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Risk factors in enterprise-wide/ERP projects

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The purpose of this study was to identify the risk factors in implementing traditional management information systems projects, describe the risk factors associated with enterprise-wide/ERP (enterprise resource planning) projects and identify the risk factors in ERP projects which are unique to these projects. Some of the unique challenges in managing enterprise-wide projects which were highlighted through the findings included the challenge of re-engineering business processes to 'fit' the process which the ERP software supports, investment in recruiting and reskilling technology professionals, the challenge of using external consultants and integrating their application-specific knowledge and technical expertise with existing teams, the risk of technological bottlenecks through client-server implementation and the challenge of recruiting and retaining business analysts who combine technology and business skills.

Introduction

In the past few years many organizations have initiated enterprise-wide/ERP (enterprise resource planning) projects using such packages as SAP, Peoplesoft and Oracle. These projects often represent the single largest investment in an information systems (IS) project in the histories of these companies and, in many cases, the largest single investment in any corporate-wide project.

These enterprise-wide/ERP projects bring about a host of new questions because they represent a new type of management challenge. The management approaches for these projects may be altogether different from the managerial approaches for traditional management information systems (MIS) projects. Some of these questions and issues are as follows.

(1) What are the major risk factors associated with implementing traditional MIS projects?
(2) What are the major risk factors associated with enterprise-wide information management projects?
(3) What are the differences?
(4) What new risk factors need to be addressed in ERP projects?
(5) What are some of the risks in ERP projects that are not factors in non-ERP projects?

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. This paper will provide case studies of seven organizations implementing enterprise-wide/ERP projects and will provide insight into each of these questions based upon their experiences.

Risks in implementing IS projects

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 (Wiegers, 1998). A number of research studies have investigated the issue of the relative importance of various risks in software development projects and have attempted to classify them in various ways. Much has been written about the causes of IS project failures. Poor technical methods is only one of the causes and this cause is relatively minor in comparison to larger issues such as failures in communications and ineffective leadership.

Studies dealing with risk factors in IS projects have described issues of organizational fit, skill mix, management structure and strategy, software systems design, user involvement and training, technology planning, project management and social commitment. Table 1 provides a summary of the risk factors in IS projects.

Organizational fit

In their paper, Barki *et al.* (1993) proposed a variety of risk factors associated with the organizational environment, including task complexity, the extent of changes, resource insufficiency and the magnitude of potential loss. In the framework developed by Keil *et al.* (1998), the risks in the environment quadrant deal with issues over which the project manager may have no control, such as changing scope/objectives and conflicts between user

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departments. In his text on the factors contributing to project failure, Block (1983) pointed to resource failures (conflicts of people, time and project scope) and requirement failures (poor specification of requirements).

Skill mix

Lack of expertise, including lack of development expertise, lack of application-specific knowledge and lack of user experience, contributes to project risk (Barki *et al.* 1993; Ewusi-Mensah, 1997). The risk factors in the execution quadrant of Keil *et al.*'s (1998) framework include inappropriate staffing and personnel shortfalls.

Management structure and strategy

In their study of the factors that software project managers perceive as risks, Keil *et al.*, (1998) addressed the risks associated with customer mandate, which deals with a lack of senior management commitment. Ewusi-Mensah (1997) also pointed to a lack of agreement on a set of project goals/objectives and lack of senior management involvement. Block (1983) described goal failures (inadequate statement of system goals) and organizational failures (lack of leadership).

Software systems design

The risks associated with scope and requirements include misunderstanding requirements and failing to manage change properly. Lack of an effective methodology and poor estimation can lead to cost and time overruns (Keil *et al.*, 1998). In his paper 'Software Risk Management: Principles and Practices', Boehm (1991) identified ten software risk factors including developing the wrong functions, developing the wrong user interface, 'gold-plating', a continuing stream of changes in requirements, shortfalls in externally furnished components, shortfalls in externally performed tasks and performance shortfalls.

User involvement and training

Lack of user commitment, ineffective communications with users and conflicts among user departments are all sources of risk (Block, 1983, Keil *et al.*, 1998).

Technology planning

In a study of the issues that contribute to the cancellation of IS development projects, Ewusi-Mensah (1997) pointed out that lack of adequate technical expertise and lack of an adequate technology infrastructure for supporting project requirements contribute to escalating time and cost overruns and are associated with project abandonment. The risk factors include technological newness (need for new hardware and software), application size (project scope, number of users and team diversity), application complexity (technical complexity and links to existing legacy systems) and failure of technology to meet specifications (Block, 1983; Barki *et al.*, 1993).

Project management

Project cost and time overruns can occur because of lack of a measurement system for assessing and controlling project risk (Ewusi-Mensah, 1997). McFarlan (1981) developed dimensions of project risk assessment based upon project size, experience with the technology and project structure. Project management and control failures caused by inadequate planning and tracking can contribute to unrealistic schedules and budgets and project failure (Block, 1983; Boehm, 1991).

Social commitment

Risk factors and risk outcomes need to take into account distinctive human and organizational practices and patterns of belief and action, as well as traditional project-related factors (Willcocks and Margetts, 1994). There is a tendency to discount problems in information technology (IT) projects and their severity may remain unknown for a long period of time. When projects run into difficulty, there is a tendency to escalate projects because of societal norms (e.g. needing to save face) and to keep pouring resources into a failing project. This may augment risk. In order to minimize problems it is essential to look for opportunities of using external feedback in order to recognize the problem and then redefine it. This may entail considering alternatives to accomplishing the project's goals and preparing key stakeholders for the decision – particularly if the decision is an exit strategy (Keil and Montealegre, 2000).

Ginzberg (1981) conducted a longitudinal study of user expectations as predictors of project success or failure and his findings suggested that systems implementation failure is more likely when there are unrealistic expectations about a system. Users who have more realistic expectations are more likely to be satisfied with the outcomes.

Managing large-scale, commercial, off-the-shelf software projects

The existing research on managing commercial, off-the-shelf software projects, including software package

Table 1. Summary of the risk factors in IS projects

Risk factor	Issue
Organizational fit	Organizational environment (resource insufficiency and extent of changes) (Block, 1983; Borki *et al.*, 1983)
	Changing scope and objectives (Keil *et al.*, 1998)
Skill mix	Lack of technical expertise (Ewusi-Mensah, 1997)
	Lack of application knowledge (Barki, *et al.*, 1993; Ewusi-Mensah, 1997)
	Inappropriate staffing and personnel shortfalls (Block, 1983; Boehm, 1991; Keil *et al.*, 1998)
Management structure and strategy	Lack of agreement on project goals (Block, 1983; Ewusi-Mensah, 1997)
	Lack of senior management involvement (Ewusi-Mensah, 1997; Keil *et al.*, 1998)
Software systems design	Misunderstanding requirements and changes in requirements (Block, 1983; Boehm, 1991; Cash *et al.*, 1992; Keil *et al.*, 1998)
	Lack of an effective methodology, poor estimation and failure to perform the activities needed (Block, 1983; Keil *et al.*, 1998)
User involvement and training	Lack of user commitment and ineffective communications with users (Block, 1983; Keil *et al.*, 1988)
	Conflicts between user departments (Keil *et al.*, 1998)
Technology planning	Lack of adequate technology infrastructure (Ewusi-Mensah, 1997)
	Technological newness, strained technical capabilities and failure of technology to meet specifications (Block, 1983; Boehm, 1991; Cash *et al.*, 1992; Barki *et al.*, 1993)
	Application complexity (technical complexity) (Barki *et al.*, 1993)
Project management	Unrealistic schedules and budgets (Boehm, 1991)
	People and personality failures, lack of effort, antagonistic attitudes and people clashes (Block, 1983)
	Lack of measurement system for controlling risk and inadequate project management and tracking (Block, 1983; Ewusi-Mensah, 1997)
Social commitment	Inability to recognize problems. a tendency to keep pouring resources into a failed project and unrealistic expectations (Ginzberg, 1981; Willcocks and Margetts, 1994; Keil and Montealegre, 2000)

implementation, manufacturing resource planning (MRP) implementation and ERP implementation, provides insight into the factors associated with project success and failure. In their analysis of implementing packaged software, Lucas *et al.* (1988) suggested that package implementation is different from custom implementation because the user may have to change procedures in order to work with the package, the user is likely to want to change some programs in the package to fit their unique needs and the user becomes dependent upon the vendor for assistance and updates. Some of the variables associated with the successful implementation of packages are (1) greater vendor participation in implementation and support, (2) a higher rating of user/customer capabilities by the vendor and (3) a higher rating of user skills by MIS management. A highly skilled workforce is important for successful package implementation.

Experience in implementing large-scale integrated packages, including MRP systems, provides a better understanding of the challenges associated with commercial, off-the-shelf software implementation. In their research on success factors in MRP projects, Duchessi *et al.* (1989) concluded that commitment from top management and adequate training were 'critical' success factors for implementation. In another study of the problems encountered during MRP implementation, Ang *et al.* (1994) found that lack of training led to difficulties in MRP systems implementation.

Enterprise-wide/ERP projects are also large-scale, commercial, off-the-shelf packages which pose unique challenges. Several studies have reported on the success factors and pitfalls in ERP implementation. Bancroft *et al.* (1998) provided critical success factors for ERP implementation, including top management support, the presence of a champion, good communication with stakeholders and effective project management. The factors which are specific to ERP implementation include re-engineering business processes, understanding corporate cultural change and using business analysts on the project team.

In their study of the factors associated with successful implementation of ERP systems, Parr *et al.* (1999) observed that ERP systems are more complex than packages because users are involved in re-engineering processes and factors associated with

project success from the literature (management support and a champion) are important because of the substantial re-engineering that takes place. Based upon interviews with senior members of ERP implementation teams, they identified factors which are necessary for the successful implementation of ERP systems, where success is understood to be adherence to time and budgetary constraints. Three of these factors were of paramount importance: management support of the project team, a project team with the appropriate balance of technical/business skills and commitment to change by all the stakeholders.

Managing client-server IS

The implementation of ERP systems often entails the use of client–server technology and this may cause further complications. It is often critical to acquire external expertise, including vendor support, in order to facilitate successful implementation. In addition, the costs of training and support are often underestimated and these costs may be many times greater than originally anticipated. Client–Server implementations often bring 'surprises' with respect to cost because of the costs of decentralized servers, systems integration software, technical support and software updates and version control. In reality, the total cost of a client–server implementation can be three to six times greater than for a comparable mainframe-based system. Even though there are great cost reductions possible through moving off the mainframe, the costs of learning the new technology and of acquiring technical support are substantial (Caldwell, 1996).

Research objectives

The purpose of this study was to develop a better understanding of the major risk factors associated with enterprise-wide/ERP projects. The following case studies will examine these risk factors. The case studies describe the experiences of seven companies implementing enterprise-wide MIS using SAP, Peoplesoft and Oracle. The case studies were developed using in-depth structured interviews with the senior project managers responsible for planning and implementing enterprise-wide/ERP systems within their respective organizations. A structured interview format was followed in each of the interviews. The questions dealt with project characteristics (purpose and scope, project duration and project justification), project management issues (project sponsorship, project team make-up and mix of internal/external team members), technical challenges, critical success factors (organizational factors, people factors and technology factors) and lessons learned. In addition to identifying the critical success factors and the risk factors associated with technology, organizational fit and people factors, the project managers provided insight into the unique factors associated with successful project management and control of ERP projects.

Company profiles

The findings describe experiences in implementing ERP systems within seven large organizations with sales ranging from $1 billion to $15 billion annually. The firms represent a variety of industries, as shown in Table 2.

The case studies: findings

The findings describe the project justification and risk factors identified by the project managers responsible for the SAP, Peoplesoft and Oracle projects within these seven organizations. The first area of discussion was project justification. The risk factors identified in the interviews were organized into the categories of organizational fit, skill mix, management structure, software systems design, user involvement, user training, technology planning and project management.

Project justification

In these case studies, the ERP projects were justified in terms of cost-effectiveness and business benefits. In 1996, the pharmaceutical manufacturer started a corporate-wide SAP project. The business justification for the project was operational excellence, e.g. cutting the costs of core transaction-processing systems, such as order processing and inventory management. In addition, an integrated package could support worldwide business operations and replace division-level systems. Before SAP, the pharmaceutical firm had four purchasing packages, one for each business unit. SAP provided economies of scale in development, maintenance and operations. Its overall costs were divided by a much larger number of users. For example, buying a $100 000 package supporting 5000 users is less expensive than buying a $25 000 package supporting 100 users. In addition, the SAP project enabled the pharmaceutical company to reduce its IS development staff from 500 to 50 people.

Some of the 'business drivers' for the SAP implementation at the pharmaceutical manufacturer included data integration, standardization, access to timely and complete information, leverage gained in

Table 2 Company profiles

	Nature of business	1998 sales ($)	Number of employees worldwide	Number IT employees	Number of project employees
Beverage manufacturer	Manufactures food and beverage products	12 832	25 123	1100	Fifty internal and 25 external
Military aircraft manufacturer	Manufactures military aircraft	15 000	60 000	850	Eighty to one hundred internal and 20 external
Electrical manufacturer	Manufacturer of electrical and electronic products and systems	12 298	100 700	90 (one division)	Twenty-five internal and 50–60 external (one division)
Investment brokerage firm	National investment brokerage firm	1 135	13 690	725	Twenty-five internal
Pharmaceutical manufacturer	Manufactures and markets high-value agricultural products, pharmaceuticals and food ingredients	7514	24 700	600	Twenty-five internal and ten external
Consumer product manufacturer	Manufactures dog/cat foods and dry cell battery products	4653	23 000	750	One hundred internal and 20 external
Chemical manufacturer	Manufactures and distributes biochemicals, organic chromatography products and diagnostic reagents	1127	6000	200	Twenty internal and ten external

External project employees refer to consultants.

purchasing and globalization. SAP cut the costs of operational systems, improved the reliability of customer service and assured timely delivery and follow-up.

The original project justification for the SAP project at the beverage manufacturer was similar. There were extensive economies of scale associated with consolidating four MIS projects into one and SAP offered an integrated, corporate-wide solution. The business justification entailed major cost savings from reducing the costs of operational level information systems. SAP provided hard-dollar savings based upon integration of data and processes, a common database and increased leverage in purchasing and buying.

The major sources of justification for the SAP project at the chemical manufacturer were the need to integrate a number of different order processing systems, the need to improve and integrate financial systems and the ability to reduce the workforce through systems integration. The major motivation behind the project was to gain a 'competitive advantage' by providing 'seamless' order processing to customers in a global market-place. This meant that any customer in the world could place orders using one integrated order processing system as opposed to using many different systems for different product lines.

The Peoplesoft project at the military aircraft manufacturer was justified in terms of better information, cost reduction and data integration. Between 70 and 80 systems were replaced by a single, integrated system. While the original intent was to implement an integrated human resources (HR) payroll system using

Peoplesoft, the first phase of the project involved completing the HR component and creating an interface with the existing payroll system. After the completion of the firm's merger with a commercial aircraft manufacturer, the plan was to integrate both the HR and payroll systems using the Peoplesoft software. As discussed later, this 'phased-in' approach created significant problems in system implementation.

The major justification for the Peoplesoft project at the investment brokerage firm was data integration, a common systems approach and hard-dollar savings through integration. The Oracle project at the consumer products manufacturer was also justified in terms of data integration and cost reduction through the re-engineering of business processes.

The major purpose of the Oracle project at the electrical products manufacturer was to implement Oracle financial, distribution and manufacturing systems. The business justification included inventory reduction, head count savings and reduced lead times through on-time delivery. Table 3 summarizes the basis for project justification for the various SAP, Peoplesoft and Oracle projects.

Risk factors

The findings provide the risk factors associated with ERP systems implementation which were mentioned by senior project leaders and identify risks which actually materialized. These factors are represented in order of how frequently each one was mentioned.

Failure to redesign business processes to fit the software

Based upon their experiences, all of the project managers learned to avoid customization. Many companies 'go to war' with the package and try to make it meet their business process requirements, only to lead the way to cost overruns and project failure in some cases. Rather than attempting to modify the software, the chemical manufacturer re-engineered its business processes in order to be consistent with the software and this proved to be critical to the project's success. In contrast, the military aircraft manufacturer customized the HR, payroll and benefits modules in a Peoplesoft ERP package and experienced significant cost and time impacts. The creation of a 'bridge' between the HR module of the ERP system and a legacy payroll application resulted in extensive time and cost delays (seven mentions).

Lack of senior management support

Without question, top management support is critical. It is important to achieve the support of senior management in accomplishing project objectives and aligning these goals with strategic business goals (six mentions).

Insufficient training and reskilling

A number of firms learned that investment in training and reskilling the IT workforce was higher than expected. 'Growing' internal IT staff members with needed technical skills, particularly in application-specific modules, was a strategy followed by four of the organizations (four mentions).

Lack of ability to recruit and retain qualified ERP systems developers

Many of the organizations found it difficult to recruit and retain good ERP specialists because the market rates for these people are high. Management must understand and appreciate the criticality of high-tech worker turnover, recruitment and retention issues. Four organizations developed recruitment and retention programmes specifically designed for addressing the need for ERP systems professionals. In their experience, the loss of trained ERP analysts to consulting firms was particularly frustrating (four mentions).

Insufficient training of end-users

Most firms emphasized making a major commitment to training end-users in system uses. This meant

Table 3 Project type and justification

	System	Justification	Project initiation
Beverage manufacturer	SAP	Cost reduction of operational systems	1996
Military aircraft manufacturer	Peoplesoft	Cost reduction and data integration	1994
Electrical products manufacturer	Oracle (financial, inventory, etc.)	Cost reduction; inventory reduction and head count savings	1996
Investment brokerage firm	Peoplesoft	Data integration and common systems	1996
Pharmaceutical manufacturer	SAP	Cost reduction of core operational systems	1996
Consumer products manufacturer	Oracle (financial and inventory)	Cost reduction and data integration	1996
Chemical manufacturer	SAP	Cost reduction and systems integration	1996

reskilling the end-users in new technologies and applications and supplementing 'generalized' user training with training in the use of specific application modules. Several firms emphasized user training in reporting applications, including the use of report generators for designing and generating custom reports (four mentions).

Inability to obtain full-time commitment of 'customers' to project management and project activities

It may be difficult to get managers to commit to project management roles because they may be uncertain about what responsibilities will still be open to them once they are transferred back to their functional areas. Getting the 'business' areas to dedicate people to the management of the project is a key priority and some of the project managers found this difficult (three mentions).

Lack of integration

In terms of factors conducive to project failure, one of the main factors associated with failure is lack of integration. The project needs to be based on an enterprise-wide design. One project manager argued that 'you cannot start with "pieces" and then try to integrate the software components later on'. Another stated that, 'it is important to use a "federal" approach; define what is needed at the enterprise-level and then apply it to the business unit level' (three mentions).

Lack of a proper management structure

Without central project leadership there is excessive duplication of effort. The pharmaceutical manufacturer put someone 'in charge' and centralized the management structure of the project in order to avoid duplication of effort. In implementing a 'centralized' system, a centralized management structure should exist. At the military aircraft manufacturing company, several senior executives had equal authority over the project and this contributed to conflicts and lack of problem resolution (two mentions).

Insufficient internal expertise

When they did not have needed expertise internally, most firms brought in the consultants they needed in order to overcome technical and procedural challenges in design and implementation. It is important to obtain consultants who are specialists in specific application modules. This was emphasized by the managers representing the electrical manufacturer and consumer products manufacturer, both of whom were implementing Oracle financial modules within various operating units of their respective companies (two mentions).

Lack of a champion

The project leader of an ERP project is clearly a 'champion' for the project and this role is critical to marketing the project throughout the organization (two mentions).

Lack of 'business' analysts

One of the critical workforce requirements for an ERP project is the ability to obtain analysts with both business and technology knowledge. Instead of 200 'programmers' with average skills, the manager of the ERP project within the chemical manufacturer argued that ERP systems can best be accomplished with 20 'business' analysts who have specialized expertise, the ability to learn quickly and effective communications skills (two mentions).

Failure to mix internal and external personnel

Using a mix of consultants and internal staff to work on a project team enables internal staff members to 'grow' the necessary technical skills for ERP systems design and implementation. The project manager for the electrical manufacturer argued that extra external consultants were needed because of insufficient time lines for growing internal staff and this resulted in much higher costs (two mentions).

Failure to emphasize reporting, including custom report development

The use of report generators and user training in reporting applications is critical to project implementation success. One of the 'lessons learned' by the military manufacturer was that insufficient end-user training can generate resistance to using the system, largely because people are ill-prepared for using it effectively (two mentions).

Insufficient discipline and standardization

Another 'risk factor' which is closely associated with the software itself is insufficient adherence with the standardized specifications that the software supports. It is important to avoid compromising the system and its specifications. In terms of 'lessons learned,' the pharmaceutical manufacturers experience demonstrated the importance of using SAP's built-in 'best practices' (two mentions).

Ineffective communications

It is critical to communicate what is happening, including the scope, objectives and activities of the ERP project (two mentions).

Avoid technological bottlenecks

Lack of an integrated technology strategy for supporting client–server implementation causes further risks and

bottlenecks in project success. The different 'technology' environments within one organization created delays in establishing consistency and coordination in the platforms, database management systems and operating system environments for the Peoplesoft application. Technology bottlenecks can occur when designers try to implement bridges between ERP modules and legacy applications. At the military aircraft company, building a bridge between the Peoplesoft HR module and a legacy payroll application contributed to significant time and cost overruns (two mentions).

A summary of the risk factors affecting the management of enterprise-wide/ERP projects and a description of which factors were unique to the ERP projects described in these case studies is given in Table 4.

The unique risks of enterprise-wide/ERP projects

The third question (What inherent risks are there in enterprise-wide/ERP projects that are not found in non-ERP projects?) revealed factors dealing with organizational fit, skill mix, software systems design and technology integration.

The first challenge which was universally supported by the respondents was the risk of failing to redesign business processes and of following an enterprise-wide design that supports data integration across the organization. This makes ERP projects unique because of their size, scope and organizational impact. The integration of business functions, elimination of redundant databases and streamlining of organizational processes are all essential for project justification.

A unique challenge involved in ERP systems implementation is acquiring the necessary skills. Insufficient training and reskilling of the IT workforce in new ERP technology, insufficient 'internal' expertise, failure to mix internal and external expertise effectively and lack of 'business' analysts were all risks associated with the recruitment and retention of IT professionals. The unique challenge here is aggravated by the scarcity of ERP-trained systems developers and the high market demand for their skills. The investment in recruiting, reskilling and retraining IT professionals was considered very high. The problem of retention was further exacerbated by the tendency of highly trained ERP analysts to move to consulting firms where the salaries were even higher.

Traditional strategies for software systems design and construction were also devalued within the context of ERP projects. Systems analysts quickly learned that failure to adhere to the standardized specifications which the software supports created risks. Data integration became a significant design issue and often entailed a top-down systems integration strategy. When legacy systems were involved, many organizations

Table 4 Summary of the risk factors in enterprise-wide/ERP projects

Risk category	Risk factor	Unique to ERP
Organizational fit	Failure to redesign business processes	Yes
	Failure to follow an enterprise-wide design which supports data integration	Yes
Skill mix	Insufficient training and reskilling	Yes
	Insufficient internal expertise	Yes
	Lack of business analysts with business and technology knowledge	Yes
	Failure to mix internal and external expertise effectively	Yes
	Lack of ability to recruit and retain qualified ERP systems developers	
Management structure and strategy	Lack of senior management support	
	Lack of proper management control structure	
	Lack of a champion	
	Ineffective communications	
Software systems design	Failure to adhere to standardized specifications which the software supports	Yes
	Lack of integration	Yes
User involvement and training	Insufficient training of end-users	
	Ineffective communications	
	Lack of full-time commitment of customers to project management and project activities	
	Lack of sensitivity to user resistance	
	Failure to emphasize reporting	
Technology planning/integration	Inability to avoid technological bottlenecks	
	Attempting to build bridges to legacy applications	Yes

found that attempts to integrate ERP systems with legacy applications could bring about significant cost and time overruns because of lack of integration and duplication of business processes.

Implications for managing ERP projects

By organizing these risk factors within the context of the stages of an ERP project and by identifying individuals responsible for managing risk factors at each phase, management can assign responsibility for managing each of these risk factors. Table 5 summarizes the risk factors to be addressed within project phases.

Recommendations

Some of the unique challenges in managing enterprise-wide/ERP projects which are highlighted through these findings include the redesign of business processes, investment in recruiting and reskilling ERP systems developers, the challenge of using external consultants and integrating their application-specific knowledge and technical expertise with existing teams and the challenge of recruiting and retaining business analysts who combine technology and business skills. Many of the strategies which can be used to minimize these risk factors were contributed by the ERP project managers.

Implications for practitioners

Enterprise-wide/ERP projects pose new opportunities and significant challenges. Some of the 'summary' ideas which are reiterated throughout the case studies are as follows.

(1) Justify enterprise-wide projects based on cost justification and economies of scale.
(2) Re-engineer business processes to 'fit' the package rather than trying to modify the software to 'fit' the organization's current business processes.
(3) Identify and implement strategies for reskilling the existing IT workforce and acquire external expertise through vendors and consultants when needed.
(4) Use 'business analysts' with both business knowledge and technology knowledge.
(5) Obtain top management support for the project and establish strong project leadership.
(6) Make a commitment to training end-users in custom report development.
(7) Manage change through leadership, effective communications and the role of a champion.

Table 6 summarizes strategies for controlling risk factors in enterprise-wide/ERP projects.

Future research

Without question, effective management of these large projects is a new and unique challenge which requires the use of project management and control methods that have not been used extensively in the past. The sheer size of these projects requires centralized control, strict discipline and extensive monitoring of project outcomes. Several research issues which can be explored in the future include conducting an assessment of the relative criticality of each of these risk factors and contrasting the risk factors which occur in large versus

Table 5 Risk factors in ERP systems projects

Project phase	Responsibility	Risk factor to be addressed
Planning	User management IT management	Lack of top management support Lack of a proper management structure for the project Lack of a champion
Requirements analysis	User management IT management Business analysts	Failure to redesign business processes Failure to follow an enterprise-wide design that supports data integration
Systems design	User management IT management IT designers	Lack of 'business' analysts Failure to adhere to standardized specifications which the software supports Lack of data integration
Systems implementation/ maintenance	IT management	Insufficient training and reskilling of the IT workforce in new technology Insufficient 'internal' expertise Failure to mix internal and external expertise effectively
Technology integration and implementation	IT management User management	Unsuccessful attempts to integrate ERP with legacy applications

Table 6 Strategies for controlling risk factors in enterprise-wide/ERP projects

Type of risk	Strategies for minimizing risk
Organizational fit	Commitment to redesigning business processes Top management commitment to restructuring and following an enterprise-wide design which supports data integration
Skill mix	Effective use of strategies for recruiting and retaining specialized technical personnel Effective reskilling of the existing IT workforce Obtaining 'business analysts' with knowledge of application-specific modules Effective use of external consultants on project teams
Management structure and strategy	Obtaining top management support Establishing a centralized project management structure Assigning a 'champion'
Software systems design	Commitment to using project management methodology and 'best practices' specified by vendor Adherence with software specifications
User involvement and training	Effective user training Full-time commitment of users to project management roles Effective communications
Technology planning/integration	Acquiring technical expertise Acquiring vendor support for capacity planning and upgrading Planning for client–server implementation including client workstations

small ERP projects. One of the greatest challenges is recruiting and retaining highly sought IT professionals with the specialized technical and application-specific skills. Further research could analyse factors contributing to effective recruitment and retention of IT professionals with these specialized skills.

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