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Published online: 22 Feb 2007.

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Strategic success factors in enterprise resource-planning design and implementation: a case-study approach

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Enterprise Resource Planning (ERP) has gained popularity among many organizations that seek to increase the efficiency and productivity as well as to streamline their operations. ERP systems are a well-known concept. The available holistic literature and theory in ERP are, however, scarce. This paper surveys current ERP literature and identifies the present state of theory in ERP by formulating propositions for four ERP strategic factors (Cost of ERP Implementation, Implementation Time and Return On Investment (ROI) Issues, ERP Employee Training, and Effective Use of ERP Features/Applications). The approach used in this research is grounded theory development. The propositions for ERP strategic factors are in turn delineated and evaluated in terms of specific subfactors associated with each factor. This is accomplished by the use of interview protocol and within the context of an in-depth analysis of two companies in different industries that have used ERP systems. The analysis of these case studies results in 15 revised propositions for ERP strategic factors and insights regarding the ERP practices. Based on these strategic factors, strategic subfactors, ERP revised propositions, and insights gained, a set of conclusions, managerial implications, and future research directions is presented.

Keywords: Enterprise Resource Planning (ERP), Time and cost of ERP implementation, ERP training, Applications and features of ERP, Case studies

1. Introduction

Enterprise Resource Planning (ERP) is not a new concept to organizations. The functions performed by ERP systems are essentially the same basic business functions that organizations have performed for decades. However, with advances in computerization and networking, computer-based ERP systems have only emerged in the last two decades. The use of computer-based ERP systems by companies of all sizes and functions contributes to their productivity (Glasgow 2002).

The use of ERP systems is not limited to certain kind of industries, products, and organization types. Service organizations have begun implementing ERP systems and have utilized ERP features to improve their efficiency and decision-making

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processes. Manufacturing companies continue using ERP systems, but are now relying more heavily on them for many new tasks and applications throughout their enterprise. ERP technology has evolved to become more user-friendly and easier to operate for many end users. In conjunction with the Internet, Customer Relationship Management (CRM), and many aspects of supply-chain management, ERP systems can now handle entire processes associated with a customer order from cradle to grave. ERP systems with network capabilities have become compatible with the Internet for customer inputs and a variety of functions unavailable in the past. Networking has allowed ERP systems at different manufacturing plants across the country to communicate with each other with ease, thus increasing their overall efficiency. ERP can now perform a broad range of operations and functions for different departments of any size organization.

One challenge facing ERP providers is to develop comprehensive, up-to-date, and relevant technology solutions for companies seeking ERP systems. ERP software providers have been criticized by the end users for not having products that meet the needs of today's high-tech companies. Recent ERP releases have new technological adaptations in order for them to become more compatible with end users' requirements. New ERP systems incorporate Internet access and are now based on the most advanced networking platforms. The technological advances provide challenges for software houses to stay relevant and up to date. The technological advances, however, provide an equally huge challenge for companies to keep their ERP hardware upgraded so that they can handle the latest ERP software technology.

ERP systems could assist companies in many ways. For example, in a manufacturing setting, they produce reports to order supplies, to construct work schedules that improve the flow of products along the assembly line, and to record a precise bill of materials for products. These are only a few applications of ERP in the manufacturing area within the broad context of the ERP systems which are applicable to many different industries and settings.

ERP systems have found homes in many businesses outside manufacturing. ERP systems have evolved to adapt to the needs of virtually every business. For nearly every application, a useful ERP system exists. These applications include but are not limited to: financial reporting, inventory management, cost controls, enterprise asset management, real estate management, project management, home-building, field services, procurement, subcontracting, order processing, and manufacturing management systems. The chief claim of ERP systems is to increase efficiency and profitability while simultaneously increasing the level of control a company has over its entire operations (Glasgow 2002).

For nearly every organization, there are obstacles to overcome during ERP implementation and there are subsequent challenges to meet in optimizing the performance of the ERP system while in service. The goal of an ERP system is to integrate all functional areas within an organization in order to allow for effective operations and communication between and among departments. In addition, ERP systems strive to provide as much information and control over operations as possible for system managers. ERP systems achieve this by replacing legacy systems and different computer software used by many departments. In a company where the human resources department, designers, planners, the warehouse, and accounting department all use different software, the ERP system could effectively enable

each department to access and transfer information between and among departments. This is achieved because every department uses a common operating platform making the ERP system become seamless. Fully utilized ERP systems enable companies to increase their productivity by reducing their communication time.

Most ERP systems were typically procured from software vendors and were subsequently supported by consultants and experts than were designed in house (Ettlie 2000). This assertion was supported by many other authors and the actual practice of securing ERP systems by many companies. Perhaps securing an ERP system and making it operational posed enough challenge for many companies in order for them not to venture into designing a system from the beginning.

1.1 *Overview of literature, topic justification, objective of the research, and research questions*

Most available literature regarding the effectiveness or usefulness of ERP systems in the modern organization was based on a broad view of how the system was intended to work, compared with the perceived needs of organizations. Published works regarding ERP effectiveness included: Brakely (1999), Zuckerman (1999), Wheatley (2000), and Rondeau (2001). All of these works described what was required to make an ERP system effective. None of these works, however, identified and evaluated relevant factors necessary for the successful implementation of an ERP system in practice. The following represents the key points regarding the available ERP literature:

1. The conceptual, quantitative, company-referenced articles did not provide an extensive treatment of ERP topics.
2. The majority of articles were short and lacked the depth to demonstrate the level of integration necessary to design and implement ERP systems across various functional areas.
3. The majority of articles assumed a prior and comprehensive understanding of the structure of an ERP system.
4. Most of the literature did not present a comprehensive definition of the basic concepts and terms.
5. The majority of literature was practitioner-based, written by individuals who had some interest or understanding of some aspects of ERP systems.

None of the literature presented an integrated design and implementation of an ERP system. Perhaps most lacking in the current ERP research were the use of case studies and the identification of practical challenges that companies faced in their ERP implementation.

The cost of new ERP systems could range from $50 million to $500 million or more, depending on the size of the organization and the ERP systems selected (Davenport 1998). There was a considerable variance in success of these systems for different companies (White *et al.* 1997). Some examples follow. Hershey Foods Corporation lost $100 million as a result of installing an ERP system. Whirlpool experienced delayed shipments when orders were on the rise. Allied Waste Industries and Waste Management, Inc. cancelled the installation of their ERP systems with an estimated cost of $100–200 million.

On the other hand, there are some success stories to report: Owens-Corning, as a result of installing an SAP system, was expected to avoid an annual expense of $35 million dollars in information system maintenance (White *et al.* 1997). Johnson (1998) stated that General Motors (GM) Corporation estimated savings of $400 million a year after its information system was integrated. This included elimination of 70% of the 1800 local information systems in GM's finance department alone.

Ettlie (2000), while acknowledging that it was difficult to capture the benefits of ERP systems, focused on two issues. First, the author stated that failures in ERP system implementation might be related to other reasons (e.g. the use of a big-bang approach to ERP adoption) than the ERP software itself. Second, Ettlie (2000) focused research on the question of how we account for the differences in outcomes of adoption of new process technologies that are intended to improve organizational coordination and integration. Ettlie (2000) argued that ERP systems were typically purchased from suppliers rather than developed in-house by most organizations. The focus of this work was clearly on broad technological innovation and adoption of advanced technologies. This work, however, did not focus on the critical success factors that were essential for the successful implementation of ERP systems.

This paper, therefore, through the use of case studies, focuses on strategic factors which are necessary to design and implement an ERP system. This focus does not exist in the available literature. An extensive review of the literature was conducted to identify common strategic factors and themes that many practitioners and academicians viewed as essential in designing and implementing ERP systems.

This paper addresses two central research questions. First, *what* are the critical strategic factors needed for the effective implementation of an ERP system? Second, *how* should a company use these strategic factors for implementation of ERP systems? It is the contention of this paper that without focusing and evaluating the relevant ERP strategic factors, we are unable to understand, gain insight, and advance the practice of ERP.

2. Methodology for grounded theory research

The approach used in this research was based on 'grounded theory development'. Strauss and Corbin (1998) described grounded theory as the mode of qualitative research where grounded theory was inductively derived from the study of the phenomenon. This study included discovering, developing, and provisionally verifying the phenomenon through qualitative data collection and analysis. This research was applied, and the case studies were explanatory where a number of propositions were formulated and evaluated. For further study in grounded theory and case study, see Yin (1993), Golden-Biddle and Locke (1997), Lee (1998), and Locke (2001).

Consistent with the guidelines for qualitative research developed by Creswell (2003), a seven-step theory-building process was employed in this research. The guidelines were divided into two broad categories of introduction (1–2 below) and procedures (3–7 below):

1. Overview of Literature (section 1.1). A comprehensive and extensive review of the existing academic and trade literature was conducted. Although many of the studies were based on mainstream non-academic journal articles, they

did represent relevant personal experiences, cases, and experiments that were highly useful in the identification of ERP strategic factors.

2. Development of the Objective of the research and Research Questions (section 1.1). The central research questions were clearly identified based on the existing literature.

3. Case Studies and Research Plan (section 3). In order to expand our understanding of ERP strategic factors and in order to gain insight into ERP practices, in-depth analyses of case studies were conducted.

4. Development of Strategic Factors and Propositions for ERP Design and Implementation (section 4). Based on the review of literature, a common theme and critical strategic factors and corresponding propositions will be developed in section 4.

5. Identify Operational Sub-Factors and Develop Revised Propositions (section 5). Based on the development and evaluation of the sub-factors and the knowledge and insights gained in the case studies, a revised proposition for each ERP strategic factor will be developed and presented. These new propositions represent the advancement in theory in ERP. The sub-factors for each ERP strategic factor will be based on the interview protocol and within the context of the case study analysis.

6. State the Insights Gained (section 5). The insights and perspectives gained as a result of developing the revised propositions and case studies will be presented.

7. Conclusions, Assessment, and Managerial Implications of the Results (section 6). This section includes the discussion regarding assessment and guidelines, managerial implications, the implementation issues of ERP systems, and future research directions.

3. Case studies

The case methodology used in this paper was an explanatory case study where a number of propositions were evaluated. McCutcheon and Meredith (1993) stated that although a case study might not be viewed as the most powerful theory testing method, it could accomplish this objective in several different ways. First, proposition testing might demonstrate the theory's applicability or lack thereof under conditions not previously investigated. Second, a single case study could be a powerful tool to establish limits on the theory's generalizability, or it could totally refute it. Third, a single site provided a high degree of control for testing a new theory or comparing multiple competing theories. There were a large number of investigations that used a single site as the focus of their case study. Some of these included: Johnson and Davidson (1982), Schonberger (1982), Monden (1983), Forslin *et al.* (1989), Molet *et al.* (1989), Nonås *et al.* (1990), Bodnar and Harrison (1991), Buchowicz (1991), Howson and Dale (1991), Persson (1991), Hill and McGowan (1999), Ghobadian and Gallear (2001), Lahteenmaki *et al.* (2001), Dubois and Gadde (2002), and Simons, Jr and Russell (2002).

Although a single case study was suitable for this research, two companies (ABC Company and XYZ Company) were selected for an in-depth analysis and

evaluation of the propositions. These two companies represented different sizes, products/services produced, nature of operations, and external competitive factors. These two companies also represented a cross-section of major companies/industries that were engaged in ERP implementation. Each case study was treated as a separate self-contained experiment. The two companies agreed to be the subject of the case study with the understanding that their identity and information would be treated with confidentiality.

ABC was a small- to medium-sized manufacturer located in the state of Missouri, USA. ABC employed nearly 170 employees. ABC has been in business for 3 years. ABC chose to implement its ERP system as soon as it began its business. A key consideration in ABC's choice of ERP systems was its need to have the system online as quickly as possible. ABC did not have any computer-based ERP system in place previously. ABC attempted to extend its ERP system to every facet of its operations, which included manufacturing processes as well as business functions.

XYZ was a city government for a medium-sized (with population of over 150,000) first-class city in state of Kansas, USA. XYZ's operations encompassed police and law enforcement, municipal court, health and environment, parks and recreation, planning and development services, public works, fire department, finance and budget administration, and a city clerk's office. There were also several administrative and managerial offices. The city was run by a mayor, city council, and a city manager. The city, given the service-intensive nature of its operations, employed more than 950 employees in all of its departments.

XYZ was a growing organization that wished to replace its legacy system with an ERP system. XYZ's manual system did not provide adequate, integrated, and timely reports to users, except for basic hard copy reports. XYZ mostly chose to implement ERP in order to make better financial decisions and to make its accounting system more accurate and efficient. As a city, XYZ's ERP system requirements were different from those of ABC. Nonetheless, suitable ERP systems for non-manufacturers served the same purpose of integrating all their functions and departments. XYZ underwent two upgrades since its initial ERP installation. XYZ's ERP system was web-based, and it was also capable of handling human resource functions.

3.1 Case-study research plan

The plan for case-study experiment followed the suggested guidelines developed by Ellram (1996). The details of the research plan are available from the author upon request. The following, however, represents some information regarding the data collection and verification activities.

Case data and sources. The information gathered regarding the companies was based on extensive participant observations, on-site interviews (structured with open-ended questions), archival records, and company documents. The data collection was conducted within the span of 4 months. No phone interviews were held. The companies agreed to make available many sources of the data with strict confidentiality.

Pilot study. The final interview protocol was developed with the assistance of three university academics and two ERP practitioners who were not connected to the companies targeted for this research. These individuals made valuable changes and provided corrections to the original interview protocol.

Content validity. This was established when the domain of the concept was made clear, and it was determined whether the measure fully represented the domain. The qualitative, yet strong, content validity was established by grounding the questions on the literature review and the current state of theory in ERP. The university academics and practitioners were specifically asked to check for content validity.

Interview protocol. An appendix entitled "Interview Protocol for Erp Strategic Factors" is available from the author upon request (because of space limitations, this appendix was not included in the paper). The interview protocol was designed to be easy to read, easy to understand, and easy to answer. The interviewees (employees and supervisors familiar and involved with ERP operations at ABC and XYZ) were not directly given the propositions. They were, however, asked about the nature and various aspects of the interview protocol in a conversational/informal manner. Also, anonymity was offered to the respondents. Respondents were selected based on their positions in the companies' organizational chart and their job descriptions. The questions were posed to at least two individuals in the same company who had direct knowledge of the subject and were, therefore, able to answer the questions properly. Many interviews were held on a one-to-one basis.

Reliability analysis. The results were cross-checked for reliability purposes. Whenever inconsistent results were obtained, additional individuals were interviewed, or additional company information or documents were sought in order to reconcile the inconsistent results. At no time was any information deemed to be inaccurate or inconsistent (and which could not be totally verified elsewhere) used in the analysis. The percentage of information eliminated did not exceed 5 and 3% of the total amount of information obtained from XYZ and ABC, respectively.

4. Development of strategic factors and propositions for ERP design and implementation

The successful design and implementation of an ERP system should consider the strategic factors from the company and end users' standpoint. The strategic factors provide the critical factors that must be considered before other detailed or operational factors are considered. It serves no purpose to proceed to operational factors if the ERP system does not meet the strategic factors or values of a firm. The four strategic factors were analysed within the context of literature review, and the case studies are presented below.

4.1 Strategic factor 1: cost of ERP implementation S(1)

The cost of an ERP system depends on the size of the operations and the scope of its implementation. In instances where the organization was small, costs could be as little as $15,000 per year for a site licence for 15 users (Rogers 2002). The author did not provide the details of the relevant costs involved in this estimate. This figure appeared to be a very conservative estimate for annual ERP spending in larger organizations. The average Total Cost of Ownership (TCO) in a medium-large organization could be $15 million (Koch 2002). TCO could reach as much as $300 million for larger companies (Koch 2002). The TCO associated with ERP systems included more than just the price of the software. Other costs included the modifications and adaptations that need to be made to the ERP systems and the opportunity cost of the waiting time for a reasonable Return On Investment (ROI) to be realized. Another inherent cost of ERP systems is the cost of upgrades, as the installed software usually requires new utilities to remain effective. Some of these upgrades are generated by the ERP vendors, and the user might have little choice but to adopt them. Upgrades could cost as much as 30% of the original cost of the software (Koch 2002). There are other additional costs associated with ERP implementation. The largest of these costs can be the fees of consultants. Consultants' fees could account for as much as half of the annual spending associated with implementation of ERP systems (Joachim 2002). Additional references that allude to or cite some aspect of ERP implementation costs included: Klafehn (1996), Stedman (1999), O'Leary (2000), Gomolski (2001), Koch (2001a), Harreld (2002), Howell III (2002), Joachim (2002), Larson (2002), Nash (2002), and Maples (2003). The proposition S(1) regarding the cost of ERP systems that would best fit the available literature was presented as follows:

> Proposition S(1). *The total cost of ownership associated with an ERP system includes a large initial cost followed by costs to maintain and upgrade the ERP system.*

4.2 Strategic factor 2: implementation time and ROI issues S(2)

The length of time required to successfully implement an ERP system ultimately varies based on the needs of the end user. The first major factor in implementation is the identification of the equipment required to operate the system and to provide easy and comprehensive access for all users. Some vendors claim that ERP implementation can be completed in as little as 3–6 months, but this often only entails the installation of equipment and software. In reality, an organization should expect ERP implementation to take as long as 2 years. This length of time is usually required for employee training and completion of data conversion so that all authorized users may have access to all available data through the ERP system (Koch 2001a). In order for an ERP system to become effective for many companies, massive changes must occur. Because an ERP system strives to increase efficiency, often the result of ERP implementation is a new mode of operations or utilization of resources.

After ERP implementation is completed, the expected return may not come as soon as desired. Many businesses choose not to perform an ROI analysis for varying reasons. Some firms claim that their reasons for implementing ERP have

nothing to do with becoming more profitable. This is a wise claim to make to investors, since most ERP systems show negative ROI for the first 5 years that they are in service (Stein 1999). After the first 5 years of use, a company can begin to expect steady returns but not in the traditional form of revenue.

Most companies using ERP systems calculate their ROI as a result of expected savings in inventory and other costs compared with the total cost of implementation. ERP systems that performed effectively reduced the cost of production and shipping, resulting in an average saving of $1.5 million per year (Stedman 1999). The cost savings included the fact that most companies that sought an ERP system had a need to replace some parts of their existing systems. Thus, some costs and conversion time (included in the calculations of ROI) would be incurred regardless of the fact that these companies choose to implement an ERP system or not. Additional relevant references included: Goodpasture (1995), Zmolek (1998), O'Leary (2000), Davenport and Harris (2002), Howell III (2002), Joachim (2002), and Rogers (2002). Given the analysis of the review of literature, the following proposition was formulated:

> Proposition S(2). *The time associated with an ERP implementation varies. It may be as long as 2 years. It may be as long as 5 years before a return on investment is realized.*

4.3 *Strategic factor 3: ERP employee training S(3)*

ERP systems, similar to other new technologies in an organization, require training for employees to be able to use them correctly and effectively. ERP training has been considered as the most important element in the success of ERP implementation. Therefore, ERP training has become a large business in itself. Large companies have been created to do nothing but train employees how to use ERP systems. If employees do not know how to effectively use the ERP system, the overall success of the system will be significantly diminished. The ERP training costs are difficult to measure. None of the literature reviewed offered a method of estimating the employee training costs. This was partially because the amount of training required would be specific to the ERP system being used and the users' previous experience.

ERP employee training is without a doubt a necessity. In cases where a company must utilize consultants for the ERP system—whether for training employees or actually operating the ERP system—the company should expect to pay $150–225 per hour for a consultant (Wheatley 2000). Therefore, training employees to perform tasks in order to reduce the need for a consultant is a must. This is especially true when highly paid consultants operate some aspects of the ERP system for the user companies. Other savings in consultant fees occur when well-trained employees are able to expand their ERP knowledge and capabilities, and to master the features of ERP systems typically reserved for consultants. In addition to all of these, a one-time effective training programme can eliminate many potential ERP problems facing companies in the future. The emergence of these problems might otherwise necessitate the use of consultants.

Companies have a few options when considering what forms of training they want to pursue. Many vendors offer training modules for end users. These modules, however, often do not cover everything necessary for proficient operation of the ERP system, and they are usually very expensive. Smaller organizations may consider classroom style training. But for many larger organizations, this is not an

option, since most facilities cannot effectively accommodate thousands of employees. As a solution for organizations with thousands of users and with many different locations, ERP training companies have developed Internet-based training programmes. Companies using Internet-based training programmes have experienced a decrease in costs and an increase in employee learning. New Internet-based training programmes could be utilized for as little as $325 per student (Violino 1998). E-learning costs could be as little as 2.5% of the equivalent traditional training costs (Dwyer 2001). This provides a more cost-effective solution for the necessary ERP employee training. Additional relevant references for ERP employee training included: Torode (1998), Gomolski (1999), Hutchinson (2002), and Koch (2002). Given the analysis of the review of literature, the following proposition was formulated:

> Proposition S(3). *Organizations must make every attempt to adequately train all ERP users as ERP training can be the most important element in the successful implementation of ERP. Training costs for ERP vary, but they must be controlled as well.*

4.4 *Strategic factor 4: effective use of ERP features/applications S(4)*

A successfully implemented ERP system has the potential to effectively integrate every department/function of an organization. ERP systems attempt to make the lines of communications as easy to use and as transparent as possible. By integrating the computer systems used by all departments, every function has access to the same records and information. Ultimately, by implementing an ERP system, an organization could increase its productivity. Since every organization is different, ERP systems play different roles in different organizations. Table 1 shows some ERP applications for two major classifications of users. The applications outlined in table 1 are not limited to these organizations types. Many of these applications might be utilized by other types of organizations as well (Smith 2001, Wyatt 2002).

The range of ERP applications is nearly unlimited. ERP systems have the ability to solve complex problems before the management team can predict their occurrence. ERP systems take in information from every function of the business and can not only make it accessible to authorized users but also analyse it for potential problems in the system. Theoretically, an ERP system can be divided into six operating sectors as shown in figure 1.

Figure 1 shows the constant flow of information between and among typical ERP departments. The lines of communication are short and effective. What figure 1 does not show is an inherent benefit of ERP systems, which is the reduction in redundant data entry and the reduction in manual paperwork. Through the use of an ERP system, customer information has to be entered in the computer system only once. From there, it can be modified and tracked, and invoices and transactions can be created from the original order. Likewise, reports for human resources, payroll, accounts payable, and many other departments can be easily generated and tracked with less human input. What is possibly the most convenient feature of an ERP system is that it records all data in the same format. Therefore, only one programme is required to view all records for all departments. These reports could easily be integrated so that more comprehensive views and analyses of the company's operations were provided (Bartholomew 2002). Additional relevant

Table 1. Some applications of ERP systems.

| Manufacturing company	Service or public-sector company
Organize and track inventory	Gain greater insight into the supply-chain, pricing, contracts and commitments, and increase efficiency
Manage equipment usage and costs	Enable department managers to automatically receive their monthly budget and expense reports online and on-time
Track equipment history	
Schedule preventive maintenance tasks	
Maintain confidential labour records	Give appropriate people accurate and quick access to payroll, expenses, and accounts payable/receivable information
Allocate resources	Improve employee recruitment and retention
Generate work orders	Empower employees to use self-service applications to select their benefits online
Generate requisition and purchase parts	
Project equipment failure	Model or simulate the effects of anticipated organizational changes, acquisitions, and additions of new lines of business
Assist in root cause failure analysis	
Export work orders	View profitability for various components of the operations
Help investigate equipment downtime	Reduce inventory levels and order turnaround time frames
Identify hot maintenance spots in the facility	View project costing and benefit analysis on a real-time basis
Provide justification for additional resources	
Produce precise plant-level reports	
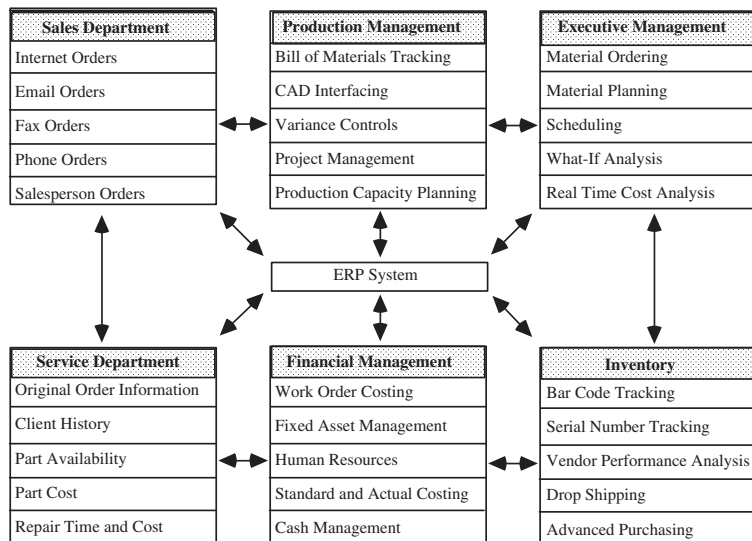
Figure 1. Conceptual framework of components of an ERP system.

references included: O'Leary (2000), Koch (2001b), Smith (2001), Davison (2002), Greengard (2002), Seewald (2002), Singer (2002), Tyler (2002), Varon (2002), Wyatt (2002), Bacheldor (2003), Caruso (2003), Fattah (2003), Gould (2003), Scheier (2003), Vijayan (2003), and Whiting (2003). Given the analysis of the

review of literature, the following proposition was formulated:

> Proposition S(4). *ERP systems have many applications. ERP users should be aware of these applications and features, and use them properly and to their advantage.*

5. Evaluation of strategic factors and development of revised propositions

The effective uses of an ERP system depend upon proper participation and implementation from all departments of the organization. The strategic factors developed serve as the bases for successful evaluations of an ERP system. Each of the propositions was evaluated by the use of case studies in order to determine the effectiveness of the ERP system.

5.1 *Strategic factor S(1) cost of ERP implementation: case-study evaluation and subfactor identification*

A comparison between the proposition S(1) cost of implementation and the actual practices found in each of the case studies resulted in the following subfactors.

1. Determining organizational needs. The first step for both ABC and XYZ was to evaluate the needs of the organization with respect to the cost of available ERP systems. ABC and XYZ took into consideration a number of factors, including their potential needs along with the ERP system costs and upgrades required. Each firm was presented with a number of options regarding choice of vendors and ERP systems/costs. ABC chose to contract with a small vendor whose speciality was in ERP systems for smaller manufacturing companies, making this choice a good fit for ABC. XYZ, on the other hand, chose a nationally known, more popular vendor, again based on its fit for the organization. Both companies focused on the available options and the needs of their companies. The potential savings offered by the vendors were secondary consideration for both firms. Based on subfactor 1, the following revised proposition of S(1) was developed.

> Proposition S(1)-1. *The choice of ERP systems should be based on organizational needs, the service, and support provided by the ERP vendors.*

2. Upgrade requirements for ERP system installation. ABC's decision in selecting its ERP vendor was also based on its need to have the ERP system installed as quickly as possible. Many of the available vendors/ERP systems would have taken much longer to install. ABC's existing computer system required a major overhaul to make it compatible with the new system. Since ABC did not have any standardization among its computing systems, its hardware also lacked the standardization needed to support the new ERP system. The cost of the upgrade was viewed as a large addition to the initial costs incurred by ABC in its ERP system installation and implementation. XYZ also had to upgrade many of its existing computing systems. XYZ was using a manual system that dated back to 1970, and it had not seen any major upgrades (especially in the area of computer-based information system) since its

implementation. XYZ's cost of upgrading was less than that of ABC because it chose to implement fewer user terminals (a total of 13 terminals) with its new ERP system. These terminals were placed in the main/sensitive departments providing fairly reasonable access for authorized users. Since ERP is flexible in meeting the needs of an organization, choosing fewer terminals is common for many cost-conscious organizations. Based on subfactor 2, the following revised proposition of S(1) was developed:

> Proposition S(1)-2. *The choice of ERP systems should be based on the upgrades required for its installation and the company's current computer compatibility with the new ERP system.*

3. Cost of ERP system. The costs of ERP systems are based on hardware, software, and its overall installation cost. Often, the costs of ERP implementation vary based on the projected number of the users of the system. As is the case with most software, ERP system costs are based on the number of users and the number of copies of software installed in various ERP terminals.

In the case of ABC, the ERP system was implemented to reach every department of the organization. In contrast, XYZ only implemented the software in the departments where it felt it would have the greatest impact on its business. With fewer users, the need for future hardware upgrading at ABC was much less than that of XYZ. Both companies met their overall ERP target costs by staying within the cost structures proposed by their vendors. Based on subfactor 3, the following revised proposition of S(1) was developed:

> Proposition S(1)-3. *The overall cost of ERP implementation is affected by the number of users and the extensiveness of available terminals throughout an organization.*

4. Customization of software. For any organization implementing an ERP system, the customization of the software to fit the unique requirements of its organization must be considered. Customization of software can improve business operations. It can also accommodate employee versatility in performing the ERP tasks unique to their organizations. Both ABC and XYZ had to make changes to the graphic interfaces that were to be used by their employees in order to make their daily tasks easier. ABC found that these changes were very easy to make. ABC's system allowed the system administrator to make changes to any of the entry fields in the ERP system. In addition, ABC's system administrator could add their own individual fields or remove the entry fields which were not relevant to ABC's operations. This feature virtually eliminated the need for costly consultants to customize the system software. XYZ, on the other hand, found its ERP system more cumbersome with regard to software customization. XYZ's ERP system had some customization capabilities, but in many cases it required assistance from either the vendor or a consultant to make the desired modifications. Based on subfactor 4, the following revised proposition of S(1) was developed:

> Proposition S(1)-4. *The ability of ERP system software to be customized to the unique requirements of a company increases the ERP system functionality and decreases future costly modifications.*

5. Data transferring and testing. The cost of data transferring had no impact on ABC since it had no previous records and data to transfer into the new ERP system. In contrast, XYZ had many years of records and data that had to be transferred to its new ERP system. XYZ alleviated this need by utilizing its own employees to transfer the data that could not be easily re-formatted or adapted to the new ERP system. One of the final remaining aspects of ERP implementation that could potentially add cost was testing the system in order to ensure its seamless operation. In the case of both ABC and XYZ, the vendor performed the initial testing. The vendor tested the system in order to make certain that every terminal had access to all necessary information, and that all the reporting systems functioned the way they were intended. Based on subfactor 5, the following revised proposition of S(1) was developed:

> Proposition S(1)-5. *The effectiveness of an ERP system design and implementation is affected by the company's ability to transfer the existing records and data into an ERP system that is positively tested for full operations.*

6. ERP system maintenance. Both ABC and XYZ had completed their implementations only recently. None of the firms had to make any upgrades for maintenance purposes. Both companies, however, expected to incur maintenance costs in the future in order to keep their ERP systems operating at full capacity. Based on subfactor 6, the following revised proposition of S(1) was developed:

> Proposition S(1)-6. *The effectiveness of an ERP system design and implementation in the long run is affected by the company's ability to perform the required ERP system maintenance.*

5.2 *Provide insight for S(1) cost of ERP implementation*

All of the presented subfactors were considered to be crucial for the success of the ERP systems for both companies. ABC found its overall implementation costs to be much greater than that of XYZ. Both companies, however, found their total cost of ownership to be below the average implementation cost for their respective similar industries. XYZ attributed its lower costs to having fewer users/terminals of the ERP system. ABC's total cost of ownership was largely driven by the choice of its vendor. ABC's selected vendor provided most of the customization and testing necessary to get the system online.

It became evident that there were many costs associated with the development and installation of an ERP system well beyond the cost of the ERP system itself. In both of the cases studied, many additional sources of cost were found that were not immediately recognizable but were absolutely necessary for ERP successful implementation. An organization should anticipate incurring these costs whenever it plans to implement a new ERP system. It is also important to be able to predict maintenance costs of ERP systems for years to come.

5.3 *Strategic factor S(2) implementation time and ROI issues: case-study evaluation and subfactor identification*

1. Implementation time. Both ABC and XYZ experienced a very different variance in their ERP implementation times. ABC had the opportunity to install its ERP system prior to commencing its operation. This not only reduced employee resistance typically seen when an established firm coverts to an ERP system but also resulted in the ERP system as not being a work in progress for employees. XYZ had much more difficulty getting its system in place. XYZ had to overcome obstacles involved with converting the components of its old system that were not linked together to the new ERP system. Another crucial conversion issue for XYZ was to determine which information to retain from its old system. In short, ABC was able to fully implement its system very quickly. From start to finish, ABC's ERP system was operational in only 6 weeks. This implementation time was much shorter than the actual implementation times found in much of the available literature. XYZ's implementation took much longer and was actually longer than the projected time frames for most ERP systems in the literature. XYZ's total implementation time was approximately 8 months. This was largely due to the nature of XYZ's operations prior to new system implementation. Based on subfactor 1, the following revised proposition of S(2) was developed:

> Proposition S(2)-1. *The time associated with ERP implementation varies greatly from one organization to another due to barriers encountered. The effectiveness of an ERP system design and implementation is affected by the company's ability to implement the ERP system in a reasonable time frame.*

2. ERP system's fit with organizational culture. For both ABC and XYZ, the success of their newly implemented ERP system depended on employee acceptance and a willingness to work with the new system. The role of top management in providing the appropriate and effective leadership and support in creating a culture that is conducive to effective ERP implementation is also essential. XYZ experienced some resistance from some staff members. These difficulties continued at XYZ. Some employees at XYZ still felt that they could accomplish the tasks of the ERP system faster by doing the work on paper. While there might be some truth to this, problems emerged when others attempted to access the work that had been done on paper. If the work had not been entered into the ERP system initially, it would have to be entered after the fact. On the other hand, ABC's employees experienced very little resistance in accepting the system. In general, ABC employees saw the ERP system as a great asset and an invaluable tool for the company's operations. Utilized by every department of ABC, the employees had little resistance or difficulty in accepting the new system. Based on subfactor 2, the following revised proposition of S(2) was developed:

> Proposition S(2)-2. *The effectiveness of ERP system design and implementation is directly affected by the employees' acceptability, top management leadership and support, and the fit of ERP with the organizational culture.*

3. Return on investment (ROI) analysis. Neither ABC nor XYZ had directly conducted an ROI analysis. In the case of ABC, an ROI analysis was impossible since its

ERP implementation was very new, and ABC did not have a system in place. ABC, however, used the ERP system to track and improve the performance of its employees, resulting in a higher ROI. For XYZ, comparisons between the new system and the handful of legacy systems that were in use prior to ERP implementation were unavailable. The old systems had no way of tracking the productivity of employees or other functions. XYZ as an organization had no desire or the time to track ROI. XYZ, however, was satisfied with the results of its ERP implementation. Based on subfactor 3, the following revised proposition of S(2) was developed:

Proposition S(2)-3. *The long-term effectiveness and viability of an ERP system is determined by the company's ability to produce high ROI even though the short-term ROI might not be present.*

4. Cost savings in human power. Both ABC and XYZ used their ERP systems to eliminate redundant data entry functions performed by their employees. ABC could not quantify the amount of savings in human power that resulted from its ERP system, since it did not have a prior ERP system. But qualitatively speaking, it was believed that the ERP system for ABC saved a great deal of labour time. It also prevented extra and redundant work and made many tasks more efficient. XYZ believed that the savings were definitely present in the departments that were fully utilizing the ERP system. Projections for XYZ included a savings of approximately 30 h of human power per week. Based on subfactor 4, the following revised proposition of S(2) was developed:

Proposition S(2)-4. *The long-term effectiveness and viability of an ERP system is affected by the company's ability to save labour costs, to eliminate redundant tasks, and to increase the operational efficiency of the system.*

5.4 *Provide insight for S(2) implementation time and ROI issues*

The in-depth analysis of subfactors associated with S(2) showed that implementing an ERP system in an established firm could be a lengthy and difficult process. After implementation, the organization's acceptance of the new system was critical for its success. Further, the ROI might not be apparent for the first few years of its operation. While the initial costs of the ERP system might not be recovered during the first few years of operation, the resulting ease of operations, newly found applications, and other efficiency areas could provide great promise for ERP implementation.

5.5 *Strategic factor S(3) ERP employee training: case-study evaluation and subfactor identification*

1. Basic employee training. For many employees, a lack of basic computer skills may be a detrimental factor in operating ERP systems. ERP use, as with any new piece of software, requires a high level of operating proficiency. Both ABC and XYZ ensured that their employees had the necessary basic computing skills in order to operate the

ERP system. Both companies had to analyse the skills of their current employees and to provide training for their deficient skills in order to operate the ERP system effectively. Based on subfactor 1, the following revised proposition of S(3) was developed:

> Proposition S(3)-1. *Determining the current level of computing skills of employees and providing the necessary basic computing skills are essential and mandatory for initial and effective ERP operations.*

2. Vendor-led training. There are a wide array of ERP systems that are on the market and available to users. These systems offer a number of different proprietary functions that are embedded in ERP systems for use by companies. This being the case, ERP vendors usually offer specialized training to make employees proficient users of the proprietary and unique features of their ERP systems. Other training options include web-based training and consultant-led training. Some vendors incorporate web-based training for larger companies who cannot bring all of their employees to one location at once for training. Both ABC and XYZ participated in specialized training programmes offered by the vendors of their ERP systems, partially through on-site training and partially through web-based training modules. Also, in both cases, the costs of training were included in the ERP implementation. Evaluating the current ERP performance of both ABC and XYZ, there was no need for further training at this point in time. In addition, both ABC and XYZ participated in vendor-led user group meetings in order to provide insights and new ideas for the effective use of their ERP systems. Based on subfactor 2, the following revised proposition of S(3) was developed:

> Proposition S(3)-2. *The full use of proprietary and specialized training programmes provided by ERP vendors is essential for the long-term effectiveness and operational viability of an ERP system.*

3. Use of ERP system administrators. Another key decision for ERP users is whether to train an internal employee to become the system administrator or to hire a specialist who may already be trained in using/administering ERP systems. While the review of literature did not present a definite need for a system administrator, the literature's central focus was on a group/team that could oversee the performance and maintenance of the ERP system. ABC had an entire department devoted to maintaining its information systems alone. ABC's information systems department was responsible for the operations of the ERP system but not its inputs. ABC had a specialist who was very knowledgeable of its ERP system. This specialist had been hired when the ERP system was implemented (upon the company being founded). XYZ had no specialist or department who was in charge of maintaining the smooth operation of the system. While XYZ had an information systems department, the ERP system itself seemed to be in the hands of the employees who used it. Based on subfactor 3, the following revised proposition of S(3) was developed:

> Proposition S(3)-3. *The hiring or training of an ERP system administrator and full use of this specialist's expertise could contribute to the long-term effectiveness and operational viability of an ERP system.*

5.6 *Provide insights for S(3) ERP employee training*

The case studies revealed a strong need for employee training for ERP systems. Employee training pertains to the overall operations of the ERP system as well as providing basic computing skills needed to use the ERP system. In addition to employee training, ERP systems might need vendor-led training programmes, ERP system administers, and consultants to ensure smooth, effective, and error-free performance of ERP systems over time.

5.7 *Strategic factor S(4) effective use of ERP features/applications: case-study evaluation and subfactor identification*

1. Integration of various functional areas. This crucial subfactor is at the heart of ERP implementation. This subfactor shows how well the companies integrate various functional areas in their ERP systems. ABC's ERP system kept records of every transaction. ABC used its ERP system to fulfil the following functions/activities: input customer orders, schedule material ordering based on work orders, improve production efficiency, identify potential production problems, accurately forecast labour requirements and delivery schedules, cost bill of materials, report actual cost of production, bill customer, maintain accounts receivable, accounts payable, cash management, fixed asset management, track efficiency ratios for each employee, manage human resources, perform and track product repairs after delivery, customer service, and more functions/activities.

One of the chief problems for XYZ was to convince the entire staff to utilize the ERP system to its fullest potential. XYZ identified fewer ERP uses than that of ABC. These functions/activities included: general accounting, general ledger, accounts payable, accounts receivable, fixed-asset management, purchase-order management, job-cost tracking, job-decision analysis, and additional functions/activities. These functions/activities were, however, very important for XYZ. Based on subfactor 1, the following revised proposition of S(4) was developed:

> Proposition S(4)-1. *The long-term effectiveness and viability of an ERP system is largely determined by the company's ability to effectively integrate various functional areas into a whole system.*

2. Use of ERP applications and features. This crucial subfactor shows how well the full potential and actual applications of the ERP systems are utilized by companies. ABC placed its ERP system into literally every possible department of its organization, from customer service, to production, and throughout the life cycles of its products. ABC designed and implemented its system to be the life-blood of its organization. Every department used ABC's ERP applications and features on a daily basis. As a manufacturer, ABC's ERP system was fully utilized to yield a reduction in human capital and an increase in overall operational efficiency. Breaking the old habits of using pen and paper to eliminate redundant tasks were still goals of XYZ company. Although XYZ as a non-manufacturing entity had been expected to use fewer applications and features than those of ABC, its actual usage of these applications and features were well below its

industry norm. Based on subfactor 2, the following revised proposition of S(4) was developed:

> Proposition S(4)-2. *The long-term effectiveness and viability of an ERP system is significantly improved by how well a company uses all its applications and features.*

5.8 *Provide insights for S(4) effective use of ERP features/applications*

Each of the case studies provided an insight into how ABC and XYZ utilized their respective ERP systems, features, and applications. The degree of utilization of ERP resources partially depended on the type of industries to which the companies belonged and partially depended on the organizational needs and capabilities of the companies using ERP systems. ABC and, to a lesser extent, XYZ identified significant benefits of their ERP system, along with improvements in efficiency compared with not using the system. The overall effectiveness of ERP systems, however, were largely dependent upon how effectively and how completely the functions and activities were integrated, and how effectively and widely used the various ERP applications and features were.

6. Conclusions, assessment, and managerial implications of the results

Tables 2–5 summarize the results of the proposition evaluation and validation for ABC and XYZ. Tables 2–5 also show the specific subfactors associated with each ERP strategic factor considered in this paper. Tables 2–5 represent the four strategic factors.

Table 2 considers the cost of ERP implementation. The cost of implementation is a crucial strategic factor for many organizations in attempting to secure an ERP system. Various costs from initial costs to maintenance costs must be considered. The cost of ERP implementation is usually among the first issues that a company faces in electing to embark on ERP installation. Both ABC and XYZ paid close attention to this important issue. Both succeeded to validate all their respective propositions except for XYZ with respect to customization of software.

Table 3 addresses the time of ERP implementation and the ROI issues. The time of ERP installation and implementation can be a prohibitive strategic factor for many organizations in attempting to embark on an ERP system. This is particularly true for existing companies with ongoing operations. Time of implementation also relates broadly to changes in organizational culture as well as generating a long-term favourable ROI. ABC paid close attention to this important issue, and all four of its propositions were verified, while XYZ verified only two of its propositions. ABC was a newer company, while XYZ was a more established company. These results could possibly indicate—subject to further research—that older companies were more susceptible to problems and difficulties than newer ones, especially when it comes to fitting their ERP systems to their existing organizational culture.

Table 4 addresses the ERP employee training issues. Employee training is an important strategic issue, particularly when a company makes its transition from

Table 2. Results of the proposition S(1) evaluation for ABC and XYZ.

ERP strategic factor	ERP proposition subfactor	ERP strategic subfactor	Result of subfactor evaluation	Summary and comments
	Proposition S(1)-1	Determining organizational needs	ABC: verified XYZ: verified	Both companies focused on the available ERP options and the needs of their companies.
	Proposition S(1)-2	Upgrade requirements for ERP system installation	ABC: verified XYZ: verified	Both ABC and XYZ were aware of major upgrade requirements to their existing systems. The upgrade costs for ABC was much higher than those of XYZ's costs.
Cost of implementation S(1)	Proposition S(1)-3	Cost of ERP system	ABC: verified XYZ: verified	Both companies met their target ERP costs. ABC installed terminals and software in every department while XYZ's installation was limited in scope requiring further future costs.
	Proposition S(1)-4	Customization of software	ABC: verified XYZ: not verified	ABC planned for and implemented software customization easily and effectively. XYZ used vendor and consultants to modify its software. This was cumbersome and costly.
	Proposition S(1)-5	Data transferring and testing	ABC: verified XYZ: verified	ABC did not have any data to transfer. The data transfer for XYZ and the testing for both ABC and XYZ went as planned.
	Proposition S(1)-6	ERP system maintenance	ABC: verified XYZ: verified	Neither company made any maintenance upgrades. Both companies expected maintenance activities and related maintenance costs.

Table 3. Results of the proposition S(2) evaluation for ABC and XYZ.

ERP strategic factor	ERP proposition subfactor	ERP strategic subfactor	Result of subfactor evaluation	Summary and comments
	Proposition S(2)-1	Implementation time	ABC: verified XYZ: not verified	ABC's implementation time was quick and effective, while XYZ's implementation time was longer, with many obstacles and difficulties.
Implementation time and ROI issues S(2)	Proposition S(2)-2	The ERP system's fit with organizational culture	ABC: verified XYZ: not verified	ABC's employees experienced very little resistance in accepting the system. ABC's employees found the system to be an asset. XYZ experienced resistance from some staff members. Some XYZ employees wanted to use the old manual system.
	Proposition S(2)-3	Return on investment (ROI) analysis	ABC: verified XYZ: not verified	ROI analysis for ABC was impossible since its ERP implementation was new. XYZ did not analyse ROI; nor did it have any desire to do so in the future.
	Proposition S(2)-4	Cost savings in human power	ABC: verified XYZ: verified	Both companies saved a great deal of labour time, prevented extra and redundant works, and made performing of many tasks more efficient.

Table 4.   Results of the proposition S(3) evaluation for ABC and XYZ.

ERP strategic factor	ERP proposition subfactor	ERP strategic subfactor	Result of subfactor evaluation	Summary and comments
	Proposition S(3)-1	Basic employee training	ABC: verified XYZ: verified	Both ABC and XYZ ensured that their employees had the necessary basic computing skills.
ERP employee training S(3)	Proposition S(3)-2	Vendor-led training	ABC: verified XYZ: verified	Both ABC and XYZ participated in specialized training programmes offered by the vendors of their ERP systems. There was no need for further training at this time for either company.
	Proposition S(3)-3	Use of ERP system administrators	ABC: verified XYZ: not verified	ABC had an information systems department and specialists who were very knowledgeable in ERP systems. XYZ had neither.

Table 5. Results of the proposition S(4) evaluation for ABC and XYZ.

ERP strategic factor	ERP proposition subfactor	ERP strategic subfactor	Result of subfactor evaluation	Summary and comments
Effective use of ERP features/ applications S(4)	Proposition S(4)-1	Integration of various functional areas	ABC: verified XYZ: not verified	ABC's integrated ERP system was used to its full potential. XYZ did not include many functions/activities in its ERP implementation.
	Proposition S(4)-2	Use of ERP applications and features	ABC: verified XYZ: not verified	Every department in ABC used ERP's applications and features on a daily basis. XYZ's use of these applications and features were well below its industry norms.

a non-ERP environment to an ERP environment. Effective employee training could assist employees to overcome the resistance that might exist toward the ERP implementation. Not surprisingly, both ABC and XYZ paid close attention to employee training issues, while ABC was more proactive than XYZ in taking advantage of employee training as a tool to advance its ERP agenda. In addition, ABC, when hiring personnel for its organization, was able to determine the match between knowledge and skills required for effective ERP implementation/operations and the potential knowledge and skills offered by the new employees. XYZ could have accomplished a similar match among its existing employees. Again, these results—subject to further research—could indicate that older companies could possibly have more difficulties in retraining and retooling their employees when it comes to new ERP systems.

Table 5 addresses the effective use of ERP features, applications, and integration issues. This factor is perhaps the most important of all four ERP strategic factors. This factor shows how well the entire effort of an organization bears fruit in terms of creating a synergy among all its functions and activities. It also shows how well an organization can use all the powerful features and applications of a fully fledged ERP system. These two critical points clearly separate more successful companies from less successful companies. These two subfactors provide clear and convincing proof as to whether a company was successful in its ERP efforts and implementation. All other factors could become secondary to these overriding strategic factors. As an example, consider XYZ whose ERP efforts appeared reasonable and fairly successful up to this point. All similar efforts appeared to be less important and had less impact when XYZ did not verify this important factor. On the other hand, ABC's efforts were highly rewarded mostly because of the approval of this critical strategic factor as opposed to other important strategic factors. ABC displayed a great deal of ease in its operations due to the use of its ERP system. ABC achieved efficiency levels that met its organizational goals. ABC's various departments experienced easy data transfer and access due to its full utilization of an ERP system.

It is also important to note that the way in which ABC and XYZ chose to utilize their ERP systems was significant. This utilization was based on the needs identified in their organizations, their top management leadership and support, and their unique organizational cultures. This important fact also points to the uniqueness of each organization's ERP efforts. It is, therefore, unreasonable to provide an ERP prescription for all companies without consideration given to the size, products produced, nature of operations, and external competitive factors among the many factors to consider. For the ERP system itself, many factors such as organizational culture, top management leadership and support, employee acceptance, replacing existing hardware and software, total cost of ownership, employee training issues, the ERP system fit with organizational needs and goals, etc. need to be considered. Potential ERP users must start by evaluating their organizational needs and goals, and then select the ERP system that holds the most potential for them. Once the ERP system has been identified, a successful implementation will require the full support of every member of the organization, from the start of implementation until ROI was materialized.

In terms of the ROI itself, ROI is often not an appropriate measure of success during the first few years of ERP installation. This is because typically the benefits

gained from ERP systems are insignificant compared with the overwhelming initial cost of ERP systems during the first few years of installation. During the initial years of ERP implementation, the emphasis should be placed on qualitative factors such as ease of daily operations and the use of new applications and features that had not existed previously.

ERP implementation is not a one-time process. Companies currently engaged in ERP systems should consider upgrades that provide new opportunities for them. Vendors develop new software frequently; thus, upgrading is seen as an inherent part of ERP systems. ERP companies should consider the new ERP features available and the age of their current equipment/software in evaluating future needs for upgrades. ABC was already seeking to upgrade its ERP system in order to remain competitive.

6.1 *Future research directions*

Given the findings of this paper and the analyses of case studies, future research directions could encompass:

1. What are the operational ERP factors and other possible barriers to ERP implementation? And what are their respective challenges to effective ERP implementation?
2. Do companies experience any significant and unexpected problems as a result of ERP implementation? If so, what are those problems? Could they be classified in one or more of the ERP strategic factors mentioned in this paper?
3. Does the use of ERP increase customer satisfaction beyond a company's products or a company's customer service?
4. How can organizations better train their employees to accept and use ERP systems? How could employee resistance to new ERP systems be overcome?
5. Are there any significant differences in ERP implementation results for older companies installing ERP systems as opposed to newer companies?
6. How can current ERP users customize their ERP systems to render them more productive and efficient?
7. What would ERP users like to see in new versions of ERP hardware/software?

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