects	Case	Interview with the senior project managers in seven companies	IT professionals and business analysts are highlighted.
L.P. Willcocks and R.Sykes	The Role of the CIO and IT Function in ERP	Communications of the ACM 43, no. 4 2000	Identify serious neglect in ERP implementations in securing the most effective roles for the CIO and IT	Case to prove scenarios	Several companies in different industry	Three factors associated with ERP failure based on CIO

			functions			
Nah, Fiona Fui-Hoon; Lau, Janet Lee-Shang; Kuang, Jinghua	Critical factors for successful implementation of enterprise systems	Business Process Management Journal; Volume 7 No. 3 2001	Better understanding of CSF.	Analysis	Ten articles were identified through a computer search of databases of published works and conference proceeding in the information systems area.	Classify CSFs into respective phases.
Zhang L., Lee K.O.M., Zhang Z., Banerjee P.	Critical Success Factors of Enterprise Resource Planning Systems Implementations Success in China	IEEE Computer Society 2002	Improve understanding of critical factors affecting ERP implementation success in China	Mail survey combined with internet research	138 companies in China	Find the local characteristics of CSF, such as culture.
Majed Al-Mashari, Abdullah Al-Mudimigh, Mohamed Zairi	Enterprise resource planning: A taxonomy of critical factors	European Journal of Operational research 146 2003	Demonstrate the linkages between ERP critical factors of success, ERP success and ERP benefit	Analysis	N/A	Model of CSF with evaluation
Elisabeth J.	Enterprise resource	European Journal of	Identify CSF, software	Case	One company case	Incorporate the CSF into real cases.

Umble, Ronald R. Haft, M.Micheal Umble	planning: Implementation procedures and critical success factors	Operational Research 146 2003	selection steps, and implementation procedures critical to success implementation

Appendix 2, Questionnaire

ERP Implementation Survey

1. What is the Financial Information System (ERP) that your company is using now?
2. What system did you use before that?
3. When did you start using the new ERP system?
4. How many months was the ERP implementation planned to take?
5. How many months did the implementation actually last?
6. How many ERP modules were implemented?
7. Would you please make an estimate of the original budget established for the ERP project?
8. Would you please make an estimate of the following cost categories actually incurred in your ERP implementation?
   - Software license
   - Hardware
   - Implementation
   - Consultants
   - Training
   - Other costs
9. Please rate the degree of your agreement with the following statements
   9.1.The ERP implementation has been completed within budget
   9.2.At the present moment, the ERP system is successfully used
   9.3.The required functionality of the ERP system was fulfilled
10. Please specify to what degree the planned business case was fully realized
11. Top management support refers to the fact that the ERP project needs to receive approval from top management. Please rate the level of top management support for your ERP project
12. The effective project management refers to the effective planning and execution of the implementation process. Please rate the level of effectiveness of the project management of your ERP implementation.
13. Business process reengineering refers to aligning the company business processes with the ERP software that will be implemented. Please rate the degree of business process reengineering for your ERP project.

14. The Suitability of Software and Hardware refers to the fit between the selected ERP system and the hardware. Please rate the level of suitability of software and hardware in your ERP project.

15. Education and Training refer to the introduction of the ERP concepts to the future users, and to providing training with regard to the features of the ERP software. Please rate the level of education and training in your project.

16. User Involvement refers to the users' participation in the development and implementation of the ERP system. Please rate the level of user involvement in your ERP project.

17. Please indicate the main industry in which your company is operating

Acknowledgements

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