Enterprise Resource Planning (ERP):

A Postimplementation Cross-Case Analysis

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ABSTRACT

In today's intensely competitive marketplace, companies can benefit strategically and tactically from enterprise resource planning (ERP) systems, if implemented correctly. However, with failure rates estimated to be as high as 50% of all ERP implementations, companies can be negatively impacted by a poorly performing ERP system. The research on ERP has focused on events leading to the selection, evaluation, and implementation of the ERP system. The intent of this research is to identify new or lightly researched theories regarding the difficulties of ERP implementations that can help practitioners successfully manage ERP implementations by performing a post-ERP implementation examination of eight corporations. We examine operations management (OM) literature rather than information systems (IS) literature in order to provide IS readers with an alternative yet valuable analysis. Further, we purposely avoid well-established findings by performing a large literature review. This article is based on a qualitative research design using case-study methodology. The propositions derived from the case studies form solid insight into the considerations that may influence the success of an ERP system.

Keywords: case studies; enterprise resource planning (ERP); implementation; planning; project management; technology

INTRODUCTION

In today's highly competitive manufacturing environment, firms are implementing enterprise resource planning systems to address the problem of fragmentation of information or "islands of information" in business organizations. ERP systems promise to computerize an entire business with a suite of software modules covering activities in all areas of the business. Furthermore, ERP is now being promoted as a critical link for integration between all functional areas within a firm's supply chain, and has shown to be a significant contributor to a corporation's success, if implemented correctly. ERP systems improve efficiency within the four walls of an enterprise by integrating and stream-

lining internal processes (Anderson, 2000; Koch, 1999). Kalling (2004) has also speculated that ERP may be a source of competitive advantage.

The ERP implementation efforts of many manufacturing companies have resulted in partial failure and, in some cases, total abandonment. Trunick (1999) reports that 40% of all ERP installations only achieve partial implementation, and nearly 20% are scrapped as total failures. Some of the failures have been shown to be user related in that new technology is not always acceptable (Nah, Tan, & Teh, 2004). An American Production and Inventory Control Society (APICS) Conference Board report issued in June 2001 stated that 40% of participants failed to achieve their business case after having implemented ERP for at least 12 months (Salopek, 2001). Other authors have suggested that the failure rate may be higher than 50% (Escalle, Cotteleer, & Austin, 1999). In a recent survey by Deloitte Consulting LLC, 25% of the 64 Fortune 500 companies surveyed said they suffered a drop in performance when their ERP systems went live (Evangelista, 1998). This is after believing that they had successfully installed the system. A recent study conducted by Professors Austin and Nolan of the Harvard Business School reveals that a remarkable 65% of executives believe ERP systems have at least a moderate chance of hurting their business because of implementation problems (Cliffe, 1999). At present, ERP is a new phenomenon and the research relating to ERP implementations is very limited (Al- Mashari, 2000; Dong, 2001; Nah, Lau, & Kuang, 2001; Parr, Shanks, & Drake, 1999). Most of the research to date focuses on preimplementation activities and provides some answers to a successful "path forward" for firms wanting to implement an ERP system. Research shows that some firms have successfully implemented ERP systems with some excellent performance improvement (Anderson, 2000; Melnyk & Stewart, 2002). However, since many ERP systems fail to meet their objectives after going live (Cliffe, 1999; Salopek, 2001), it is logical to conclude that there must be postimplementation improvements be-

ing performed by firms committed to using ERP as a successful business tool. This research seeks to uncover new information about the successful implementation and management of ERP systems by analyzing eight firms who have multiple years' experience, with varying degrees of success, with ERP systems.

The intent of this research is to identify new or lightly researched theories regarding the difficulties of ERP implementations that can help practitioners successfully manage ERP implementations by performing a post-ERP implementation examination of eight corporations. Our findings are formed into propositions. We examine operations management literature rather than information systems literature in order to provide IS readers with an alternative, yet valuable analysis. Further, we purposely avoid well-established findings by performing a large OM literature review.

LITERATURE REVIEW

OM ERP implementation literature can be segmented into five major areas, with each addressing several subtopics. These areas include strategic considerations, costs, training, project management, and the implementation process. Since our goal is to provide new ideas and theories, we reviewed the existing OM literature to gain insight into established theory on why ERP implementations are so difficult and often fail. This analysis allowed us to refrain from publishing heavily researched areas that may not make much of a contribution. Table 1 provides a summary of an extensive and critical review of the OM literature.

ERP adoption must be seen as a business decision (See for example: Anderson, 2000; Brakely, 1999; Ng & Ip, 1999) and not as a technology decision. This viewpoint will be helped along in the organization if strategic benefits are identified initially (i.e. response to customer demands, improved communications within and outside the firm, and improved customer and supplier relationships (See for example: Davenport, 2000; Herr, 1994). Top management support is not only necessary but critical in a project

Table 1. ERP implementation literature review

Research Area	Application	Literature Support
Strategic		
Strategic Assessment of ERP and Management Support	ERP adoption should be seen as a business decision rather than a pure technology decision. Top level managers must understand and appreciate the strategic value of ERP and be willing to provide unswerving support for the project.	Anderson, 2000; Brakely, 1999; Davenport, 2000; Griffith et al., 1999; Ng and Ip, 1998; Shulman, 1998; Vasilash, 1997; Volkoff et al., 1997.
ERP Package and Module Selection and Subsequent Technical (Information Technology) Issues	If the firm decides to implement an ERP, the information gathered in the needs assessment will provide a ready checklist for configuring an ERP system with all the necessary modules and their associated subsystems. If the expertise is not located internally it should be solicited from a third party.	Booker, 1999; Davenport, 2000; Holland and Light, 1999; Koch, 1999; Lail, 1999, Nah, et al, 2001; Shulman, 1998; Travis, 1999, Trepper, 1999.
Economic/Financial and Strategic Goals of ERP	Many ERP projects proceed without a formal analysis of costs and benefits. Major strategic benefits such as improved response to customer demands, improved and streamlined internal and external communication, and improved customer-supplier relationships should be factored into the expected benefits.	Davenport, 1998; Herr, 1994; Koch 1999; Maxwell, 1999; Melnyk and Stewart, 2002, Schaeffer, 1999; Vasilash, 1997.
Top Management Support	Top management commitment is much more than a CEO giving his or her blessing to the ERP system and then moving on to other projects. Management commitment should look beyond the technical aspects of the project to the organizational requirements for a successful implementation.	Cotteler et al., 1999; Dong, 2001, Herr, 1999; Maxwell, 1999. Oliver, 1998; Rausch, 1994.
Cost Considerations		
Economic and Strategic Justification of ERP	Economic and strategic justification for an ERP project, prior to installation, is necessary because of the enormous investment and risk involved. Moreover, the justification process helps identify all the potential costs as well as the strategic and economic benefits that can accrue from the ERP implementation.	Cliffe, 1999; Cotteler et al., 1998; Herr, 1994; Koch, 1999; Schaeffer, 1999; Vasilash, 1997.
ERP Implementation Costs	Many firms budget for these systems without adequate appreciation for the full costs of an implementation. Systems integration costs are often more difficult to predict. Often training and education costs are grossly underestimated.	Bradley et al., 1999; Koch, 1999; The Meta Group;
Training		
Training and Education	Extensive training and education are considered to be critical for the success of an ERP implementation. Training of both management and employees is required.	Al-Mashari, 2000, Appleton, 1997; Capron and Kuiper, 1998; Griffin, 1998; Griffith et al., 1999; Schaaf, 1999; Trunick, 1999.
ERP Skill Assessment and Training Needs	Formal assessment of the knowledge and understanding of ERP principles for all levels of employees is required to evaluate the amount of training required. It is also critical in establishing who has the ability to learn and change and if they can survive in the new organization.	Cliffe, 1999; Herr, 1994; Koch, 1999; Kropp, 1994; Muscatello 2002.

Table 1. ERP implementation literature review (cont.)

Research Area	Application	Literature Support
Project Management		
ERP Project Scope	"Scope creep" can create a project that never ends. The functional departments and processes that will be affected by the ERP installation should be selected at the beginning of the project and jealously guarded against additions.	Delaney and Mabary, 1994; Herr, 1994; Holland and Light, 1999; Lewis, 1993; Trepper, 1999
ERP Project Management and Team Structure	A project management structure that includes an executive steering team, a full-time project manager, a project management team and process teams is recommended.	Cotteller et al., 1999; Dong, 2001, Herr, 1994; Koch, 1999; Lewis, 1993; Nah, et al, 2001; Trepper, 1999; Vasilash, 1997, Volkoff et al., 1999; Welti, 1999.
Project Management Tools	The implementation of an ERP package is a complex task requiring specific project management skills and knowledge. As with every project, timely reports and updates are needed to evaluate ERP project progress in terms of time, cost targets and achieved benefits.	Lewis, 1993; Trepper, 1999; Wight, 1993; Welti, 1999.
Managing an ERP project Time Line	Implementing an ERP system in phases allows the executive management team to evaluate the current project phase's success or failure. This allows them to make business decisions without jeopardizing the full project cost.	Cliffe, 1999; Ferman, 1999; Frank, 2000; Holland and Light, 1999
Implementation		
Quality Assurance Methods for an ERP Implementation	Developing a "day in the life of" business case for key functions such as order entry, billing, shipping, etc. and piloting them in a conference room can drive out problems before the module is fully activated.	Benjamin and Levinson, 1993; Herr, 1999; Holland and Light, 1999; Lewis, 1993.
Process Reengineering	Companies need to integrate their core processes, combine related activities and eliminate those activities that do not add value prior to adopting the any new manufacturing or information technology.	Al-Mashari, 2000; Chalmers, 1999; Davenport, 1993; Dickey, 1999; Hammer and Champy, 1993; Hammer and Stanton, 1999; Jenson and Johnson, 1999; Nah, et al, 2001; Muscatello, 2002; 1999; Smith, 1999.

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of the scope of an ERP system (See for example: Cliffe, 1999; Cotteller, Austin, & Nolan, 1998). Management commitment is essential not only in providing the financial support, but in providing the organizational processes that will ensure the success of the implementation. Package selection and identification of the features and functionality required is a tedious and resource-consuming task. Providing resources initially for the preparation of the needs assessment also requires top management support (See for example: Booker, 1999; Travis, 1999).

The second area of cost consideration is also shown in Table 1. Economic and strategic justification must be detailed and accurate in a project of the scale of ERP. Costs and benefits are critical, and must include contingencies and timing of both costs and benefits. While costs may be estimated, there are two categories of costs that are commonly underestimated. These include systems integration and training (See for example: Bradley, Thomas, Gooley, & Cooke, 1999).

Training and education are critical for the success of ERP (See for example Al- Mashari, 2000; Griffith, Zammuto, & Aiman-Smith, 1999). Skills and needs assessment must be done for all levels in the organization. Several authors identify the need to assess an employee's readiness for organizational change (See for example Cliffe, 1999; Muscatello, 2002).

Project management skills and abilities are also important in a high-profile project such as an ERP implementation. These include project structure (See for example Dong, 2001; Koch, 1999), managing scope (See for example Delaney & Mabary, 1994), managing the project time line (See for example Ferman, 1999), and overall project communication (See for example Welti, 1999).

Finally, process reengineering (See for example Chalmers, 1999; Smith, 1999) and quality assurance (See for example Holland & Light, 1999) are but two of the implementation issues that require attention in an ERP implementation.

The gap that exists in current research has to do with the postimplementation ERP ef-

fects on a business. What processes, programs, or duties changed post-ERP implementation? What interdisciplinary effects were observed? What are the observed ongoing effects? This research extends the theories on ERP implementation by exploring the selected case studies, both pre- and postimplementation.

METHODOLOGY

Case-study research methodology has been highly recommended by many researchers as an ideal tool for improving conceptual and descriptive understanding of complex phenomena (Flynn, Sakakibara, Schroeder, & Bates, 1990; McCutcheon & Meredith, 1993; Meredith, 2002; Stuart, 2002; Yin, 1994). The case-study method also offers many benefits, such as the ability to directly observe causality, and combine evidence and logic to build, develop, or support theories that are not available using other research methods (Maffei & Meredith, 1995). In contrast to survey research formats, it allows for more meaningful follow-up questions to be asked and answered, and can result in more extensive findings and insights that are valid, generalizable, and rigorous (Meredith, 1998).

ERP implementation is an expensive and extensive undertaking involving all activities related to planning, justification, installation, and commissioning of the installed system. An ERP system extends across the entire organization and beyond to cover integral partners in the supply chain. Furthermore, ERP projects can take two, three, or more years to fully implement (Parker, 1999). All of the above factors contribute to the complexity of ERP installations, and make snap-shot/cross-sectional approaches unsuitable for investigating the entire ERP implementation process. We adopt a case-study methodology to create propositions based on a longitudinal analysis of postimplementation factors that contribute to the successful installation and management of an ERP system. However, unlike the majority of studies in this area that focus on single case studies or survey information based on a spe-

cific ERP process or implementation plan, we develop propositions based on ERP implementations at eight diverse manufacturing facilities.

Selection of organizations is a very important aspect of building theory from case studies. While the cases may be chosen randomly, random selection is neither necessary, nor even preferable. Given the limited number of cases that can be studied, it has been suggested that researchers choose extreme situations and polar types in which the process of interest is transparently observable (Eisenhardt, 1989). Of the eight ERP implementation projects included in this study, four were successful, two are partially completed with low to moderate success, and two were eventually abandoned with very little gain. It was difficult to assess whether the abandoned projects should be included in a postimplementation study since obviously, their postimplementation was a failure. However, after reviewing the supporting documents and conducting preliminary interviews we decided to include them since they believed they had implemented the ERP system and abandoned it after the project team was disbanded. The author of this study served as a team member on six of the eight projects, with different roles on each project. His roles included Executive Sponsor, Project Manager, Subject-matter Expert, and Project Team Member. On the other two studies, the author had follow-up access to the project charter, plan, reengineering records, scope, quality plan, meeting minutes, consultants, project manager, team members, and executive sponsors.

Multiple methods were used to generate the data including the principle author's observations and constant interactions with ERP project team members during and after implementation. As an integral member of the pre- and postimplementation project team for six projects, and as a postimplementation advisor to the remaining two businesses, the principle author had unlimited access to historical documents and other records, financial data, and operations statistics. Open-ended interviews were also held with corporate officers, divisional managers, project leaders, super-users, and various project team members. A minimum of 10 interviews was held for each case study. These interviews included opening statements by the interviewer, open-ended questions, and nonsolicited interviewee statements. These interview techniques permitted the project participants to identify and frame the important issues and factors that affect ERP implementation success, as also suggested in Maffei and Meredith (1995). This approach is consistent with the recommendation that, in an area where theory is relatively undeveloped, researchers should use an inductive approach to the process of identifying issues for inclusion in the study (Flynn, Schroeder, & Sakakibara, 1994; Hensley, 1999; Spector, 1992). The written records, project plans, interview findings, and financial data were sorted for relevancy and completeness, and placed into tables that are referenced later in this paper. Sorting data into well-defined components in order to perform cross-case analysis follows the case-study analysis recommendations of Maffei and Meredith (1995).

COMPANY BACKGROUND AND DATA

Four of the companies covered by this study were divisions of larger companies. Four were stand-alone companies. They represented a range of firm sizes, products, types of manufacturing (continuous process, batch, and job shop) markets, and organizational arrangements, as shown in Table 2. The companies also had different prior experiences with manufacturing and information technology. The financial performances of seven of the eight companies were below the expectations of their corporate headquarters. Company G had average profits compared to the industry. Four companies (A, B, E, and F) were recording consistently declining profits. Company C was just breaking even in a growing market, and companies D and H were losing money. In addition, they were all experiencing problems with excessively high inventory levels and low inven-

tory turnover rates. Only companies D and H had on-time delivery performances better than the industry average, while the remaining six were below average. Corporate and divisional management for all the companies recognized the need for immediate strategic and operational responses to these problems.

All eight of the companies entered their ERP decision process under directives from corporate headquarters or the company's executive management team. Companies A and G had been threatened with widespread divisional management changes if the decline in profitability was not reversed. Company B's corporate management had stated that it would close down the division and transfer the work to a foreign division of the company. Executive management of company C had threatened to find an external source for this division's products, and the corporate management of companies D and H indicated that they were going to close the division/company if the losses continued. Company E's management required improvements or underperforming divisions would be closed or sold. Executives at company F required improvement or the acquisition plan would be scuttled, leaving fewer opportunities for middle management. Corporate management of four of these companies had recent encouraging experiences with enterprise system (ES) installations at their headquarters or in other divisions; they were favorably disposed to ES solutions for streamlining divisional operations. Experienced internal managers and consultants, vendors, board members, or other professionals who had an understanding of ERP systems influenced the companies who were not divisions or subsidiaries. Corporate management at all firms viewed integrated enterprise systems as a means of improving efficiencies and communications across all their divisions, and between the divisions and corporate headquarters. Corporate management was also the primary selector of the project sponsor and senior project team members.

A detailed business profile and the findings of each case study are shown in Table 2. To maintain anonymity, the names of the corporations have been removed. The intent of this case analysis is to infer relationships between project interdependencies and project performance. Therefore, each case is akin to a laboratory or complete survey experiment (Meredith, 1998).

PROPOSITIONS AND THEORETICAL FRAMEWORK

The author derived eight propositions based on the eight case studies. Each proposition will be presented at the end of the discussion. Propositions were developed based upon the analysis of the grouped company profile data, the supporting case-study documents, financial records, project plan and meeting notes, interviewer findings and, if any, relevant OM literature. The supporting statements made before each proposition are an accumulation of ideas/statements formed into a single like-minded expression. The development of generalities is acceptable for developing propositions when a rigorous case-study analysis has been carried out. (Maffei and Meredith (1995). The companies who contributed to each statement are noted after each statement.

Participants were very vocal about the need to assess the skill and training level of the existing employees after the implementation. There was a general dismay at the lack of ERP and business knowledge residing in companies that implemented ERP systems. One participant stated: "People don't understand how the whole company operates, just their little corner of the world. They need to understand that an ERP system requires timely and accurate data in order to perform the planning functions. They view transactions as an afterthought and not 'real work' like production. This mentality is killing our ERP system."

Three companies (C, D, and F) performed no formal review of their existing employees' skill levels until after the implementation. Companies A and B did the skill review with in-house senior managers who had successfully transformed other divisions, and two managers with multiple ERP systems installations. Three companies (E, G, and H) used outside consultants

Table 2. Company profiles and analysis

Company	A	B	C	D	E	F	G	H
Type of Business	Chemicals	Inorganic coatings	Electronics assembly	Centrifugal and static foundry	Specialty paint and coatings	Specialty heat resistant steels. Metals.	Health and safety products	Steel products, fasteners & specialty construction materials
Operation type	Manufacturing	Manufacturing	Manufacturing/ Distribution	Manufacturing	Manufacturing	Foundry & fabrication Also reseller	Manufacturing/ Distribution	Manufacturing
Category	Fortune 500 division	Fortune 500 division	Fortune 500 division	Division of $300MM corporation	Fortune 500	Small Private Company	Fortune 500	Large Private Company
Annual Sales (millions)	$90	$75	$200	$55	$3,500	$60	$2,200	$800
Market Share	30%	65%	30%	15%	15%	28%	14%	4%
Primary Markets (B2B, B2C)	B2B	B2B	B2B B2C	B2B	B2B B2C	B2B	B2B	B2B
Type of Manufacturing	Continuous process	Batch/repetitive	Batch/repetitive	Job-shop	Batch/repetitive	Job shop	Batch/repetitive	Job-shop, batch/repetitive
Number of Employees	87	131	145	106	1,228	311	944	512
Finished goods	High	High	High	Low	High	Average	High	Low
WIP	Low	High	Low	Low	High	High	Average	High
Raw Mat'l	High	High	High	High	High	High	High	High
Inventory Turnover Rates	Low compared to industry	Low compared to other divisions in company and Industry	Slightly below industry	Low compared to industry	Low compared to industry	Low compared to other divisions in company and Industry	Slightly below industry	Low compared to industry
On-time (in full) Delivery Performance	60%	78%	62%	76%	85%	62%	90%	83%

Table 2. Company profiles and analysis (cont.)

Company	A	B	C	D	E	F	G	H
Industry on-time delivery performance	85%	70%	85%	60%	98%	90%	99%	80%
Impetus for Process Change	Declining profits (40% over a 3 year period)	Declining profits & below corporation targets.	Just breaking even in a growing market.	Losing money	Declining profits, loss of market share.	Declining profits & below corporation targets.	Moderate profits compared to industry.	Losing money. Old plant & ideas. Unionized
Corporate Stance	Improvement or wholesale management changes	Improvement or closure of the division with transfer of work to another country	Improvements or will consider outsourcing	Improvements or closure	Improvement or sell or close under performing divisions	Improvement or no acquisitions	Improvements and growth or wholesale management changes and/or outsourcing	Improvements or closure
Estimated ERP cost (millions)	$1.00	$1.20	$3.00	$0.70	$57	$0.55	$90	$22
Year of ERP Implementation	1998	1994	1997	1998	1998	1998	1997	1999
Estimated Implementation time	1 year	1 year	1.5 years	1 year	2 years	1 year	3 years	1.5 years
Actual Implementation time (years)	2	2.5	3	Abandoned	3	Ongoing	3	Ongoing
Budgeted Investment (millions)	$1.00	$1.20	$3.00	$0.70	$57	$0.55	$90	$22
Expected savings (millions/year)	$1.00	$1.25	Not Available	Not Available	$12.50	$0.30	$17.50	$6.00
-Inventory	$400,000	$500,000	Decrease	Decrease	$5.50	$0.20	$10.00	$3.00
-AP DPO	$150,000	-	-	-	-	-	-	-
-Mfg Efficiency	$250,000	-	Decrease	-	$3.00	-	-	-
-Direct Labor	$100,000	$500,000	Decrease	Decrease	$4.00	$0.10	$5.00	$2.00
-Overhead	$100,000	$250,000	Decrease	-	-	-	$2.50	$1.00
-Customer Service increase	To 95%	-	To 95%	-	To 95%	-	-	-
-Mkt Share	-	-	-	-	-	-	Increase	-

Table 2. Company profiles and analysis (cont.)

Company / Modules/Sub-Systems	A	B	C	D	E	F	G	H
General Ledger (GL)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Accounts Payable (AP)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Accounts Receivable (AR)			Yes	Yes		Yes	Yes	
Budgeting	Yes				Yes		Yes	
Sales Order Processing	Yes				Yes	Yes	Yes	
Master Production Schedule	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Material Req. Planning	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inventory	Yes	Yes			Yes	Yes	Yes	Yes
Capacity Req. Planning	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Shop Flow Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Statistical Process Control			Yes		Yes		Yes	
JIT/Kanban	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Order Entry/Billing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Demand Management			Yes		Yes		Yes	
Distribution			Yes		Yes		Yes	Yes
Advanced Planning		Yes			Yes		Yes	Yes
Warehousing		Yes					Yes	
Forecasting	Yes	Yes	Yes		Yes		Yes	

Table 2. Company profiles and analysis (cont.)

Company	A	B	C	D	E	F	G	H
Existing Process Systems	MRP	MRP II	MRP, SFC	None	MRPII	Manuel	MRPII, SPC	MRPII, Legacy Accounting/OE
ERP Skills Assessment	Internal	Internal	None	None	External	None	External	External
No. of division employees	87	131	145	106	1,228	311	944	512
No. (%) of employees involved in the ERP implementation	14 (16.1%)	12 (9.2%)	14 (9.7%)	9 (8.5%)	96 (7.8%)	25 (8.0%)	77(8.2%)	26 (5.1%)
Estimated project cost (millions)	$1.00	$1.20	$3.00	$0.70	$57	$0.55	$90	$22
Actual project cost (millions)	$1.22	$2.10	$3.00	$0.70	$67	$0.75	$87.50	$23
Actual/Estimated	122%	175%	100%	100%	118%	136%	97%	105%
New Hardware requirements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interface with legacy systems	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Cost & Efficiency Improvements (millions/yr)	$1.195	$1.925	$0.10	Not Applicable	$9.30	$0.50	$14.70	$1.30
Inventory savings	$.70 (50%)	$.38 (40%)	-	-	$4.3 (20%)	-	$7.70 (22%)	$1.30
Mfg Efficiency	Reject rate reduced by 25%	Eliminate 2 warehouses	-	-	$3.30	-	-	-
Direct Labor	$0.36	$1.00	-	-	$1.70	$0.05	$3.90	-
Overhead	$0.14	$0.25	$0.10	-	-	-	$3.10	-
Market share before ERP	30%	65%	30%	15%	15%	28%	14%	4%
Market share after ERP	35%	70%	Not available	Not applicable	16%	28%	16%	3.5%

Table 2. Company profiles and analysis (cont.)

Current status of Firm				
	Company A is still in business and has increased market share and profits faster than their competition. They are expanding into TQM and Lean Manufacturing principles	Company B is the largest producer in a market that is replaced by plastics. They feel their ERP system has allowed them to remain competitive	Company C lags the market in both sales and revenue. Only the accounting modules of the ERP system are implemented	Company D closed its doors in 1999. Fortunately for the researchers, we were able to locate several of the senior managers and ERP implementers
	Company E enjoys and increased reputation in the market for both low price and high service	Company F has declined in profitability and has now implemented plans to use off-shore manufacturing	Company G has a strong financial statement and enjoys profits higher than the industry average. They have also implemented Six-Sigma improvement practices	Company H is losing money and closed a division in 2000.

to assess the current skill level, ability to grow, and amount of education and training necessary to grow. The assumption from most management is that after implementation, a person is fully trained. This reasoning is misguided because it assumes that once an employee has gone through an ERP training program, they now understand the business philosophy behind an ERP system. This analysis found that in all eight firms, process and job functions changed so radically in the areas of customer service, production scheduling, purchasing, inventory, and logistics that some employees who were deemed adequate or better performers before the implementation were not able to satisfactorily grasp the new procedures. Human-resource administrators in all eight companies stated they had significantly changed the job descriptions, requirements, and interview procedures after implementing ERP. All of the firms felt they had grossly overestimated the abilities and current job knowledge of at least a few of their employees. Thus,

Proposition 1: Firms who implement ERP systems will significantly change the education, training, and experience requirements for future hires.

Also, after the "go live" date, five firms (A, B, C, E, and G) reported that they implemented more functionality of their ERP systems than planned, and had to conduct further training and education of their employees. Some of the postimplementation functionality implemented included advanced planning systems (APS), distribution requirements planning (DRP), desktop report writers, online costing systems, Internet integration, engineering configurators, and bolt-on software such as timekeeping systems, amongst others. This caused a further gap in the abilities of current employees, and lead to management having to go through the painful process of reevaluating employees again. However, six firms (A, B, C, E, F, and G) all stated that without the continuous upgrade in employee skills through hire/fire, training and education, or outsourcing, their

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ERP implementation would have failed, been less successful, or taken longer and been more expensive. So, we propose,

Proposition 2: Firms who address the gap in employees' abilities and performance after the ERP implementation, through an ongoing analysis, will have a greater likelihood of successfully implementing ERP than those who do not.

All eight of the companies performed "needs" assessments. However, there were some differences in their approaches. Company D used an in-house team and examined software packages from various vendors. The remaining companies used independent, third-party consultants to assist in their assessments, and used the results of their reengineering efforts to develop the configuration for their ERP packages. They performed a checklist assessment provided by the consultants to determine the best-fitting software. Company B used a similar checklist and was aided by an outside consultant on their selection of a package. Since they had not yet performed their process reengineering, they selected a package based only on an evaluation of their current processes. After company B's reengineering efforts, changes had to be made to the chosen ERP system to incorporate the requirements of expected future processes. The checklists used by all three companies included questions on

(1) Current IT systems (including hardware)
(2) Type of business (continuous, repetitive, batch, job shop)
(3) Market analysis (demand management, forecasting, customer relationship management, etc.)
(4) Scheduling (MPS, MRP, and BOM requirements; shop floor scheduling, etc.)
(5) Logistics (warehousing, transportation scheduling, etc.)
(6) Purchasing (EDI, Internet, integration to inventory, and MRP, etc.)
(7) Inventory (transactions, bar codes, package types, analysis, etc.)

(8) Performance measurements (types of measurements)
(9) Financial and accounting (GL, AP, AR, credit, online banking, depreciation, aged inventory, budget control, costing, etc.)
(10) Other

All companies came to the conclusion that they needed to install modern information systems, and that this was at least part of the answer to their problem. This conclusion was reached after examining current trends in the marketplace, and after careful consideration of IT needs for their current or reengineered processes, their current IT systems (including hardware), and available IT solutions. The firms all reached several common conclusions about their existing systems that suggested a need for the implementation of new information technologies and ERP systems. We list some of these conclusions drawn by our study participants, as well as supporting research for each conclusion:

• The existing systems required multiple points of input and there was significant duplication, with the same data being entered at multiple points in the system (Davenport, 1998).
• The organization's information and manufacturing technology needs were not adequately being met by the existing systems (Chalmers, 1999; Cliffe, 1999).
• Maintenance and support for the existing systems required significant effort both in terms of time and human resources (Capron & Kuiper, 1998; Griffith et al., 1999).
• The enterprise had islands of information, and many of these systems were incompatible (Muscatello, Chen, & Small, 2003).
• Too much information was stored informally, and "fire fighting" and "expediting" had become the norm (Davenport, 1998; Dickey, 1999).
• In too many instances, employees were unable to respond easily and quickly to questions or information requested by key cus-

tomers or suppliers (Escalle et al., 1999; Jenson & Johnson, 1999).

The companies expected the ERP systems to provide the required crucial links between factory floor operations and information requirements across all the support functions of the business. The fact that these systems could also be extended to cover partners in the supply chain was also appealing to these companies. The decision to implement ERP was also due, in large part, to the influence exerted by corporate management.

Although all eight companies felt that their "needs assessment" efforts helped them to configure and select ERP systems that would provide a good fit with their operations, it is clear from the postimplementation respondents that "needs assessment is ongoing in an ERP project." The six firms who had some success with their ERP implementation added additional hardware and/or software after the project "go–live" date. In two instances, the main information systems had to be upgraded due to an unforeseen increase in the usage of the system. Also, five firms (A, B, C, E, and G) decided to install additional modules and/or peripheral devices such as radio frequency (RF) controllers, advanced planning modules, payroll systems, electronic data interchange (EDI), and Internet electronic commerce capabilities. These additional tools were deemed unnecessary or too costly at the beginning of the project. However, after implementation, the value of these technologies was uncovered, and they were subsequently added to the business system.

Proposition 3: A firm's ability to successfully implement an ERP solution requires an ongoing assessment and implementation of technical and functional capabilities beyond the initial scope of the ERP project.

In all eight cases, the manufacturing-marketing interface became much more scrutinized after the implementation of ERP. Current research shows this to be an issue in many organizations (Calantone, Droge, & Vickery, 2002;

Parker, 1999). Our study found that the implementation of an ERP system magnifies the diverse perspectives and motivations of manufacturing and sales.

The causes for this increase in potential conflict arise from a variety of factors. First, there is an increased scrutiny of inventory investment since it is one of the leading cost-reduction areas used to justify the implementation. Second, salespeople are rewarded for increasing volume, and this was a project justification factor for all but firm C. In six firms (B, C, D, F, G, and H), manufacturing and sales did not have common performance measurements or goals. Manufacturing was judged on labor cost models, leading to a big run size, lowchangeover philosophy. The sales function was judged on total sales dollars and gross margins, leading to a high stocking philosophy. It was also observed that in five firms (A, C, D, F, and H), there was no formal notification system of changes to the sales plan such as incentive programs, advertisement, and so forth. This led to inventory spikes and stock-outs due to the manufacturing's mandate to lower inventory.

Our study found that postimplementation issues between manufacturing and sales were resolved in several ways. First, five firms (A, B, C, E, and G) created joint performance objectives for all levels of management in the areas of manufacturing and sales. The manufacturing managers had a review component consisting of total sales dollars, gross margins, lost sales, and customer complaints related to customer-service delivery issues. The sales managers had a review component consisting of total inventory dollar investment, schedule changes after freezing the master scheduling, and activity-based product costing. As one executive from firm E described it, both manufacturing and sales had "skin in the game." The same five firms (A, B, C, E, and G) all felt that after they implemented joint performance measurements, manufacturing and sales worked in greater harmony and morale increased in both groups.

Proposition 4: Firms that use ERP functionality to improve performance objectives shared by manufacturing and sales will strengthen the manufacturing-sales interface.

Firms (A, B, C, E, and G) who relied on product forecasts took an integrated role to forecasting. The sales managers were given a forecast variance, plus or minus, that they were expected to adhere to. Manufacturing managers were required to meet the forecast, plus or minus variance, without raising product costs. This created a measurement system that both manufacturing and sales had input into, and the consequences were established. This performance objective helped minimize the after-the-fact arguments between manufacturing and sales.

Proposition 5: Firms that use ERP functionality to create relevant performance objectives for sales forecasting will strengthen the manufacturing-marketing interface.

In summary, the extended theory of ERP implementations reveals that the processes changes forced by an ERP implementation, if acted upon, will strengthen key interfaces and improve the general communication between manufacturing and sales.

Proposition 6: ERP functionality will strengthen the manufacturing-sales interface and increase morale in both areas.

Six firms (A, B, C, E, F, and G) found that the implementation of an ERP system had a dramatic impact on purchasing's role in the corporation, regardless of whether the firm had a centralized or decentralized purchasing function. Five firms (A, B, C, E, and G) reported that the increased pressure to reduce total inventory dollar investments and total product costs caused a greater role for purchasing. In six firms (A, B, C, E, F, and G), purchasing went from a quasiclerical function to a highly skilled pro-fessional function because of the emphasis placed on material requirement plans, just-in-time deliveries, and the increased cost of material shortages due to the minimization of raw and component inventory.

Six firms (A, B, C, E, F, and G) agreed that purchasing's role became more strategic after the implementation of the ERP system because of the overall impact to the effective management of the supply chain, and the direct impact to product costing, financial performance measures (inventory turns, etc.), and shop-floor disruption costs.

Proposition 7: Purchasing's strategic and tactical value increases with the implementation of an ERP system

Interestingly, those same six firms (A, B, C, E, F, and G) showed an increase in the amount of time purchasing managers were involved in marketing, financial-, and operations-planning meetings. This also corresponded with an increase in participation from nonpurchasing managers in purchasing meetings, creating more formal integrated purchasing teams. This is interpreted as further proof that purchasing's strategic and tactical value increases with the implementation of an ERP system.

Proposition 8: The Use of Integrated Purchasing Teams Increases with the Implementation of an ERP System

CONCLUSIONS, IMPLICATIONS AND FUTURE RESEARCH

Many researchers have argued that firms implementing ERP systems would benefit from a better understanding of how to implement an ERP system and how will it change their business. This paper conducted an intensive review of OM current literature, academic and practitioner, to determine what theories have been established, and to create groundwork for managing the case studies. We purposely stayed away from areas that have been researched in an attempt to provide new insight

into the transforming that takes place with an ERP implementation.

While this study is exploratory in nature, the results provide a number of insights that contribute to ERP strategy research and practice. Current ERP theories showed a strong link between the amount and level of ERP training and implementation success. Our findings conclude that training and education cannot be shorted even after the "go live" date of an ERP implementation. Also, firms implementing ERP systems must realize that future employees will have to have a significantly greater skill set than previous employees, and that human resources must react to the change. Second, the study demonstrates that there is no single, proven path that a firm can take regarding hardware, software, and other functional capabilities. Each firm has to remain flexible after the "go live" date, and tune the technical and functional capabilities of the system. Also, a firm should remain flexible and be willing to revisit current processes to establish a better fit between business processes and the hardware and software technology. This point builds upon the findings in OM literature that strong project management skill sets are required for success.

The third conclusion is the suggestion that an ERP system will increase the harmony between manufacturing and marketing. To receive business benefits from an ERP system, manufacturing and marketing need to understand that they both strongly influence the likelihood of success. While this perspective is advanced in the emerging manufacturing strategy literature, it is not found to be uniformly prevalent in practice (Hausman, Montgomery, & Roth, 2002). Hence, firms should strive to increase the harmony between manufacturing and marketing, by integrating performance metrics, to achieve the benefits of ERP.

Fourth, this study highlights the increasing strategic and tactical role purchasing is responsible for in the new supply-chain models. The implementation of an ERP system should increase the visibility and authority of current purchasing managers and their processes, and elevate the need for cross-functional purchasing teams. This is a solid contribution to the emerging practice of strategic purchasing.

Despite the merits of this study, it has certain limitations that should be recognized. First, the study is exploratory and introduces new concepts that need to be verified by further research. Second, we examined only eight companies, and it limits our responses. This research should spawn studies that examine different contextual factors such as SIC codes, firm size, and international firms, amongst others, which may find different results.

Clearly, the effects of an ERP system need to be studied further, especially in light of its pervasive system of choice among operation and service organizations. In summary, this study calls for the extension of current research, and identifies new areas of interest for both researchers and practitioners interested in ERP.

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