Assessing risk in ERP projects: identify and prioritize the factors

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Keywords

Risk management, Resource management, Analytical hierarchy process, Delphi method

Abstract

Various figures have stated that ERP (enterprise resource planning) systems have become one of the largest IT investments in recent years. The implementation of ERP system, however, is not an easy task. Previous research reports unusually high failure in ERP projects, sometimes jeopardizing the core operation of the implementing organization. The most famous case is FoxMeyer filed for Chapter 11 bankruptcy protection. Further, ERP systems appear to present unique ongoing risks due to its uniqueness. In this study, we used a Delphi method to identify potential ERP projects risk factors, and constructed an AHP-based framework to analyze and then prioritized the ERP projects risk factors. The result reveals that some important risk factors deserve more attention during the implementation of ERP projects.

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Introduction

With the rapid expansion of e-commerce/e-business, enterprises are facing management pressure from customers, suppliers, and competitors. Their customers are pursuing low cost, high quality, and quick supplement responds. The flexibility to reduce the inventory and to decrease the cost during the operation process has become the major tasks of enterprises (Zheng *et al.*, 2000). For these reasons, the enterprise needs the support of a strong alley to keep the competition advantage that enterprise resource planning (ERP) system emerges.

The ERP system market is one of the fastest growing markets in the software industry (Willis and Willis-Brown, 2002). ERP systems are huge and complex systems and warrant careful planning and execution to ensure their successful implementation (Gupta, 2000). AMR research (2002) pointed out that the ERP market would be $16 billion in 2002 and will remain so through at least 2004. Current major ERP vendors are SAP AG, Baan, Oracle, and J.D. Edward, etc. These vendors occupy over 50 percent of the market (AMR research, 2000).

In addition, PMP research (2001) carried out an ERP related survey on the impact of manufacturing system, and the results revealed that 70 percent of sample companies believed that the average implementation time of ERP system is from six months to two years. Regarding the investment effort of ERP system in US 5000, more than 68 percent of companies would apply the Big Bang methodology to change their system and business processes at one time, and the ERP system implementation costs companies at the average of approximately one million dollars, as indicated by the survey results of Keil and Montealegre (2000). It is a big investment project for an enterprise.

But according to the estimation of Standish Group International 90 percent SAP R/3 projects run late (Scott and Vessey, 2002), and Williamson (1997) indicated that 3/4 ERP projects were considered as failure and cannot be accepted. And in the case of FoxMeyer Drug, it has led to bankruptcy proceeding (Scott and Vessey, 2002). One explanation for the high failure rate is that managers do not take prudent measures to assess and manage the risks involved in these projects (Mark *et al.*, 1998; Wright and Wright, 2001). An ERP is necessary for an enterprise in the world market. It is obvious that ERP has become the core competition ability of the enterprises. The enterprise manipulates the capabilities of ERP to sustain routine operations. How to implement ERP system well is the urgent and important issue.

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Various ERP implementation methods had been proposed in the past decades. They tried to mitigate the failure rate of ERP systems or to implement ERP system more efficiently. Unfortunately, they do not seem to work very well (Hong and Kim, 2002; Huang *et al.*, 2001; Nikolopoulos *et al.*, 2003). What are the major factors causing this problem? Some researchers proposed that the risk concepts of ERP projects may be the reason (Wright and Wright, 2001). According to Wiegers (1998), "A simple definition of 'risk' is a problem that has not yet happened but which could cause some loss or threaten the success of your project if it did." With this definition, some research has promoted to investigate the relative importance of various risks in ERP projects and try to classify and eliminate these risks.

McFarlan (1981) also mentioned that failure to assess individual project risk and to adapt management methods was a major source of the software project problem. According to Barki *et al.* (1993), a task that is critical to the proper management of software project development risk is the assessment of the risk facing the project. Based on previous research, the estimation of risk must be taken during the implementation of the information system. That is the reason why we try to establish a framework of risk estimation of ERP projects. Kliem (2000) figures that the relevant work of risks management is best performed as early as possible in the life cycle. In this research, we assume that the estimation of the risks is from the initiation of ERP projects. As the popular proverb says "prevention is better than cure", Matthys and Shorter (2000) stated that a researcher or adopter should pay particular attention to the definitions and problem corrections of the ERP system implementation.

Much research has described that there is an obvious difference between ERP projects and software projects (Bingi *et al.*, 1999; Majed, 2003). Most software projects are to develop a software system. But an ERP project is composed of software projects and business processes. The ERP system consists of tightly linked interdependencies of business processes, software systems, and process reengineering (Wright and Wright, 2001; Xu *et al.*, 2002), that presents unique risk factors formed with software systems and its wide applications. According to the previous investigators (McFarlan, 1981; Kliem, 2000), we would expose the risks during ERP implementation and provide suggestions to improve it during ERP implementation. In this work, we try to find the major risk factors associated with ERP projects, construct a risk estimate framework for ERP projects, identify and verify the existing risks to decrease or to prevent the impacts of risks of ERP pre-implementation.

Background

The term risk is associated with many human endeavors because of its space exploration, nuclear reactor construction, company acquisition, security evaluations of information systems, or information systems development. As such, people in a variety of domains have studied the notion of risk (Barki *et al.*, 1993). Siropolis (1986), classified risk into three categories: pure risk, fundamental risk, and speculative risk. The speculative risk involves gain or loss by an organization. An example of speculative risk would be the evolvement of a new software or implementation of new information system (IS) that has the potential to reap great rewards if the software reinforces productivity. Conversely, it may cause a loss, i.e. loss of investment. The risk factors exposed during ERP implementation belong to speculative risk, that we can prevent the damage of ERP risk factor.

Software development problems have been a major issue until now. Unfortunately, it appears that software development efforts still suffer from age-old difficulties of cost overruns, project delays, and unmet user needs (Wiegers, 1998). A well-known article by McFarlan (1981) on software risk management was published, one decade ago, with development failure examples just like the ones listed above. He stated that failure to assess individual project risk and to adapt management methods accordingly was a major source of the software problem. Even though McFarlan's views have been well received by practitioners and researchers, little research has been done to advance our knowledge of software development risks.

Alter (1979) identified eight risk factors: nonexistent or unwilling users, multiple users or implementers, turnover among all parties, inability to specify purpose or usage, inability to cushion impact on others, loss or lack of support, lack of experience, and technical or cost-effectiveness problems. Boehm (1991) recommended the use of approximate methods, and proposed a prioritized checklist of ten software risk items: personnel shortfalls, unrealistic schedules and budgets, developing the wrong software functions, developing the wrong user interface, gold plating, continuing stream of requirement changes, shortfalls in externally furnished components, shortfalls in externally performed tasks, real-time performance shortfalls, and straining computer science capabilities. Zmud (1980) states the

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factors that influence the outcome of software development project: technological complexity, degree of novelty or structure of the application, technological change, and project size. Davis (1982) identifies four sources of project uncertainty: the task to be supported, the application to be developed, the users, and the analysts. Ewusi (1997) suggests that several sources of uncertainty be taken into account in the management of software development projects: complexity, lack of structure, instability of project objectives, newness of the technology, users, IS management, upper management, and project size. Barki *et al.* (1993) reveals a high degree of resemblance between what some authors have labeled "risk factors" and what others have called "uncertainty factors". In these given similarities, the lists of uncertainty and risk factors identified in the IS literature were examined in order to group factors with shared meanings.

ERP projects are unique in that they require the intense collaboration of groups of stakeholders, namely; IS staff, end users and management. Hence ERP projects are organization-oriented activities, and therefore subject to all the vagaries of group dynamics, interactions, coordination, and communication. Due to the aforementioned reason, Sumner (2000) held an investigation to a better understanding of the major risk factors associated with enterprise-wide/ERP projects. Wright and Wright (2001) also investigated the risk factors of ERP projects due to ERP systems, which inherently present unique risks associated with its tightly linked interdependencies of business process, relational database, and process reengineering. Sumner (2000) used case studies to describe the experiences of several companies which had implemented enterprise-wide information management systems using SAP, Peoplesoft, and Oracle. Wright and Wright (2001) held a semi-structured interview with experienced participants. They found that Insufficient training and re-skilling, Insufficient internal expertise, Lack of analysts with the knowledge of business and technology, Failure to mix internal and external expertise effectively, unable to comply with the standard which ERP software supports, and lack of integration between enterprise-wide systems could be ERP risk factors. Based on previous research, the ERP risk factors are listed in the Table I.

Methods used for identification of risks

Boehm (1991) proposed the risk assessment process as risk identification, risk analysis, and risk prioritization. Risk identification produces lists of project-specific risk items that are likely to compromise a project's success. Risk analysis assesses the loss in probability and magnitude for each identified risk item. Risk prioritization produces a ranked ordering of risk items that are identified and analyzed. In this paper, we used Delphi method to identify the risk factors, and then used AHP (Satty, 1990) to analysis and prioritize the risk factors. Delphi is a group process that may use written media to solicit and aggregate information from a group of disjoint individuals (Schmidt *et al.*, 2001). It provides a means to obtain, refine, and communicate the informed judgments of experts. On the strength of experienced practitioners and professional consultants who had ever placed ERP project, we can extract the appropriate ERP risk factors.

This research invited seven experts to participate in this study; they are all experienced and well performed in ERP projects (Table II). The Delphi method consists of three rounds, in which the first round focuses on the exploration of the subject and participants contributes additional information. Some consensus occurs in the middle round. In the last round a final evaluation occurs when all previous information has been analyzed and results have been provided for participant evaluation. After obtaining consensus from Delphi method, we extracted 28 proper risk factors. We then categorized these factors based on their attributes. These categories are organization fit, skill mix, project management and control, and software system design user involvement, technology planning. We used these risk factors to construct the framework of the risk assessment.

The AHP provided a flexible and easily understandable way of analyzing project risks. It is a multi criteria decision-making methodology that allows subjective as well as objective factors to be considered in project risk analysis. The first step of this research by using Delphi method has formulated the decision problem in the form of a hierarchy structure (Figure 1). In a typical AHP model, the top level reflects the overall objective or focus of the problem. The elements affecting the problem are represented in the intermediate level.

After constructing the hierarchy, the prioritization procedures are started to determine the relative importance of the element in each level of the hierarchy. The elements in each level are compared pair-wise with respect to their importance in making the decision. The verbal scale used in an AHP enables the decision-maker to incorporate subjectivity, experience and knowledge in an intuitive and natural way. After creating the comparison matrices, the process moves on the phase in which relative weights are derived for various elements. The relative weights

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Table I Risk factors of ERP

Category	Risk factors in IS	Risk factors unique in ERP
Organization fit	Organizational environment (resource insufficiency and extent of changes) (Barki *et al.*, 1993) Extent of changes (Keil and Montealegre, 2000)	Failure to support cross-organization design Wright and Wright, 2001
Skill mix	Lack of technical expertise (Ewusi, 1997) Lack of application knowledge (Barki *et al.*, 1993; Ewusi, 1997) Inappropriate staffing and personnel shortfalls (Boehm, 1989; Keil and Montealegre, 2000)	Insufficient training and re-skilling (Wright and Wright, 2001) Lack of analysts with business and technology knowledge (Sumner, 2000) Failure to integrate internal and external expertise effectively (Sumner, 2000)
Project management and control	Lack of agreement on project goals (Ewusi, 1997) Lack of senior management involvement (Ewusi, 1997; Keil and Montealegre, 2000) Lack of effective project management methodology (Keil and Montealegre, 2000; Ewusi, 1997)	
Software system design	Unclear/Misunderstanding changes in requirements (Rainer *et al.*, 1991; Boehm, 1989; Keil and Montealegre, 2000) Lack of an effective methodology, poor estimation and failure to perform the activities needed (Rainer *et al.*, 1991; Keil and Montealegre, 2000)	Unable to comply with the standard which ERP software supports (Wright and Wright, 2001; Sumner, 2000) Lack of integration between enterprise-wide systems (Sumner, 2000; Wright and Wright, 2001)
User involvement and training	Lack of user commitment and ineffective communications with users (Rainer *et al.*, 1991; Keil and Montealegre, 2000) Conflicts between user departments (Keil and Montealegre, 2000)	Insufficient training of end-user (Sumner, 2000; Wright and Wright, 2001)
Technology planning	Capability of current enterprise technical infrastructure (Ewusi, 1997) Technology newness,(Rainer *et al.*, 1991; Boehm, 1989; Barki *et al.*, 1993) Technology complexity (Barki *et al.*, 1993)	Attempting to link legacy applications (Sumner, 2000; Wright and Wright, 2001)

Table II Expert demographic

	Panel						
Characteristics	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Title	Director	Professor	Vice-primer	Director	Director	Director	Professor
Seniority	11	4	17	3	12	13	3
Numbers of ERP project panelist has Members in ERP project	5	6	100	17	50	5	2
Max	15	20	200	100	30	15	12
Min	3	5	5	10	3	5	3

of elements of each level with respect to an element in the adjacent upper level are computed as the component of the normalized eigenvector associated with the largest eigenvalue of their comparison matrix. The composite weights of decision alternatives are then determined by aggregating the weights through the hierarchy. This is accomplished by following a path from the top of the hierarchy to each alternative at the lowest level, and multiplying the weights along each segment of the path. The overcome of this aggregation is a normalized vector of the overall weights of the options. The Table III shows the mathematical basis for determining the weights which has been established by Saaty (1990).

Data collection

The target of AHP method in this study was the people who had ever participated ERP implementation. We constructed a Web-questionnaire and invited 198 members of a Chinese Enterprise Resource Planning Society (CERPS) to participate the research. The sample was chosen because the members of CERPS typically have expertise on ERP project

Figure 1 The risk hierarchy of ERP project

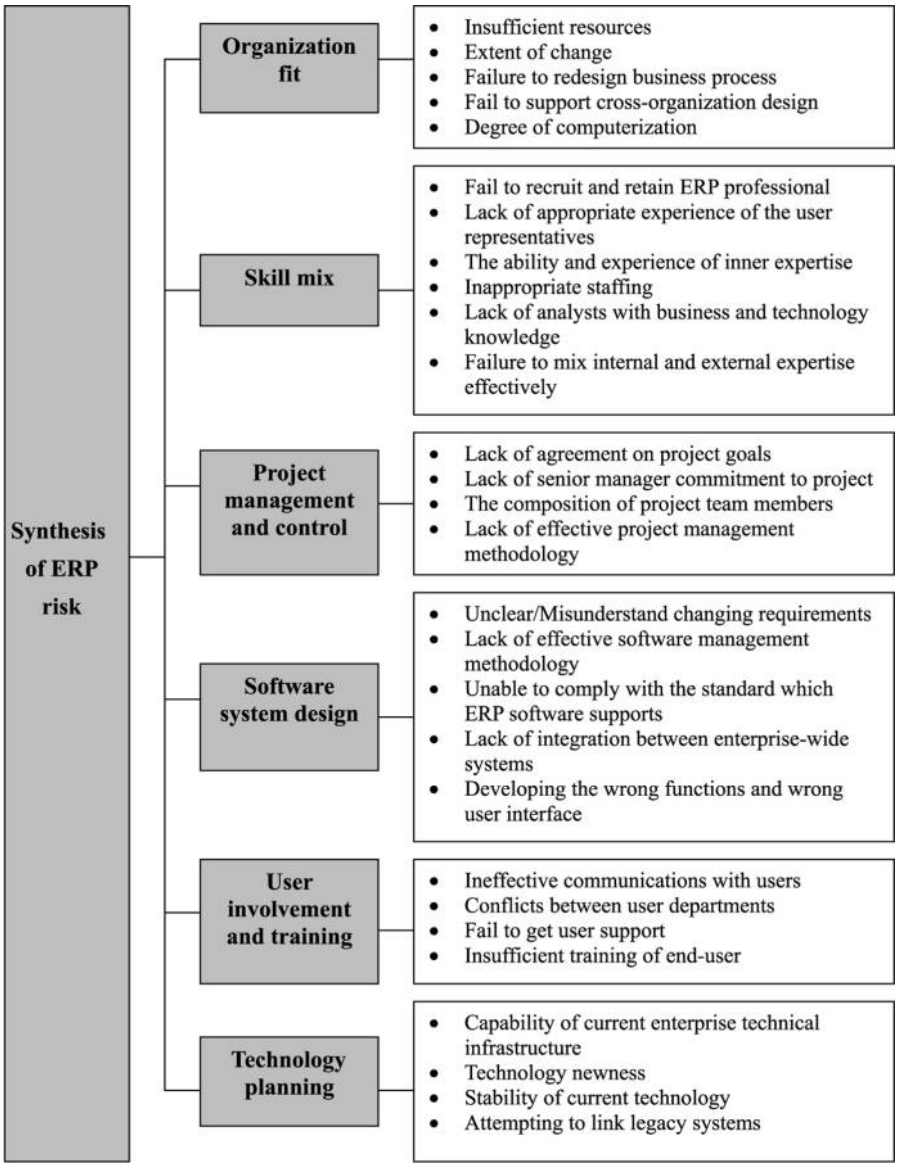

Table III Scale of relative importance for correspondence table

Intensity	Definition	Explanation
1	Equal importance	Two activities contribute equally to the object
3	Moderate importance	Slight favors one over another
5	Essential or strong importance	Strongly favors one over another
7	Demonstrated importance	Dominance of the demonstrated importance in practice
9	Extreme importance	Evidence favoring one over another of highest possible order of affirmation
2,4,6,8	Intermediate	When compromise is needed

Source: Saaty (1990)

management and have widely been used in ERP project management research. All the respondents are assured that their response would be kept confidential. A total of 30 questionnaires were returned, 4 were invalid (C.R $>$ 0.1), effective questionnaire is 14 percent (26/198). A summary of the demographic characteristics of the sample is presented in Table IV.

Data analysis

User involvement and training, project management and control are the facets concerning the sample. These two facets occupy almost 50 percent of the total factor. Within the user

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Table IV Sample demographic

Characteristics	Total
Position	
Engineer	7
Manager	18
Other position	1
Work experience	
1-5 years	15
6-10 years	8
15 or above	3
Organization size	
Under 100 employees	0
100-500 employees	5
500-1000 employees	14
1000 or above	7
Experience with ERP	
Yes	26
No	0
Implementation years with ERP system	
0-1 year	5
2-3 years	15
4-5 years	6
Above	0

involvement and training risk category – ineffective communications with users, failure to get user support, and insufficient training of end-user are the major causes of ERP project failure (Table V).

The other major risk category for project achievement is project management and control. Lack of senior manager commitment to project and lack of efficient project management methodology are the major reasons of project failure in this category. Conventionally, risk analysis is performed at the overall project level. Among the synthesized of 28 risk factors, we summarized the top ten risk factors that affect the ERP projects more than others (Table VI).

To implement ERP in the enterprise needs business process reengineering and may change the enterprise environment. It needs a lot of effort to ease the fear of users, and to eliminate the resistance of users. Previous research indicated that user training is a key requirement for ERP implementation. Pertaining to the insufficient training of end-user, Davenport (1998) suggested that ERP systems can empower users by equipping them with real-time data, and Rao (2000) observed that ERP was associated with greater job flexibility by expanding individual awareness, creativity, and innovation. Robey *et al.* (2002) figured that the above advantage should be on the premise of training. Before the user could use an ERP system efficiently, they need to learn the business processes that were revised following system implementation. They suggested that firms

Table V Weights of risk factors facets

	Loading	Factors	Loading
Organization fit	0.142	Insufficient resources	0.25
		Extent of change	0.17
		Failure to redesign business process	0.26
		Failure to support cross-organization design	0.19
		Degree of computerization	0.13
Skill mix	0.12	Failure to recruit and retain ERP professional	0.14
		Lack of appropriate experience of the user representatives	0.17
		The ability and experience of inner expertise	0.16
		Inappropriate staffing	0.14
		Lack of analysts with business and technology knowledge	0.17
		Failure to mix internal and external expertise effectively	0.21
Project management and control	0.23	Lack of agreement on project goals	0.13
		Lack of senior manager commitment to project	0.47
		The composition of project team members	0.18
		Lack of effective project management methodology	0.22
Software system design	0.15	Unclear/Misunderstand changing requirements	0.25
		Lack of effective software management methodology	0.17
		Unable to comply with the standard which ERP software supports	0.16
		Lack of integration between enterprise-wide systems	0.22
		Developing wrong functions and wrong user interface	0.20
User involvement and training	0.23	Ineffective communications with users	0.30
		Conflicts between user departments	0.19
		Fail to get user support	0.24
		Insufficient training of end-user	0.27
Technology planning	0.13	Capability of current enterprise technical infrastructure	0.25
		Technology newness	0.19
		Stability of current technology	0.24
		Attempting to link legacy systems	0.33

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Table VI Top ten risk factors of ERP risk

Name	Loading	Priority
Lack of senior manager commitment to project	0.11	1
Ineffective communications with users	0.073	2
Insufficient training of end-user	0.066	3
Fail to get user support	0.052	4
Lack of effective project management methodology	0.049	5
Attempting to build bridges to legacy applications	0.043	6
Conflicts between user departments	0.043	7
The composition of project team member	0.041	8
Fail to redesign business process	0.037	9
Unclear/Misunderstanding changing requirements	0.036	10

addressed the need for users to learn new system by providing formal training for users and by taking an incremental approach to system implementation. The training should contain operation skills of new system, procedural training, revised business process and management change. The user training should not only focus on software procedure but also management change and the concepts of process-orientation (Schmidt *et al.*, 2001).

The implementation of ERP contains various changes, which may cause conflicts of different departments. Without the intervention of senior management, no one will compromise the rearrangement of ERP. Ewusi (1997) stated that the failure of senior management to request and enforce regularly scheduled management review meetings to monitor progress on a project is a major cause of failure. Umble and Umble (2002) suggested that if the top management is not strongly committed to the system, does not foresee and plan for the profound changes necessitated by ERP, or does not actively participate in the implementation, the implementation is at high risk of failure. The implementation of ERP must be viewed as a transformation in the way the company does business. Besides the supports from top management, excellent project management techniques are also required (Umble and Umble, 2002). They indicated that implementation teams should take a disciplines approach to project management, including a clear definition of objectives, development of a work plan, and establishment of resource requirement plan. Most of all, appropriate project evaluation measures must be included during ERP implementation. The policy of compensation, award, assist, responsibility, and replacement of incapable staff should be preserved and monitored until final completion. Umble and Umble (2002) indicated that some of the biggest ERP system implementation failures occur because the new software's capabilities and needs are mismatched with the organization's business process and procedures. The mismatch between ERP systems, existing structure, and business process of organization will generate widespread chaos. Robey *et al.* (2002) suggested that the core team and consultants could aid in solving this kind of problems. In most firms a core team assumed responsibility for configuring the system, it served as forces promoting new knowledge against the knowledge barriers of the existing organization memory. With the method of staffing core team with experienced business and technology managers could provide needed business and technical expertise. Due to the integrated nature of ERP, data entered into a system may be used throughout the organization. If the inaccurate data is entered into the common database, erroneous data may have a negative domino effect throughout the enterprise. The domino effect will cause the ERP lose credibility and will encourage people to ignore the new system and continue to run the company under the old system (Umble and Umble, 2002).

Conclusion

The purpose of this study is to build a framework of ERP risk assessment. Previous research stated that proper risk assessment requires an understanding of

(1) what the actual risks are; and
(2) which of these risks managers perceive to be more deserving of their attention.

In this study, we have taken some steps toward addressing each of these points. First we employed the Delphi method to acquire the risk factors associated with ERP project and we found that 28 such risk factors would affect during ERP implementation. Second, we establish an AHP-based framework to assess and prioritize these factors; the results also demonstrated that there are discernible differences in the identification and perceived importance of certain risk factors. The results of this study can assist practitioners on assessing the risk of ERP projects.

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