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European Journal of Operational Research 146 (2003) 315–338
EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
www.elsevier.com/locate/dsw

The impact of strategy and integration mechanisms on enterprise system value: Empirical evidence from manufacturing firms

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Abstract

This paper "conceptualizes the fit" of enterprise resource planning systems in manufacturing firms by conducting a study to identify how well organizational strategies and integrating mechanisms fit management's expectations of the system's value. The empirical findings indicate that the extent of BPR, competitive strategy, adequacy of end-user training, role of steering committee, package functionality, integration of IT, and manufacturing decisions related to technology, workforce, quality, production planning and organization are important determinants of managements perceptions of system value.

Keywords: Manufacturing; Project management and scheduling; Organization theory; ERP planning; Package software implementation

1. Introduction

Over the last decade, companies have abandoned legacy systems in favor of a new class of comprehensive packaged application software designed to integrate the core corporate activities of an organization. Variously called enterprise resource planning systems (ERP), enterprise-wide systems or enterprise systems, ERP systems are the software tools used to manage all the enterprise data, and to provide information to those who need it when they need it. These systems help organizations deal with their supply chain: receiving, inventory management, customer order management, production planning and managing, shipping, accounting, human resource management, and all other activities that take place in a modern business (Davenport, 1998b).

The speed with which organizations have embraced and implemented ERP systems over the past few years has been phenomenal. Designed to solve the problem of fragmentation of information in large organizations and promising the seamless

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0377-2217/03/$ - see front matter
PII: S0377-2217(02)00552-0

integration of all the information flowing through a company (Davenport, 1998a), a properly selected and implemented ERP system can have significant benefits. However, difficulties to realize the promised benefits have plagued many ERP implementations and many are "pulling the plug" even after investing millions of dollars (Bailey, 1999).

Apart from being profoundly complex pieces of software requiring large investments of money, time, and expertise (Davenport, 1998b) ERP systems differ from custom development in three ways: (1) the user may have to make changes to business processes and procedures, or (2), the user may need to introduce customizations, and (3) the user becomes dependent on the vendor for assistance and updates (Lucas et al., 1988). While system settings may be modified to more closely fit the customer's organizational structure, business practices and workflow (Chalmers, 1999), a study of SAP R/3 users reported that at least 20% of their need functionality is missing from the package (Scott and Kaindl, 2000). In the midmarkets, few vendors seem to have packaged the right combination of technology, functionality, and services to provide the appropriate level of value and comfort (Hill, 1999). In the international context, Soh et al. (2000) identified three types of misfits (data, functional, and output) and proposed a spectrum of misfit resolution strategies, which trade off between the amount of organizational change and the amount of package customization required. Hence, we argue that central to achieving the promised benefits of enterprise systems is the importance of developing a proper "fit" between the technology and the organization's strategy and implementation choices.

An old fable of *The Blind Men and the Elephant* by John Godfrey Saxe tells about seven blind men who examine an elephant. One touches the trunk, the other his ear, the third his legs, and so forth. Each of them incapable of seeing the whole comes up with a completely different description. The elephant is variously a wall, a spear, a snake, a tree, a fan or a rope depending on which feature of the animal each man seizes.

The notion of ERP fit is like the elephant in the fable, a complex, multivariate phenomenon, whose parts we need to understand to comprehend the whole, but which we cannot simply arrive at by adding its parts. This paper conceptualizes our vision of ERP fit and seeks to extract key dimensions that are relevant to research and practice that can help us comprehend the whole. The heart of the ERP fit model is the assumption that integration mechanisms provide value by being instrumental in tasks that facilitate the correspondence between strategy and system. Thus, this paper examines the value implications of fit between an organization's strategies (*business and manufacturing strategy*, *and manufacturing capabilities*) and a broad variety of integration mechanisms (*aligning ERP with strategy*, *project organization*, *package adaptation*, *and organizational adaptation*).

In the first section of the paper, the development of the research model is proposed. Following this, a diagram makes explicit the expected fit among organizational strategies, integration mechanisms and system value. The theoretical bases for the correspondences between strategy and integration mechanisms are reviewed and research questions proposed. Multiple discriminant analysis explores the effects of both strategy and integration mechanisms on system value using data obtained from 202 manufacturing firms. The subsequent sections outline the analytical approach and present the results. Finally, conclusions are discussed and some of the study limitations are acknowledged.

2. Development of the research model

2.1. A model of ERP fit

Fig. 1 summarizes the major elements of our model of ERP fit. It suggests that a variety of integration mechanisms are appropriate for bringing about internal consistencies between the organization's strategies and the new technology, and, ultimately their impact on the value of the system. A summary of the integration mechanism and organizational strategies of the ERP fit model are presented in Tables 1 and 2.

ERP projects like any other project should be business, not technology driven and have a clear

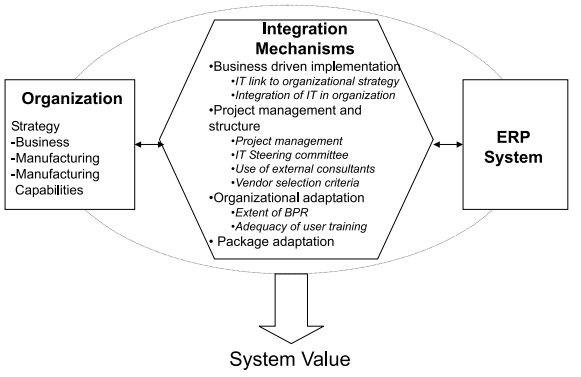

Fig. 1. A conceptual model of ERP fit.

link to the organization's strategy. Implementing an ERP system is a careful exercise in strategic thinking, precision planning, and negotiations with departments and divisions (Bingi et al., 1999) that requires careful selection and the appropriate project organization, management structure and methods. ERP projects frequently require companies to adapt the organization to the package and implement extensive business process reengineering which in turn necessitates appropriate change management processes. Organizational adaptation also involves extensive user training, which is a critical and often neglected factor in ERP implementations. At the same time, proper configurations of the package as well as customizations are adaptations of the technology side that effect the fit between the organization and the ERP package.

3. Aligning ERP with strategy: Business driven implementation

3.1. IT link to organizational strategy

The need for alignment between IT applications and strategy is well established in the literature. In the manufacturing sector, which has extensive investments in information technologies, an IT application should be aligned with a company's manufacturing strategy in terms of competitive priorities and process structure (Kathuria et al., 1999; Kathuria and Igbaria, 1997). Kotha and Swamidass (2000) found that a fit between certain dimensions of strategy and advanced manufacturing technology was associated with superior performance. ERP projects should thus demonstrate a clear link to organization strategy and be business rather than technology driven to ensure they achieve their desired impact.

The consistency of the business and manufacturing strategies manifests the role of the manufacturing function within the organization (i.e. the better the fit, the higher the role of manufacturing in the business). Hayes and Wheelwright (1984) argued that the alignment between manufacturing strategy and business strategy is one dimension of consistency for manufacturing strategy. Hayes and Schmenner (1978) contended that "manufacturing functions best when its facilities, technology, and policies are consistent with recognized priorities of corporate strategy". Anderson et al. (1989) have stated that proper strategic positioning or aligning of operations capabilities can significantly impact the competitive strength and business performance of an organization. Likewise, Skinner (1985) using several case studies has demonstrated that in organizations where functional strategies are in consonance with business strategy, performance is superior to organizations where functional strategies and the business strategy are not aligned.

In this paper we have operationalized business strategy by using Porter's (1980) typology. Effective business strategies can be classified as cost leadership strategies, differentiation strategies, or focus strategies. As Porter (1980) noted, "cost leadership requires aggressive construction of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customer accounts, and cost minimization in areas like R & D, service sales force, advertising, and so on" (Porter, 1980, p. 35). Differentiation strategies refer to the creation of something that is unique to the industry. This uniqueness "provides insulation against competitive rivalry because of brand loyalty by customers and resultant lower sensitivity to price" (Porter, 1980, p. 38). The basis of a focus strategy is the selection of a particular buyer group, segment of the product line, or the concentration on a particular geographic market. The focus strategy's key to competitive success is lower costs than

Table 1
Summary of organizational strategy constructs

Business strategy
Aims to be the lowest-cost producer in the marketplace
Qualifies its products or services in a way that allows it to appear unique in the market place
Limits its scope to a narrower segment of the market and tailors its offerings to that group of customers
Manufacturing strategy[a]
Capacity
A common set of criteria for use in developing/presenting an investment proposal
Policies for economic or competitive conditions required for planning, starting, or postponing capacity changes
Facility
Parameters governing the size and location of individual facilities
Guidelines for permanent reductions in capacity at mature facilities
Technology
Policies for the organization and layout of production processes
Criteria for equipment selection and the level of automation to be pursued
Vertical integration
Policies for make/buy analyses and changes in backward integration
Rules for establishing internal transfer prices
Workforce
Benefit packages and pay scales
Policies for unionization, hiring, promotion, and employment stability
Quality
Standardized reports, reporting relationships, and job definitions
Guidelines of performance measures such as the cost of quality, field failures, and expected quality levels
Production planning
Parameters for manufacturing system specifications and hardware approval
Rules for measuring and evaluating inventory performance
Organization
Definitions for job classifications and direct/indirect staffing levels
Policies regarding manufacturing engineering support levels and use of outside service
Manufacturing capabilities[b]
Dimensions important to firm's corporate mission
Product research
Product development
Product design
After sales service
Price
Product quality
Delivery on schedule
Rapid delivery
Cost minimization
Quality assurance
Flexibility to volume changes
Flexibility to customer specification changes

[a] Items were averaged to form an index.

[b] Manufacturing capabilities was measured through Likert scaled indicators reflecting the degree to which sampled organizations engaged in activities critical to the firms' corporate mission. The sum of the points obtained for twelve dimensions were calculated to represent the degree to which companies are committed to corporate mission.

competitors, the ability to offer something uniquely different from competitors, or perhaps a combination of both.

Since Skinner's (1969) seminal article discussing the importance of including the manufacturing function in the corporate strategy process, several

Table 2
Summary of integration mechanisms

Alignment of ERP with strategy: Business driven implementation
Integration of IT in organization[a]
"IT under business unit control"
"Strategic importance of IT"
IT link to organizational strategy[a]
Project organization
Project management issues[a]
"Planning"
"Monitor schedules, costs, implement BPR"
"Communication and meeting schedules"
"Project scope and analysis of processes"
Role of steering committee[a]
"Provide organizational leadership, strategic direction, IT resource allocation decisions"
"Provide IT increased visibility, coordination, enlist support"
Use of external consultants
Vendor selection criteria[a]
Organization adaptation
Business process reengineering in implementation
End-user training
Package adaptation
Package Attributes[a]
"Vendor assurances"
"Package functionality"
"Ease of application extensions"

[a] These integration mechanism constructs were factor analyzed. Factor labels are shown above in quotation marks.

researchers have stressed the need to incorporate the manufacturing perspective in the business strategy (Anderson et al., 1989; Hayes et al., 1988; Hill, 1994, Swamidass and Newell, 1987). Theoretically, the argument has been that manufacturing's exclusion from the strategic debate has lead to a more reactive mode of operation. The result is a manufacturing area that is unable to capitalize on current capabilities or gain the resources needed to develop new ones (Hayes et al., 1988; Hill, 1994).

Hayes and Wheelwright (1984) presented one of the most cited models of the relationship between business strategy and functional strategy. They suggested that manufacturing strategy is determined by the pattern of decisions actually made over time and related to structural and infrastructural choices. The structural components involve choices concerning technology, capacity, facilities, and vertical integration. Infra-structural components, which are deemed more tactical because the decisions tend to be ongoing, include human resource policies, quality, production planning and materials control, and organizational structure and design.

Other researchers (e.g., Prahalad and Hamel, 1990; Stalk et al., 1992) have suggested that sustainable competitive advantage for a business unit results from building core capabilities or competencies. Manufacturing strategy content embodies the choice of the most beneficial set of manufacturing capabilities for a business unit and the investments needed to build that set of capabilities. Capabilities, such as low cost, quality, flexibility and delivery performance that a manufacturer possesses, are strategic assets, which have been accumulated through a pattern of investments over time. Although various authors have used different terms (e.g. competitive priorities, order winners and qualifiers) to describe these capabilities,

in this paper we refer to them as manufacturing capabilities, because we address "realized" instead of "intended" strategies.

3.2. Integration of IT in organization

Traditional management strategy has been a bottom–up approach where the various functional areas were automated on an application-by-application basis. Little consideration was given for integration and optimization at the firm level. As firms move toward evolution in their management orientation, planning, organization, and control aspects of its IT function, they should institutionalize a formal top–down planning process for linking information systems strategy to business needs, transfer the technology to a wider spectrum of applications, and contribute to a high degree of technology integration for better exploitation of IT within the firm (Cash et al., 1992; Premkumar and King, 1992). Similarly, Kochan (1999) argues that an integrated software package is useless without an integrated working environment.

One of the important characteristics of an ERP system is that it can use a centralized database operation on a common computing platform. ERP system components should interact with an integrated set of commonly designed applications, consolidating all business operations into a uniform system environment. To ensure that their information systems are in alignment with the business strategy of the organization, firms will need better integration of IS with their business plans. For example, Wal-Mart had great success integrating ERP and supply chain management (SCM). Like many companies, Wal-Mart started down the road to total integration by first linking its internal systems e.g., it automated the tracking of its inventory system by barcode technology. But soon it realized that integration must be from one end of the business chain to the other—from its suppliers through to its customers. To achieve the total integration, Wal-Mart has linked its ERP system to that of the suppliers. In the past few years, the focus has shifted toward an emphasis on integration of supply side of the value chain using SCM.

Intertwining systems with suppliers and business customers allows firms to make dramatic improvements in their business processes, which ultimately lock in profitable relationships with their suppliers and customers for a long time to come. Integrated firms use IT to create new products and services, use IT to alter linkages with suppliers and customers, use IT to establish new standards of performance in their industries, display more proactive orientation toward IT, and have the ability to deliver consolidated information to customers. Integration is often facilitated by employing processes to identify and exploit IT activities. This often requires changes in business practices and culture (Johnson and Carrico, 1988).

4. Project organization

4.1. Project management issues

Project management involves the use of skills and knowledge in coordinating the scheduling and monitoring of defined activities to ensure that the stated objectives of ERP projects are achieved. The contingency approach to project management suggests that project planning and control is a function of the project's characteristics such as project size, experience with the technology, and project structure, and several other variables (Applegate et al., 1999). The vast combination of hardware and software and the myriad of organizational, human and political issues make many ERP projects huge and inherently complex, requiring new project management skills (Ryan, 1999). The high implementation risks of these projects imply the need for multiple management tools such as external and internal integration devices and formal planning and results controls (Applegate et al., 1999). While keeping to a schedule appears to be critical to successful timely implementation (Chain Store Age, 1999), rushed deadlines may result in premature cutover and costly consequences.

4.2. Role of IT steering committee

A project management structure with a "steering committee", consisting of senior management from across different corporate functions, senior

project management representatives, and end users who will have daily contact with ERP, is an effective means of ensuring appropriate involvement (Slater, 1998; Chimni, 2000) and make ERP succeed (Sumner, 1999). The steering committee is usually involved in system selection and monitoring during implementation, and management of the outside consultants. This is critical to the successful implementation of an ERP system (Bingi et al., 1999). It has been argued that the use of a steering committee is one of the most efficient ways to improve an organization's IS planning efforts (Gupta and Raghunathan, 1989). IS planning is the planning undertaken by an organization when it seeks to determine its IS requirements globally and systematically so it can prepare to meet its short and long-term needs. Steering committees are viewed as effective in keeping top management involved, they ensure the fit of IS with corporate strategy and improve communications with management and users.

4.3. Use of external consultants

Many organizations use consultants to facilitate the implementation process. Consultants may have specific experience in specific industries, comprehensive knowledge about certain modules, and may be better able to determine which suite will work best for a given company (Piturro, 1999). Performance ratings for consultants have been mixed (Cooke and Peterson, 1998). Major concerns stem from financial ties to the recommended software vendor, lack of expertise and experience in ERP appropriate to the business, and inability of consultants to transfer knowledge to internal employees (Piturro, 1999). The adoption of a vendor-only approach may be more effective than the vendor-consultant approach due to greater communication and coordination costs in the three-way network (Thong et al., 1994).

4.4. Vendor selection criteria

ERP systems are a way of life that need continuous exploitation to obtain their strategic value, and may be a lifelong commitment for many companies (Davenport, 1998a). There will always be new modules and versions to install and better fits to be achieved between business and system. Consequently, vendor selection criteria represent an important factor with any packaged software. There are indications that rapid implementation technologies and programs provided by the vendors can significantly reduce the cost and time of deploying ERP systems. An additional goal of implementation tools is the transfer of knowledge with respect to using the software, understanding the business processes within the organization, and recognizing industry best practices.

Research has shown that a better fit between the software vendor and user organization is positively associated with packaged software implementation success (Janson and Subramanian, 1996), and that organizations should attempt to maximize their compatibility with their vendors (Thong et al., 1994). Lack of fit results in diminished performance benefits (Burn and Szeto, 2000). The relationship between the software buyer and vendor should be strategic in nature with the ERP provider enhancing an organization's competitiveness and efficiency (Travis, 1999; Butler, 1999).

5. Organizational adaptation

5.1. Extent of business process reengineering

Organizations are confronted with new markets and competition and increasing customer expectations. To become more responsive to customers and competition, organizations are re-engineering their business practices and procedures. Information technology and business process reengineering have combined to provide organizations a competitive advantage (Yang et al., 2000). One of the problems associated with implementing any packaged software is the incompatibility of features with the organization's information needs and business processes (Janson and Subramanian, 1996; Lucas et al., 1988). ERP implementations frequently require companies to adapt the organization to the package through extensive business process reengineering. In order to maximize the benefits of ERP investments, the supplementary

redesign of business processes promises the highest ROI, but also increases the level of complexity, risks and costs (Kirchmer, 1998). Recently, studies have investigated the extent of processes reengineered on benefits achieved through ERP implementation (e.g. Yang et al., 2000). Interestingly, the most reengineered processes, those associated with purchasing and manufacturing, have no significant correlation with benefits from ERP implementations (Yang et al., 2000). On the other hand, many firms that have experienced success with ERP have comprehensively reengineered their organizational processes and structures as a method for enterprise-wide transformation (Mische and Bennis, 1996). It has been reported that reengineering targets traditional business practices to renew leadership and optimize a firm's competitive position and shareholder value (Mische and Bennis, 1996).

5.2. Adequacy of end-user training

The role of training to facilitate software implementation is well documented in the MIS literature (Nelson and Cheney, 1987; Santhanam and Sein, 1994). Training is also very critical in ERP implementation. Problem ERP implementations and implementation failures have been attributed to lack of user training and failure to completely understand how enterprise applications change business processes (Crowley, 1999; Wilder and Davis, 1998). Without proper training, about 30–40% of front-line workers will be unable to handle the demands of a new ERP system (Sweat (1999)). User training should account for 15–20% of the implementation budget, and everyone who uses ERP systems should receive training in terms of how they work and how they relate to the business process (Marion, 1999; Slater, 1998).

End-user training is important in facilitating a favorable user attitude toward end-user computing (EUC) (Guimares and Igbaria, 1998), and in creating a supportive environment that is responsive to end-users concerns and needs, which is essential to support organizational learning and end-user experimentation with new tool and software applications (Guimares and Igbaria, 1998).

6. Package adaptation

6.1. Package attributes

Choosing the right ERP software that best matches the organizational information needs and processes is critical to ensure minimal modification and successful implementation and use (Janson and Subramanian, 1996). Selecting the wrong software may mean a commitment to an architecture and applications that do not fit the organization's strategic goals (Robinson and Dilts, 1999) or business processes. Interestingly though, the ERP selection process often lacks a structured process with companies evaluating a limited set of criteria (Hecht, 1999).

Many ERP systems can be configured to more closely fit the customer's organizational structure, business practices and workflow (Chalmers, 1999). This fine tuning of the standard system, which represents a key process in the implementation of the system (Bancroft et al., 1998), involves accurately translating business needs into appropriate parameter settings to improve productivity and minimize custom modification. While a large number of adaptations are possible, configuring the system involves making compromises and has its limits (Bancroft et al., 1998; Davenport, 1998b).

When options allowed by the system are not sufficient, the enterprise system's code can be modified or rewritten. Because customizations are usually associated with increased information systems costs, longer implementation time, the inability to benefit from vendor software maintenance and upgrades (Janson and Subramanian, 1996) and communication problems with vendor and supplier systems (Davenport, 1998b), customization should only be requested when essential or when the competitive advantage can be clearly demonstrated (Escalle and Cotteleer, 1999).

7. System value

Measuring the benefits from an enterprise system is a difficult task, particularly when the benefits of these systems are strategic in nature. Understanding the value of an ERP system entails

examining the amount of duplicated effort that the ERP system eliminates and the increased efficiency that results from having an ERP solution in place. Savings can be derived from a reduction in staff numbers and productivity improvement. ERP helps companies control their purchasing, inventory, manufacturing, finance and human resource activities by bringing together in one place information collected from dispersed geographical sites. A year after implementing ERP, Par Industries in Moline, Illinois reduced lead time, on-time delivery performance increased, work-in-progress inventory decreased and the life of a shop floor order went from weeks to hours (Appleton, 1997). Inventory reduction emerged as the most frequent tangible benefit from implementing ERP according to a survey of senior executives at 62 Fortune 500 companies by Deloitte and Touche (1998). This is in consonance with a statement by one manager who reportedly is saving $1 million per month through inventory management (Connolly, 1999). At the same time, many organizations are not certain that they will realize positive returns. Even worse, many fail to see immediate benefits from moving to ERP or experience adverse effects, like missed sales and profit targets (Michael, 1998).

8. Research questions

The above discussion leads us to specify research questions for our discriminant analysis:

(1) Can management's perceptions of system value (i.e., the benefit of ERP has failed to meet, is below, has met, or has exceeded expectations), be reliably predicted from knowledge of organizational strategies (business, manufacturing and manufacturing capabilities) and integration mechanisms (business driven implementation, project organization, organizational adaptation and package adaptation)?
(2) If system value can be predicted reliably, along how many dimensions do the four groups differ? How can those dimensions be interpreted?
(3) Given the obtained classification functions, how adequate is the classification?

9. Research methodology

To empirically examine the research propositions, a field survey of top-level IS executives at large manufacturing organizations was employed. Data collection, construct measurement and evaluation, analysis, results, and model classification are described next.

9.1. Data collection

The manufacturing companies included in this study were randomly drawn from the Michigan Harris Database, 2000. Research by Automation Research Corporation in Dedham, MA indicated that Tier 1 manufacturers in the US, those with annual revenues in excess of 500 million, have been the primary targets of ERP implementations. Sales to this particular segment drove the ERP market to 6.8 billion—almost 80% of the total market—in 1996. An ERP system has been identified as the most applicable information system for the modern manufacturing industry (Ng et al., 1999). Hence, the manufacturing sector was chosen because it represents a relatively homogeneous set of firms which have the same technology, similar manufacturing infrastructure and environments, and compete under similar conditions.

The questionnaire was pilot tested with five IS executives from a variety of manufacturing organizations. [2] They were asked to judge the appropriateness of the items in each category, clarity of the questions, and to identify any ambiguities. Accordingly, several changes were made to the questionnaire. The questionnaire was mailed to 1250 IS executives (e.g. CIO, MIS manager) at large (500 or more employees) manufacturing firms. Approximately 18 declined to participate in the survey as a general corporate policy and 37 were undeliverable by the postal service for a number of reasons. The mailing resulted in a total response of 287 usable questionnaires. From these responses, firms who indicated their ERP implementation was

[2] Pilot testing was done with IS executives from automotive, electronic, tool, chemical, and consumer products manufacturing firms.

Table 3
Description of manufacturing organizations in the sample

Revenue ($ Millions)	Number of companies ($n = 202$)
Over 1000	55
501–1000	47
251–500	32
101–250	28
25–50	19
Less than 25	8
Unknown	13
Stage that best classifies the status of ERP system	
Decision making stage[a]	2
Beginning implementation[a]	43
Early to mid implementation[a]	40
Late implementation (near completion)	68
Implementation completed last year	54
Implementation completed over one year ago	80
Title of respondent	
CIO	5
VP of IS/IT	36
MIS/IS/IT Manager	79
Director of IT/IS/Mfg	38
Project Manager	21
Unknown	23
Total number of employees in organization	
Over 10,000	2
5001–10,000	3
1001–5000	33
501–1000	56
251–500	48
101–250	27
Less than 100	10
Unknown	23

[a] Omitted from analysis.

(1) in the decision making stage (i.e. deciding use of vendor and/or consultants, planning, design), (2) beginning implementation, and (3) early-to-mid implementation were removed, resulting in 202 firms. The response rate of 24% is fairly typical of mail surveys (Torkzadeh and Xia, 1992; Yap, 1990). The characteristics of the manufacturing organizations are described in Table 3.

9.2. Construct measurement and evaluation

An instrument was developed that provided valid and reliable measurement of the model constructs. Each construct was operationalized with specific questions, and following Nunnally's (1978) recommended procedures, multiple items for the same priority were developed. Since multiple item measures are generally thought to enhance confidence that the constructs of interest are being accurately assessed (Nunnally, 1978; Etezadi-Amoli and Farhoomand, 1996), they are used, where possible, to improve the reliability and validity of the measures.

Most of our constructs are measured with Likert-type scales that provide the advantage of standardizing and quantifying relative effects. Each question required respondents agreeing or disagreeing on a five-point scale. The agree–disagree response format is one of the most frequently used types of questions in social science research and has been shown to have stronger validity than several other types of questions (Schriescheim et al., 1991). Additionally, where possible, scales that had demonstrated good psychometric properties in previous studies were employed. The measures and their sources are shown in Appendix A.

Multi-item constructs were evaluated for construct validity. Nunnally (1978) notes that, "... the clustering of variables as done in factor analysis constitutes a very important aspect of construct validation". A principal components factor analysis with orthogonal (varimax) rotation was performed on six integration mechanisms, which contained multi-items: (1) role of the IT steering committee, (2) project management issues, (3) package selection attributes, (4) integration of IT in the organization, (5) vendor selection criteria, and (6) IT link to organizational strategy. The results of the factor analyses, which provide support for construct validity, are shown in Tables 4–9. The number of factors selected was based on the number of principal factors with eigenvalues greater than one. Factors were named based on the inherent construct identified from the item loadings. Reliability, which measures the internal consistency of the instrument, was assessed using Cronbach's alpha, and is shown in Tables 4–9. In general, there was a high degree of reliability for each of the scales analyzed, with all in excess of 0.60. Therefore, the constructs were considered to

Table 4
Rotated component matrix[a] for *Role of IT Steering Committee*

Role of IT steering committee	1[b]	2[c]
The IT steering committee was formed to provide organizational leadership for exploiting and managing IT	0.938	
In our organization, the IT steering committee is charged with steering IT activities that are in line with the strategic direction of the organization	0.926	
The IT steering committee makes resource allocation decisions in the areas of systems development and recruitment for IT function	0.897	
The IT steering committee is created to increase visibility or revamping of IT		0.862
The IT steering committee is formed to enlist top management support for IT activities		0.837
The IT steering committee provides a mechanism for coordinating requirements and practices	0.183	0.608
The IT steering committee is appointed to wrest control of the technology from the IT specialist[d]		
The IT steering committee provides a mechanism for keeping and sustaining necessary reserved powers centrally[d]		
Cronbach Alpha Coefficient	0.913	0.674

	Rotation sum of squared loadings		
Component	Total	Percent of variance	Cumulative percent
1	2.580	42.992	42.992
2	1.829	30.480	73.472

[a] Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization.
[b] Label: "Provide organizational leadership, strategic direction, IT resource allocation decisions".
[c] Label: "Provide IT increased visibility, coordination, enlist support".
[d] Item removed from analysis (low reliability).

exhibit adequate reliability. After identifying the factor loading pattern, the mean of each factor was calculated from the raw scores and considered as the factor index for further analysis.

9.3. Analysis

While univariate analyses are useful to identify the important variables, they do not provide a meaningful interpretation of the relative importance among the various constructs. Since one of the objectives was to determine the differences in strategy and integrating mechanisms among IS management with different perceived expectations of system value, discriminant analysis was chosen as the appropriate statistical technique. This technique derives a profile based on a linear combination of variables that will best discriminate between the a priori defined groups. [3]

Inputs to the model consist of twenty-six discriminating variables (see Table 10 for listing) representing the organizational strategies and integrating mechanisms, X_{gji} $(i = 1, 2 \ldots 26)$, where X_{gji} is the value of the ith variate for the jth

[3] Groups are determined based on the extent ERP has been beneficial to the organization in terms of such things as cost savings, customer satisfaction, supplier satisfaction, return on investment, increases in overall productivity, better decision making capabilities, accelerated information sharing and distribution.

Table 5
Rotated component matrix[a] for *Project Management Issues*

Project management issues	1[b]	2[c]	3[d]	4[e]
Set realistic deadlines	0.971			
Had a formal project management plan	0.972			
Had regular project status meetings	0.971			
Had a formal project management team	0.970			
Planned for actual rollout very early in the project cycle	0.822			
Used an implementation readiness assessment to determine if the necessary IT infrastructure was in place to handle the transition to the new ERP system	0.547			
Had strict monitoring of implementation schedules and costs		0.867		
Had appropriate feedback mechanism in place		0.855		
Had a project champion		0.720		
Implemented proposed changes to business processes		0.626		
Had good communication between team members and other organizational members			0.860	
Finished the implementation approximately on schedule			0.859	
Carefully defined the scope of the project				0.863
Spent time analyzing the organization's existing processes				0.830
Cronbach Alpha Coefficient	0.944	0.776	0.667	0.648

Component	Rotation sum of squared loadings		
	Total	Percent of variance	Cumulative percent
1	4.834	34.530	34.530
2	2.569	18.353	52.883
3	1.520	10.857	63.740
4	1.509	10.778	74.517

[a] Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization.
[b] Label: "Planning".
[c] Label: "Monitor schedules, costs, implement BPR".
[d] Label: "Communication and meeting schedules".
[e] Label: "Project scope and analysis of processes".

organization in group g. There are four groups in the analysis [4]. The variables are transformed into a discriminant function of the form

$$Z_{gj} = V_1 X_{gj1} + V_2 X_{gj2} + \ldots V_{26} X_{gj26} \quad (1)$$

where Z_{gj} represents the discriminant score for the jth organization in group g, and $V_1, V_2, \ldots, V_{25}$ are the coefficients.

[4] The groups are: failed to meet my expectations of benefits, below my expectations of benefits, met my expectations of benefits, and exceeded my expectations of benefits.

For theoretical reasons, we wish to determine the discriminating capabilities of the organizations' strategies and integrating mechanisms concurrently, and, therefore enter all the variables into the model simultaneously. In Table 10 we show the Wilks' lambda Λ, and the univariate ANOVA, used to assess the significance among group means of the strategies and integrating mechanisms, for the dependent variable, management's expectations of system value. The F-statistic is used to test the null ($H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$) and alternative hypotheses ($H_1 : \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$) for each of the discriminating variables, where μ_1, μ_2, μ_3, μ_4, are, respectively, population means for the manage-

Table 6
Rotated component matrix[a] for importance of *ERP Package Attributes*

Package attributes	1[b]	2[c]	3[d]
Ease of installation process	0.914		
Vendor's commitment to improving their product and adding features	0.915		
Vendor closely matched our organization's business needs	0.878		
Ability to extend with custom Web applications	0.829		
Ability to leverage new technology	0.825		
Vendor's corporate stability	0.524		
Extent of customizations		0.943	
Ability to do a lot with few modifications		0.919	
Ease of upgrade		0.823	
Interfaces with legacy system		0.773	
Software functionality availability for key processes		0.744	
Distribution of application processing across clients and servers			0.939
Middleware-enabled interoperability with third-party applications			0.918
Cronbach Alpha Coefficient	0.904	0.897	0.894

	Rotation sum of squared loadings		
Component	Total	Percent of variance	Cumulative percent
1	4.145	31.888	31.888
2	3.573	27.488	59.376
3	1.843	14.178	73.554

[a] Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization.
[b] Label: "Vendor assurances".
[c] Label: "Package functionality".
[d] Label: "Ease of application extensions".

ment expectation groups. The null hypothesis will be rejected, if the mean of at least one pair of groups is significantly different. As seen in Table 10, sixteen of the variables show significant differences (at $\alpha = 0.05$) among management's expectations of system value.

Table 11 details the overall impact of the discriminant functions, which represent the differences among management's expectations of system value. It is possible to divide the variation between the four groups into a maximum of three independent dimensions, represented by three discriminant functions. The chi square statistic is typically used for assessing the statistical significance of all the discriminant functions. The significant chi-square value ($\chi^2 = 148.351$; df $= 75$; $p = 0.000$), shown in Table 11, suggests that *at least* the first discriminant function is significant; other discriminant functions may or may not be significant. The statistical significance of the remaining discriminant functions determines whether they jointly explain a significant amount of difference among the four groups that has not been explained by the first discriminant function. Since the chi-square value for the test of functions two through three is statistically significant ($\chi^2 = 81.688$; df $= 48$; $p = 0.002$), we conclude that the second discriminant function also explains a significant amount of difference among management's expectations of system value that was not explained by the first discriminant function.

Based on the canonical correlations, the total amount of variance explained by the first function is 0.548^2, or 30%. The second function explains 0.527^2, or 28% of the remaining variance. Emphasis is placed here on interpreting the first two functions, since the canonical correlation coefficients, which measure the association between the

Table 7
Rotated component matrix[a] for *Integration of Information Technology* in organization

Integration of information technology	1[b]	2[c]
The introduction of, or experimentation with, new technologies takes place at the business unit level under business unit control	0.914	
Some IT development resource is positioned within the business unit	0.915	
There is a cost center rather than profit center orientation in controlling IT activities	0.878	
We have relatively unsophisticated IT chargeout procedures	0.829	
There is ongoing education for top management in IT capability		0.959
There is a top–down planning process for linking information systems strategy to business needs		0.952
In my firm top management perceives that future exploitation of IT is of strategic importance		0.751
Cronbach Alpha Coefficient	0.843	0.880

	Rotation sum of squared loadings		
Component	Total	Percent of variance	Cumulative percent
1	2.728	38.977	38.977
2	2.477	35.392	74.370

[a] Extraction method: Principal component analysis. Rotation method: Varimax with Kaiser normalization.
[b] Label: "IT under business unit control".
[c] Label: "Strategic importance of IT".

Table 8
Principal component matrix[a] for *Criteria Important in ERP Vendor Selection*

ERP vendor selection criteria	1[b]
Training	0.750
Service	0.744
Price	0.743
Knowledge of our business and operations	0.710
Support personnel	0.696
Consultation	0.695
Quality	0.686
Cronbach Alpha Coefficient	0.842

	Rotation sum of squared loadings		
Component	Total	Percent of variance	Cumulative percent
1	3.611	51.581	51.581

[a] Extraction method: Principal component analysis.
[b] Label: " Vendor selection criteria".

groups and functions are greater than 0.50, and hence, are of greater importance.

9.4. Results

In Table 12 we show summary measures that allow us to determine the relative importance of strategies and integration mechanisms in discriminating among management's expectations of system value. For interpretative purposes, the higher the loading of a given attribute on a function, the more representative a function is of that attribute. When sample sizes are small or the potential for multicollinearity among discriminating variables is high, the use of discriminant loadings is not affected by relationships with other variables, and tends to be more stable and defensible than use of the standardized discriminant coefficients (Hair et al., 1998). Like-signs among structure correlations and centroids indicate a direct relationship and opposite signs an inverse one.

Discriminant function one suggests that management's perceptions of system value are primarily separated by several variables. The first

Table 9
Principal component matrix[a] for *IT Link to Organizational Strategy*

Information technology link to organizational strategy	1[b]
An internal IT group is set up as the sole source to meet IT demand within reasonable costs	0.913
IT specialists of our firm compete against outside vendors for providing users' information systems needs	0.875
IT resources and expenditures are constrained and their use are determined by resource allocation procedures, such as ROI criteria	0.867
We have developed state of the art IT to create business opportunities	0.811
Users determine their own IT needs and how to satisfy them	0.785
A central decision-making unit integrates business needs with both IT capabilities and the potential of IT for creating a competitive advantage	0.786
Cronbach Alpha Coefficient	0.9161

	Rotation sum of squared loadings		
Component	Total	Percent of variance	Cumulative percent
1	4.23	70.648	70.648

[a] Extraction method: Principal component analysis.
[b] Label: "IT link to strategy".

function is named "Planning, integration, and competitive priorities" based on an examination of the variables that are related to it. First, "IT under business unit control" has the highest relationship with this function, followed by project planning, workforce decisions, manufacturing capabilities, vertical integration decisions, and communication and meeting schedules. The differences in management's expectations of system value, emphasized by the loadings on the second function, are related to "organization, technology, and process adaptation" issues, that is, organization decisions, extent of business process reengineering, steering committee's role to provide organizational leadership, strategic direction, IT resource allocation decisions, business strategy of organization, adequacy of end-user training, and technology, quality and facility decisions.

Based on these analyses, and a post hoc analysis of means, we find that when management's perceptions of system value has failed to meet, or is below their expectations, these organizations tend to have less involvement with steering committees and project management issues, ascribe lower importance to package selection attributes, and have poorer integration of IT within the organization.

9.5. Model classification

The organizations are classified into one of the four a priori groups by the discriminant model. The accuracies of prediction, for the functions on the sample from which they were derived, are given in Table 13. Sixty-two percent of the organizations are correctly classified. Since classification is based on a discriminant function derived from the same group it is expected that the model should have high classification power. However, the subset of discriminant variables determined from the analysis may be significant only with respect to the analysis firms and not over the entire population. The predictive power of the model is dependent on the extent to which the analysis group represents the entire population on the discriminant function.

10. Conclusions

This paper presents a multiple discriminant analysis of the effect of strategy and project integration mechanisms on management's expectations of system value. We feel that the results of

Table 10
Group descriptive statistics and tests for the equality of the group means

Strategy and integration mechanisms[a]	Means[b]				Tests for the equality of group means[c]		
	Group 1	Group 2	Group 3	Group 4	Wilks' Lambda	*F*-ratio	Significance
Extent of BPR	**1.88**[d]	**2.07**	**2.13**	**1.65**	**0.951**	**3.413**	**0.018**
Use of external consultants	1.56	1.43	1.42	1.50	0.992	0.537	0.658
Business strategy	**1.87**	**2.07**	**2.13**	**1.70**	**0.959**	**2.803**	**0.041**
Adequacy of end-user training	**1.87**	**2.07**	**2.09**	**1.65**	**0.956**	**3.034**	**0.030**
Role of steering committee:							
"Provide organizational leadership, strategic direction, IT resource allocation decisions"	**3.48**	**3.58**	**3.22**	**3.79**	**0.954**	**3.179**	**0.025**
"Provide IT increased visibility, coordination, enlist support"	**2.81**	**3.12**	**2.64**	**2.88**	**0.959**	**2.822**	**0.040**
Project management issues:							
"Project planning"	**2.71**	**2.86**	**3.37**	**3.59**	**0.898**	**7.500**	**0.000**
"Monitor schedules costs, implement BPR"	**1.95**	**2.29**	**2.11**	**1.84**	**0.961**	**2.645**	**0.048**
"Communication & meeting schedules"	2.44	2.38	2.40	2.18	0.961	0.572	0.634
"Project scope and analysis of processes"	1.86	1.95	1.88	1.82	0.995	0.336	0.800
Package attributes:							
"Vendor assurances"	*2.04*	*2.48*	*2.21*	*2.47*	*0.966*	*2.318*	*0.077*
"Package functionality"	**2.13**	**2.71**	**2.43**	**2.70**	**0.961**	**2.645**	**0.048**
"Ease of application extensions"	2.18	2.67	2.53	2.52	0.974	1.782	0.152
Integration of IT in organization:							
"IT under business unit control"	**2.79**	**3.05**	**3.46**	**3.49**	**0.870**	**9.884**	**0.000**
"Strategic importance of IT"	3.11	3.44	3.40	3.18	0.987	0.902	0.441
Vendor selection criteria	3.69	3.91	4.05	3.92	0.984	1.097	0.352
IT Link to organizational strategy	**3.47**	**3.64**	**3.15**	**3.75**	**0.943**	**3.986**	**0.009**
Manufacturing strategy:							
Capacity decisions	3.77	3.67	3.78	3.86	0.996	0.253	0.859
Facility decision	3.65	3.53	3.50	3.86	0.974	1.749	0.158
Technology decisions	**3.15**	**3.11**	**3.03**	**3.55**	**0.955**	**3.110**	**0.027**
Vertical integration decisions	3.48	3.52	3.63	3.86	0.973	1.860	0.138
Workforce decisions	**3.21**	**3.42**	**3.81**	**3.91**	**0.893**	**7.877**	**0.000**
Quality decisions	**3.50**	**3.47**	**3.33**	**3.98**	**0.961**	**2.707**	**0.046**
Production planning decisions	**3.40**	**3.95**	**2.80**	**3.27**	**0.919**	**5.794**	**0.001**
Organization decisions	**2.96**	**3.32**	**3.57**	**2.97**	**0.955**	**3.085**	**0.028**
Manufacturing capabilities	**3.23**	**3.14**	**3.38**	**3.33**	**0.947**	**3.722**	**0.012**

[a] Twenty-six strategy and integration mechanism used as discriminating variables.
[b] Group 1 = failed to meet my expectations, Group 2 = below my expectation, Group 3 = met my expectations, Group 4 = exceeded my expectations.
[c] Wilks' Lambda and Univariate *F*-ratio with 3 and 197 degrees of freedom.
[d] **Bolded Numbers**, $p < 0.05$; *Italicized Numbers*, $p < 0.10$.

this exploratory study are very encouraging, in that our research questions have been adequately addressed by the analysis. That is, (1) there are multiple, equally effective ways in which an organization can achieve ERP fit based on strategy and integration mechanisms, (2) the configuration of integration mechanisms will vary from company to company and is contingent on the contextual

Table 11
Summary of canonical discriminant functions

Function[a]	Eigenvalue	Percent of variance	Cumulative percent	Canonical correlation
1	0.430	46.0	46.0	0.548
2	0.384	41.1	87.2	0.527
3	0.120	12.8	100.0	0.327
Test of function(s)	Wilks' Lambda	Chi-square	df	Significance
1–3	0.451	148.351	75	0.000
2–3	0.645	81.688	48	0.002
3	0.893	21.092	28	0.575

[a] Although three canonical discriminant functions were generated, the first two functions were significant and will interpreted in the analysis.

Table 12
Summary of interpretive measures[a]

Independent variables: strategy and integration mechanisms	Discriminant function loadings		
	Function 1[b]	Function 2[c]	Function 3
Integration of IT in organization: "IT under business unit control"	**0.556***	0.205	0.084
Workforce decisions	**0.512***	0.131	0.042
Project management issues: "Project planning"	**0.510***	0.067	0.032
Manufacturing capabilities	**0.331***	−0.015	0.279
Vertical integration decisions	**0.249***	−0.064	0.011
Vendor selection criteria	**0.129***	0.137	0.097
Project management issues: "Communication & meeting schedules"	**0.120***	0.070	−0.071
Organization decisions	0.071	**0.332***	0.136
Extent of business process reengineering	−0.112	**0.341***	0.129
Role of steering committee: "Provide organizational leadership, strategic direction, IT resource allocation decisions"	0.073	**−0.313***	0.262
Business strategy	−0.081	**0.313***	0.136
Adequacy of end-user training	−0.123	**0.310***	0.147
Technology decisions	0.194	**−0.284***	0.030
Quality decisions	0.167	**−0.273***	0.062
Facility decisions	0.106	**−0.235***	−0.068
Production planning decisions	−0.230	−0.219	**0.624***
Role of steering committee: "Provide IT increased visibility, coordination, enlist support"	−0.089	−0.147	**0.510***
ERP package attributes: "Package functionality"	0.184	0.001	**0.463***
ERP package attributes: "Vendor assurances"	0.155	−0.032	**0.452***
Project management issues: "Monitor schedules costs, implement BPR"	−0.101	0.217	**0.383***
ERP package attributes: "Ease of application extensions"	0.026	−0.340	**0.363***
IT link to organizational strategy	0.129	−0.103	**0.372***
Use of external consultants	−0.031	−0.053	**−0.235***
Integration of IT in organization: "Strategic importance of IT"	0.032	−0.147	**0.202***
Project management issues: "Project scope and analysis of processes"	−0.051	0.057	**0.151***
Capacity decisions	0.062	−0.038	**−0.116**

*Largest absolute correlation between each variable and any discriminant function.
[a] The first two functions are significant and will be interpreted.
[b] This function named "Planning, integration, and competitive priorities".
[c] This function named "Organization, technology process adaptation".

Table 13
Classification results[a]

Actual group membership	Number of cases	Predicted group membership			
		Failed to meet my expectations	Below my expectations	Met all of my expectations	Exceeded my expectations
Failed to meet my expectations	64	**36 (56.3%)**	16 (25%)	5 (7.8%)	7 (10.9%)
Below my expectations	42	7 (16.7%)	**24 (66.7%)**	6 (14.3%)	1 (2.4%)
Met my expectations	55	10 (18.2%)	4 (7.3%)	**33 (60%)**	8 (14.5%)
Exceeded my expectations	40	5 (12.5%)	5 (12.5%)	3 (7.5%)	**27 (67.5%)**

[a] 61.7% of the original grouped cases correctly classified.

factors facing the organization and, (3) ERP fit provides increased capabilities for realization of perceived system value (benefits).

This leads us to suggest that, with the increasing importance of enterprise systems, organizations should begin to assess the emphasis they place on strategy and integration mechanisms. Any positive approach taken toward the careful examination of these variables by an organization's management could very well augment the benefits that can be provided by it. Organizations must learn how to identify their information needs, select the best ERP package that suits their individual needs based on their organizational characteristics, and manage ERP so that benefits are achieved. First and foremost, however, decision makers must be sure that forethought and analysis precede the ERP implementation, and when considering an ERP system, should evaluate it within the context of a strategic plan. More specifically, key variables are identified, such as manufacturing capabilities, project management, and technology integration issues that allow management to employ a strategy to accentuate these characteristics to meet or exceed expectations of system value. An organization needs to build and have in place a set of manufacturing capabilities, and a set of strategic choices in manufacturing, which include workforce and vertical integration decisions, and proper project planning and integration, which support higher perceptions of system value. An organization can therefore impact system value through a series of key choices related to a few substantive areas (e.g. manufacturing capability, manufacturing strategy, project planning).

Likewise we find that business strategy is strongly linked to organization, technology and process decisions. It appears that the role of manufacturing decisions, such as organization, technology, quality and facility decisions, related to the organization's processes, people, structure, support the overall business strategy and consequently explain perceptions in system value by management. This set of choices is most critical for a differentiation strategy. Critical decisions about systems implementation must be related to the business strategy, which is enabled by manufacturing decisions, and proper planning and integration of IT. The results indicate that top management needs to understand and support the strong position of the manufacturing function and exploit that strength strategically in system implementation.

Thus, a general conclusion from our study is that an organization is more likely to perceive system value, beyond their expectations, when there is a fit between its strategy and integrating mechanism. ERP systems standardize processes, integrate information and centralize control; organizations that find this consistent with their own strategies, characteristics and integrating mechanism are more likely to realize higher system value from their ERP.

11. Limitations

The results of this study may be improved by a number of alterations. First, and foremost is the stability of the discriminant function. To test the predictive power of the proposed model, the discriminant function determined from the analysis group should be used to classify organizations from a hold out sample. Second, the examination

of other types of firms would indicate the contribution of industry classification to the discriminant function. Likewise, there are other variables that may be considered too, such as the level of competition in the industry and environmental characteristics. Limitations that need to be recognized are: (1) the sample for this study was primarily from medium to large manufacturing firms, and to that extent the results of the study can only be generalizable to similar organizations; and (2) the use of perceptual measures from a single respondent in an organization could result in some informant bias, and thus, the results must be interpreted with caution. On the other hand, while perceptual data introduce limitations through increased measurement error and the potential for monomethod bias, the use of such measures is not unprecedented (Dollinger and Golden, 1992; Powell, 1992).

Acknowledgements

We would like to thank the guest editors and the anonymous reviewers for their constructive comments and feedback on earlier versions of this manuscript.

Appendix A. Sample of questions from survey instrument

Business, manufacturing and manufacturing capabilities:

An organization's *business strategy* is assessed using Porter's (1985) three basic types of competitive strategy a firm can follow: price leadership, product differentiation, or market focus.

- Now we would like you to assess the *strategy* of your organization. Please check *one* of the following types of competitive strategies that *best describes* your organization.

  Our organization:
  - ☐ Aims to be the lowest-cost producer in the marketplace.
  - ☐ Qualifies its products or services in a way that allows it to appear unique in the market place.
  - ☐ Limits its scope to a narrower segment of the market and tailors its offerings to that group of customers.

Manufacturing strategy was characterized by the pattern of a firm's manufacturing decisions related to use of capacity, facility, technology, vertical integration, work force, quality, production planning, and organization. Hayes and Wheelwright (1984) multi-item measures were used to measure manufacturing strategy.

- Please indicate the extent of agreement or disagreement with each of the following statements. In my firm we have established:

Capacity:

A common set of criteria for use in developing/presenting an investment proposal.

Policies for economic or competitive conditions required for planning, starting, or postponing capacity changes.

Facility:

Parameters governing the size and location of individual facilities.

Guidelines for permanent reductions in capacity at mature facilities.

Technology:

Policies for the organization and layout of production processes.

Criteria for equipment selection and the level of automation to be pursued.

Vertical interation:

Policies for make/buy analyses and changes in backward integration.

Rules for establishing internal transfer prices.

Workforce:

Benefit packages and pay scales.

Policies for unionization, hiring, promotion, and employment stability.

Quality:

Standardized reports, reporting relationships, and job definitions.

Guidelines of performance measures such as the cost of quality, field failures, and expected quality levels.

Production planning:

Parameters for manufacturing system specifications and hardware approval.

Rules for measuring and evaluating inventory performance.

Organization:

Definitions for job classifications and direct/indirect staffing levels.

Policies regarding manufacturing engineering support levels and use of outside service.

Note: Response Scale: 1 = strong disagreement to 5 = strong agreement.

Manufacturing capabilities that a manufacturer possesses are stocks of strategic assets, which have been accumulated through a flow of investments in capability building programs over time. Hill (1989, p. 54) classifies such capabilities as order winners and qualifiers, according to the extent to which manufacturing can support its products in the marketplace.

- Now we would like to ask you some questions related to your firm's competitive market stance. Please indicate the extent to which you believe the following dimensions are important to your firm's corporate mission.
  - Product research
  - Product development
  - Product design
  - After sales service
  - Price
  - Product quality
  - Delivery on schedule
  - Rapid delivery
  - Cost minimization
  - Quality assurance
  - Flexibility to volume changes
  - Flexibility to customer specification changes

Note: Response Scale: 1 = very low importance to 5 = very high importance.

Source: Hayes and Wheelwright (1984); Roth and vander Velde (1991); Hill (1989, p. 54).

Integration Mechanisms:

Package attributes were measured using thirteen items.

- Next, we would like to ask you a few questions about the importance of various attributes in selecting your ERP package.
  - Extent of customizations.
  - Ease of upgrade.
  - Software functionality availability for key processes.
  - Interfaces with legacy system.
  - Vendor closely matched our organization's business needs.
  - Ability to leverage new technology.
  - Ability to extend with custom Web applications.
  - Vendor's corporate stability.
  - Ease of installation process.
  - Ability to do a lot with few modifications.
  - Vendor's commitment to improving their product and adding features.
  - Distribution of application processing across clients and servers.
  - Middleware-enabled interoperability with third-party applications.

Note: Response Scale: 1 = very low importance to 5 = very high importance.

Vendor selection criteria were assessed using seven multi-items.

- Please indicate the extent to which the following criteria were important in selecting an ERP vendor(s).
  - Knowledge of our business and operations
  - Price
  - Quality
  - Service
  - Support personnel
  - Training
  - Consultation
  - Others (Please specify)

Note: Response Scale: 1 = very low importance to 5 = very high importance.

Project management issues were measured using fourteen items which were assessed for their reliability and factor analyzed into a meaningful subset of dimensions.

- Next, we would like to ask you a few questions about *project management*. Please indicate the extent of agreement with each statement.
  Our organization:
  Had a formal project management *plan.*
  Planned for actual rollout very early in the project cycle.
  Used an implementation readiness assessment to determine if the necessary IT infrastructure was in place to handle the transition to the new ERP system.
  Had a formal project management *team.*
  Had regular project status meetings.
  Set realistic deadlines.
  Had strict monitoring of implementation schedules and costs.
  Had appropriate feedback mechanism in place.
  Had a project champion.
  Finished the implementation approximately on schedule.
  Had good communication between team members and other organizational members.
  Carefully defined the scope of the project.
  Spent time analyzing the organization's existing processes.
  Implemented proposed changes to business processes.

Note: Response Scale: (1 = strongly disagree to 5 = strongly agree).

The role of the Steering Committee was measured using eight multi-items. These items were assessed for internal consistency using Cronbach's alpha coefficient and factor analyzed into meaningful dimensions.

- Please indicate the extent to which you agree or disagree with the following statements as they relate to the IT steering committee in your organization.
  In our organization, the IT steering committee is charged with steering IT activities that are in line with the strategic direction of the organization.
  The IT steering committee was formed to provide organizational leadership for exploiting and managing IT.
  The IT steering committee makes resource allocation decisions in the areas of systems development and recruitment for IT function.
  The IT steering committee is appointed to wrest control of the technology from the IT specialist.
  The IT steering committee is formed to enlist top management support for IT activities.
  The IT steering committee is created to increase visibility or revamping of IT.
  The IT steering committee provides a mechanism for coordinating requirements and practices.
  The IT steering committee provides a mechanism for keeping and sustaining necessary reserved powers centrally.

Note: Response Scale: (1 = strongly disagree to 5 = strongly agree).

Source: The original list developed by Earl (1989) presented a total of eleven reasons for the existence of a steering committee. Three of these reasons were specific to firms where IT organization is structured as a business unit or business venture arrangement, and were therefore not applicable to the current context.

An organization's usage of external consultants, beginning, during or post ERP system implementation was measured using a single item.

- Did your organization employ external consultants, beginning, during, or post ERP implementation?
  ☐ Yes ☐ No ☐ Uncertain

The extent of business process reengineering (minor changes, moderate changes or significant changes to an organization's business processes) was measured with a single item.

- What do you believe was the extent of business process engineering associated with the enterprise system implementation in your organization?
  - ☐ Minor changes to our business processes
  - ☐ Moderate changes to our business processes
  - ☐ Significant changes to our business processes

The adequacy of end-user training (less than what was needed, about adequate, more than what was needed) was assessed using a single item.

- Do you believe the end-user training provided by your organization was:
  - ☐ less *than* what was needed
  - ☐ about adequate
  - ☐ *more than* what was needed

The extent to which IT is linked to the organizational strategy of the organization was measured using six items. The items were assessed for reliability and factor analyzed.

- Now we would like to ask a few questions on the extent to which information technology (IT) is linked to the organizational strategy of your organization.

  In our organization:

  A central decision-making unit integrates business needs with both IT capabilities and the potential of IT for creating a competitive advantage.

  We have developed state of the art IT to create business opportunities.

  Users determine their own IT needs and how to satisfy them.

  IT specialists of our firm compete against outside vendors for providing users' information systems needs.

  An internal IT group is set up as the sole source to meet IT demand within reasonable costs.

  IT resources and expenditures are constrained and their use are determined by resource allocation procedures, such as ROI criteria.

Note: Response Scale: 1 = strong disagreement to 5 = strong agreement.

The extent to which IT is integrated within the organization was measured using six items.

- Please indicate the extent to which you agree or disagree with the following statements as they relate to *integration* of information technology (IT) in your organization.

  In my firm top management perceives that future exploitation of IT is of strategic importance.

  There is ongoing education for top management in IT capability.

  There is a top–down planning process for linking information systems strategy to business needs.

  Some IT development resource is positioned within the business unit.

  The introduction of, or experimentation with, new technologies takes place at the business unit level under business unit control.

  There is a cost center rather than profit center orientation in controlling IT activities.

  We have relatively unsophisticated IT chargeout procedures.

Note: Response Scale: 1 = strong disagreement to 5 = strong agreement.

Source: Feeney et al. (1987) found eight characteristics that distinguished firms with high integration from those with low integration. All these factors were present where integration was high and none were present where integration was low.

The perceived benefits the organization has been able to derive from use of the ERP system.

- Please take a moment and think about the *benefits* your organization has been able to realize from integrating enterprise systems.

  Overall, and to the best of your knowledge based on your experiences and perceptions, to what extent has ERP been beneficial to your organization, for example, but not limited to such things as cost savings, customer satisfac-

tion, supplier satisfaction, return on investment, increases in overall productivity, better decision making capabilities, accelerated information sharing and distribution?

- ☐ Unable to make a conclusion
- ☐ Has failed to meet my expectations
- ☐ Below my expectations
- ☐ Has met my expectations
- ☐ Has exceeded my expectation

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