Chapter XV
ERP Usage in Practice:
An Empirical Investigation

Mary C. Jones
University of North Texas, USA

Randall Young
University of North Texas, USA

ABSTRACT

This study presents the results of an exploratory study of Fortune 1000 firms and their enterprise resource planning (ERP) usage, as well as benefits and changes they have realized from ERP. The study empirically examines ERP in these organizations to provide insight into various aspects that firms can use to evaluate how they are managing their ERP systems. Findings provide information about functionality implemented, extent to which benefits are realized, extent of ERP-related organizational changes firms have realized, and the way firms measure ERP success. The study also addresses the extent to which various types of ERP software have been implemented and whether there is a relationship between type of software and benefits. Finally, it examines ERP-enabled change in light of organizational configuration.

INTRODUCTION

Enterprise resource planning (ERP) is a tool that enables organizations to streamline operations, leverage common business processes, and manage multiple operations, and is implemented through an integrated suite of software modules and a centralized database (Jacoby & Bendoly, 2003; Scott & Kaindl, 2000). Although the term ERP may be used to represent a variety of concepts, in this article, the term is used to constitute the seamless integration of processes across functional areas with the standardization and integration of various business practices in order to manage operations more effectively and to gain an overall view of the business (Boudreau & Robey, 1999; Jacobs & Bendoly, 2003; Mabert et al., 2000).

The transition to an enterprise resource planning framework is often a long, difficult, and

costly process due to the nature and complexity of ERP systems. Many firms are grappling with the tradeoff between the costs of implementing an ERP system and not having one (Stedman, 1999). For example, some have come to believe that "competitively and technically it's a must-do, but economically there is conflicting evidence, suggesting it is difficult to justify the associated costs, and difficult to implement to achieve a lasting business advantage" (Willcocks & Sykes, 2000, p. 32). However, in spite of many failures reported (Davenport, 1998; Kransner, 2000), there are many success stories, suggesting that if properly managed, organizations can and do realize significant benefits from ERP (Davenport, Harris, DeLong & Jacobson, 2001).

With the abundance of conflicting information and the seeming propensity to report failures rather than successes in the literature, many firms that have not implemented may still be wondering whether ERP is right for them and whether the benefits touted by ERP vendors exist. Others that have implemented may be wondering if the benefits and changes they have achieved are consistent with that of other implementers and whether ERP was worth the effort. The purpose of this study is to examine empirically the organizational usage of ERP in order to provide insight into various aspects of usage that firms can use to evaluate their own ERP usage and what they are gaining from ERP. Although there is much empirical and descriptive work about ERP, there is little that assesses ERP after implementation is complete (Sarkis & Sundarraj, 2001). Although the former research provides valuable insights, it often overlooks the final and longest stage of ERP life in which firms begin to realize the impact of ERP. Much of what is known about ERP may only be a reflection of the state of ERP at or immediately after implementation. However, senior IT and business managers believe that the integration and usage of enterprise systems is one of the most important issues that they are now facing (Luftman & McLean, 2004). Much post-implementation ERP research provides mixed evidence about ERP's impact on overall organizational performance (Hitt et al., 2002; Hunton et al., 2003; Poston & Grabski, 2001). However, there is a need to explore the impact of ERP at various organizational levels, at the individual level, and at the ERP functionality level (Gattiker & Goodhue, 2002, Hitt et al., 2002). Thus, additional research that extends knowledge about post-implementation ERP is valuable.

The fundamental research question underlying this study is what is the state of post-implementation ERP in terms of benefits and changes organizations are able to realize? In answering this question, this study provides information about the extent to which benefits are realized, the extent of ERP-related organizational changes that firms have realized, and the way firms measure ERP success. It also addresses the extent to which various types of ERP software have been implemented and the relationship between the type of software and benefits. Finally, it examines ERP-enabled change and benefits in light of organizational configuration.

The rest of the article is organized in six sections. One is a discussion of the background for issues and questions examined followed by a brief discussion of the methodology for the study. A profile of respondents is presented in the fourth section, and data analysis and results are presented in the fifth section. The sixth section presents conclusions, implications of findings for practitioners, and directions for future research.

BACKGROUND

Firms implement ERP to help them integrate business processes and to share common resources across the organization (Zheng, Yen, & Tarn, 2000). ERP helps to do this through sets of integrated modules that allow companies to manage multiple operations from a standardized platform (Boudreau & Robey, 1999). At the time of this

study, SAP AG® held the largest market share in ERP software, with PeopleSoft®, JDEdwards®, Oracle®, and Baan® following[1]. ERP software provides modules to support all or most functional areas in an organization, including financial operations, purchasing, materials management, project scheduling, human resources management, production planning, and plant maintenance. Some software packages provide a comprehensive set of modules, whereas others provide a more limited set designed for optimizing the management of particular aspects of the organization (Scott & Kaindl, 2000). As a result, some organizations adopt functionality from various ERP software vendors in an effort to put together the best overall set of functionality, sometimes referred to as a best-of-breed strategy (Krumwiede & Jordan, 2000). However, this strategy can lead to integration problems and may result in lack of benefits if the software from various vendors is not compatible (Menezes, 1999; Palitza, 2001). There also seems to be conflicting evidence as to the extent to which firms adopt best of breed. Thus, we wondered both what functionality and what software packages firms are adopting and the extent to which they are following a best-of-breed approach. It is difficult to get a good picture of this aspect of the state of ERP implementation today because there are few, if any, articles that provide all this information in one study. Issues about software in use could become particularly relevant as ERP vendors begin to merge and as firms are forced to fewer sources for new software, upgrades to existing software, and support.

Regardless of the ERP software, firms implement them in order to achieve benefits, the most common being overall cost savings and, specifically, reduced cost of operations (Bingi et al., 1999; Hitt et al., 2002). ERP offers the potential for many beneficial organizational changes across many areas of the firm, including strategy, technology, culture, and organizational structure (Al-Mashari & Zairi, 2000; Murphy & Simon, 2002). Specific changes include reduction in silo behavior, inte-

gration of processes, greater collaboration and teamwork, and broader knowledge of employees about tasks and processes (Baskerville et al., 2000; Palaniswamy & Frank, 2000). However, it is difficult to determine the extent to which these benefits are realized, because even when success stories are reported, there is little evidence about the extent to which investments in ERP are paying off (Shang & Seddon, 2002).

Research indicates that far less than one-half of firms that have implemented ERP use metrics to assess their investment (Bradford & Roberts, 2001). More recent research indicates that the number of firms using standard financial metrics to assess ERP, such as return on investment (ROI), is larger than this (Mabert et al., 2003). However, approximately 30% of firms do not perform any type of capital investment analysis on their ERP systems beyond those performed for the initial justification of ERP at the time the system is purchased (Mabert et al., 2003). Because there are widely varying reports of ERP success and failure, and because financial metrics are the standard way that firms evaluate other investments, we believe that it is important for firms to understand the extent to which this is applied to ERP and to think through whether they should apply them to their own ERP investments. Thus, we examine not only the extent to which benefits are realized but also the extent to which firms measure ERP benefits and the types of metrics they are using in order to provide a clearer picture of how and whether firms are assessing ERP investments.

It is also important to understand what impacts the extent to which firms realize benefits. This study examines two key factors that may impact the benefits of ERP implementation: software type and organizational configuration. The ERP packages on the market today evolved out of responses to specific market or organizational needs (Welti, 1999). Some firms have sometimes found it difficult to adapt the products to their own specific needs, even though vendors have revised and expanded the scope of their offerings

(Jones, 2001). A recent anecdotal experience of the authors is an adaptation of an ERP product originally targeted for human resource management in a university environment to support everything from human resource management to student enrollment and admissions. Although the product works well, there were a number of configuration and training issues that had to be resolved in the adaptation of the product to another environment that may or may not have been present if it was adapted to only the human resource facet of the university.

Given that the software products represented in this study are the most widely adopted across industries, it is reasonable to assume that some firms may find differences in their abilities to realize benefits because of differences in the match between their business structures and the ERP software. In spite of the fact that ERP requires organizations to adapt their business processes to the practices embedded in the software, it seems that not everything will port equally well. Therefore, we explore the following proposition about the relationship between software type and a firm's ability to achieve expected benefits:

P1: ERP software type influences the extent to which a firm achieves ERP benefits.

Organizational configuration also may influence the extent to which a firm realizes ERP benefits (Hanseth, Ciborra, & Braa, 2001; Mezenes, 1999). Firms that do not consider fully the impact of their organizational configuration when they implement ERP may implement systems that do not adequately integrate their data and processes (Markus, Tanis, & van Fenema, 2000; Soh et al., 2000). Some organizational configurations are not suited for organization-wide deployment of a single ERP instance (Gattiker & Goodhue, 2004). Other configurations do not facilitate significant enough changes for firms to realize ERP benefits. In addition, firms often implement ERP

with changes to their organizational configuration in mind (Gattiker & Goodhue, 2000). Thus, we explore the following propositions:

P2a: Organizational configuration influences the extent to which ERP benefits, in general, are realized.

P2b: Organizational configuration influences the extent to which organizations are able to make changes after ERP implementation.

METHODOLOGY

The data for this study were collected using a mail survey in a field study during the summer of 2003. Fortune 1000 firms comprised the sampling frame. Because there are few published validated scales that specifically address ERP issues, the survey questions were derived from findings about the constructs of interest in the ERP literature (Jones & Price 2001, 2004; Shang & Seddon, 2002). Questions 1 through 8 and question 26 were checklist questions, where respondents were asked to check which response(s) best applied to them. Questions 9 through 25 were measured with a five-point Likert scale ranging from strongly disagree with the statement (response = 1) to strongly agree with the statement (response = 5). See Appendix A for questions used to measure constructs and demographics in this study.

Surveys were mailed to upper-level managers responsible for the information technology function of their organization, as indicated in a database obtained from Fortune. These respondents were chosen because these individuals have been shown to be appropriate respondents about organization-wide change efforts that depend on information technology (Terziovski et al., 2003). However, in some cases, this executive might not have direct knowledge about their firm's ERP. We asked them in the survey cover letter that if

this were the case to forward the survey to the individual who was most directly involved in ERP management at the senior level.

Fortune 1000 was selected as the sampling frame for several reasons. This study examines a variety of ERP issues. Thus, one criterion for a sampling frame was one that contained firms that have completed large-scale implementations, where a variety of functionalities was implemented across divisions of the organization. Both the scope and cost of this type of implementation suggests that the study should draw upon large firms. The Fortune 1000 database is a listing of information for the 1000 largest companies in the U.S., which is compiled and maintained by the publishers of the business magazine, *Fortune*. It includes companies with yearly revenues in excess of $1 billion U.S., and thus fits this criterion. In addition, we were interested in gathering data about a variety of software types. Because some software is more suited to one or more given industries, another criterion was to choose a sampling frame that is representative of a variety of industries. Fortune 1000 also meets this criterion. Finally, we wanted to select a group in which a large percentage of firms are using ERP. It is estimated that more than 70% of Fortune 1000 companies have implemented ERP systems (Barker & Frolick, 2003), thus meeting this criterion.

Of the 1000 surveys mailed, 70 were returned, representing a 7% response rate. Of the 70 returned surveys 20 were discarded because the contact person was no longer there, and either the company returned the survey unopened or the organization has a policy of not responding to surveys. Extrapolating the 20 out of 70 unusable surveys to the population indicates that 285 of the 1000 firms surveyed may fall into one of these categories. Using the remaining 715 as the population, the 50 usable surveys still represent a 7% response rate. Several companies telephoned the authors to indicate that they did not respond to surveys, and others returned the surveys unopened with a stamp on the envelope indicating the contact person was no longer there. One telephoned to say that they were filing for bankruptcy protection and would not be responding.

One explanation for the low responses rate is the general difficulty of getting responses from executives at that level of the organization and a decline in the response rate of surveys, in general (Hambrick, Gelekanycz, & Frederickson, 1993). This response rate is consistent with those in other exploratory studies of post implementation ERP (Mabert et al., 2003). In the last several years, there has been more demand on executive time for information from academia, industry analysts, external stakeholders, and internal surveyors (Eisenhardt, 1989). Although there are a number of techniques for improving response rates, such as offering incentives, follow-ups, and telephone calls, these techniques have been shown to be relatively ineffective in mail surveys of executives at this level (Cycyota & Harrison, 2002). Thus, we did not use these techniques. Although a higher response rate is desirable, this sample does provide a set of response on which we can base an exploratory assessment of the constructs of interest.

However, assessment of non-response bias indicates that these respondents represent a cross-section of ERP adopters in this sampling frame (the Fortune 1000 companies). Non-response bias was assessed on the basis of two indicators: number of ERP users in an organization and the number of ERP modules implemented. Research suggests that these may be better indicators of the size of an ERP implementation than more traditional organizational size measures (Francalanci, 2001). Very large organizations that implement a broad scope of ERP functions may do so only for one or two business units that represent a smaller percentage of the total company size (Jones & Price, 2004). For example, a firm might have several thousand employees yet only implement in one division that have just several hundred employees. Furthermore, research indicates that ERP implementations are not substantively different

among large firms that are defined as having over $1 billion U.S. in annual revenue (Mabert et al., 2003). This is the size of all the firms in our study. Although there may be a variety of reasons for this finding, one is that organizational size may not be sufficient to capture differences. Other findings that there are differences in the ERP implementation experiences of large firms lends support for this (Hebert & Oppenheim, 2004; Songini, 2003; Swanton, 2003). These respondents represent a broad range of size of implementations in terms of number of users (Table 1). Roughly, they are equally distributed across five categories of size, although there is a somewhat larger percentage in the *less than or equal to 500 users* category (27%) than in the others.

Another indicator of ERP size is the number of modules (functionality) implemented (Francalanci, 2001). Because we are comparing across ERP packages and because ERP packages achieve functionality in varying degrees of submodules, we confine our assessment of functionality to the general modules (e.g., financial accounting, materials management, etc.) rather than drilling down into submodules such as master data, general ledger, or inventory control (Francalanci, 2001). The majority of our respondents (69%) have implemented between four and nine modules of functionality (Table 1). Another 21% has implemented 10 or more modules. Therefore, it appears that they represent a broad range of implemented functionalities. Because the sampling frame is comprised of large firms, it is not surprising that few have implemented only one, two, or three modules. Given the range of ERP users and modules implemented that are represented here, this distribution of respondents is believed to be representative of the sampling frame.

PROFILE OF RESPONDENT FIRMS

Because the unit of analysis is the organization, a profile of respondent firms is provided in order to help clarify the lens through which findings are interpreted (Table 1).

Not surprisingly, almost all respondents have implemented the financial accounting and purchasing functions. This is consistent with evidence that accounting and purchasing are the two areas over which firms desire to gain the greatest control. Other functions that have been implemented widely include controlling, asset management, materials management, human resource management, and data warehousing. To achieve this functionality, a larger percentage of respondents (40%) use a combination of software types than individual packages. However, only 18% indicated that they chose the functionality in their packages based on best-of-breed criteria. Among respondents who do use a single software type, SAP is the one used most (30%), followed by PeopleSoft at 18%.

The majority of respondents had implemented ERP at least two years prior to the study. Years of use is roughly equally distributed between two to three years, three to five years, and more than five years. Furthermore, approximately 30% have done one upgrade, 23% have done two upgrades, and 21% have done three upgrades since the initial implementation. This is not unexpected, given the length of time that ERP has been in use in these firms and the relative frequency with which some software companies add new features to their product. These demographics indicate that respondents are from firms with moderate to substantial experience with ERP and that it has been in place long enough for them to have realized benefits and made ERP-related changes.

DATA ANALYSIS

General Benefits and Software Package

Respondents indicated that benefits of ERP have met but not exceeded original expectations (Table

Table 1. Profile of respondent firms

Number of ERP Users in the Organization	Percent of Respondents
Less than or equal to 500	27
Between 500 and 1000	17
Between 1000 and 2500	23
Between 2500 and 5000	15
More than 5000	18

Number of Modules Implemented	
1 to 3	10
4 to 6	31
7 to 9	38
10 +	21

Functionality*	
Financial Accounting (e.g., general ledger, accounts receivable, etc.)	98
Controlling (e.g., profitability analysis, product costing, etc.)	52
Asset Management (e.g., depreciation, planning/acquisition of capital assets, etc.)	76
Project Management (e.g., project planning, project tracking, etc.)	36
Sales and Distribution (e.g., customer order management, product pricing data, etc.)	48
Production Planning (e.g., master scheduling, bill of materials, etc.)	42
Materials Management (e.g., master inventory data, materials tracking, etc.)	64
Purchasing (e.g., requisitions, purchase orders, goods receipt, etc.)	98
Plant Maintenance (e.g., maintenance schedules, equipment histories, etc.)	34
Service Management (e.g., service contracts, warranty coverage, etc.)	16
Human Resources Management (e.g., time accounting, payroll, etc.)	70
Strategic Management (e.g., strategic planning and simulation, balanced scorecard, etc.)	14
Data Warehousing (e.g., central storage of business data, data retrieval, etc.)	50
Other (including Enterprise Portal, Warehouse Management, Trade Management, CRM)	10

* *categories not mutually exclusive*

Software Packages Used	
SAP only	30
PeopleSoft only	18
Oracle only	12
Baan only	0
JDEdwards only	2
Other only (Lawson, Adage, SSA/CT)	6
Combination (any combination of the above packages)	32

Amount of Time Since Implementation *	
Less than 12 months	14
Between 1 year and 18 months	8
Between 18 months and 2 years	4
Between 2 and 3 years	20
Between 3 and 5 years	22
More than 5 years	22

* *numbers do not add up to 100% due to missing values*

Table 1. Profile of respondent firms (cont.)

Number of Upgrades Since Original Implementation*	
0	18
1	26
2	20
3	18
5	2
10	2

* numbers do not add up to 100% due to missing values

Table 2a. Extent to which companies realize ERP benefits

Benefit Realization	μ*	σ
Benefits met original expectations	3.73 0	.92
Benefits exceeded original expectations	2.75 1	.00
Benefits revised downward after implementation	2.54 1	.45
Realized significant cost savings overall	3.54 0	.99
Realized reduced cost of operations 3	.67	0.85

Sample size = 50
* All responses measured on a scale of 1 to 5 where 1 = strongly disagree and 5 = strongly agree

Table 2b. Methods organizations use to evaluate ERP success

Method Used	Respondents*
Return on Investment (ROI) 5	8
Net Present Value (NPV)	24
Change in Return on Assets (ROA)	8
Other**	
Balance Sheets and Income Statement	2
Impact	2
Internal Rate of Return (IRR)	2
Getting Decision Support Information	4
Faster	2
Impact on Strategic Objectives	
Strategic Necessity	

Sample size = 50
* categories not mutually exclusive 24% reported using 2 or 3 measures
** listed by respondents

2a). Extent to which benefits are realized was measured using a five-point Likert scale, where 1 is strongly disagree that they have realized the benefit and 5 is strongly agree that they have realized the benefit. These benefits have been realized in the form of cost savings overall, particularly in terms of reduced cost of operations. Furthermore, it does not appear that respondents simply are reporting their perceptions of whether benefits and savings are there. Table 2b provides insight into the extent to which respondents report using various tools to evaluate ERP success. Note that these questions address benefits in general. More specific benefits/changes that firms realized from ERP are addressed in detail in the following sections.

Well over one-half of the respondents (58%) indicated that they use ROI, and another 24% use

Table 3a. Analysis of variance results for assessment of relationship between realization of benefits and type of ERP software used*

Dependent Variable	F-value	p
Benefits met original expectations	0.35	0.7904
Benefits exceeded original expectations	1.90 0	.1429
Benefits revised downward after implementation	2.20 0	.1016
Realized significant cost savings overall	2.36 0	.0848
Realized reduced cost of operations** 7	.42	0.0004

Sample size = 50
* Wilks' Lambda for overall effect = 0.43, F = 2.62, p = 0.0021
** significant at α = 0.01

Table 3b. Mean and standard deviations of reduced cost of operations for each category of software type

Software Type	μ **	σ
SAP only 4	.00	0.76
PeopleSoft only	2.63 0	.74
Oracle only	3.50 0	.55
Combination* 3	.84	0.69

Sample size = 50
* As defined in Table 1
** Tukey's HSD test for differences of means indicates that the mean for reduced cost of operations is significantly greater for SAP only than for PeopleSoft only and that the mean for any combination of Software Type is greater than for PeopleSoft only at α = 0.05.

NPV to assess ERP success[2]. These are not mutually exclusive categories, because respondents may use more than one financial measure. In fact, 24% report that they use two or three measures. Again, this paints a somewhat different picture than reports that indicate that few firms have formal financial evaluations of their ERP system results after their initial justification for purchasing the package (Mabert et al., 2003).

Closer examination of benefits indicates that the type of software package used may play a role in the extent to which firms realize ERP benefits, particularly with regard to cost savings. A one-way analysis of variance (ANOVA) was used to examine the relationship between the software package and benefits. Results are shown in Tables 3a and 3b. Because of the small number of respondents in the JDEdwards only (n = 2), Baan only (n = 0), and other only (n = 4) categories, these were removed from analysis. The remaining categories were SAP only, PeopleSoft only, Oracle only, and any combination of software types. Because the sample sizes are unequal among categories, violation of the assumption of homogeneity of variance necessary for interpreting ANOVA results was a concern. Brown and Forsythe's test of homogeneity of variance was used because it has been shown to be best at providing power to detect variance differences (Conover, Johnson & Johnson, 1981; Olejnik & Algina, 1987). Results indicated that the assumption of homogeneity of variance held at α = 0.05 for all benefits variables except Benefits Greater than Expected (p = 0.00089). However, Welch's ANOVA, which is more robust to violations of the homogeneity of variance assumption than the standard ANOVA (Welch, 1951), provided results consistent with the standard ANOVA at α = 0.01 and α = 0.05. The standard ANOVA results are reported next and in Table 3a.

Table 4. Changes after ERP implementation

ERP Change	μ*	σ
Greater collaboration among functional areas in divisions	3.94 0	.63
Reorganization of processes	3.88 1	.11
Greater integration of processes across the organization	3.69 1	.08
Reduced silo behavior within divisions of the organization	3.67 1	.14
Reduced cost of operations 3	.67	0.85
Reduced silo behavior across the organization 3	.65	1.07
Greater collaboration across divisions of the organization 3	.63	1.05
Greater integration of processes within divisions 3	.50	1.29
People have a better view of the big picture	3.43 0	.89
More teamwork in the organization	3.41 0	.86
More projects that cut across divisions/functional areas 3	.22	0.96
Organization more receptive to change 3	.12	0.95
Easier to access resources in other areas for cross-cutting projects	3.00 0	.84

Sample size = 50
* All responses measured on a scale of 1 to 5 where 1 = strongly disagree and 5 = strongly agree

Wilks' Lambda for overall effect is significant at $F = 2.62$, $p = 0.0021$. This indicates that benefits differ among types of software used. Reduced cost of operations is the only benefit that varies significantly with software type at the $\alpha = 0.01$ level. Overall cost savings were not significant nor were the extent to which benefits were realized, exceeded, or revised downward. Thus, proposition P1 is somewhat supported. Note, however, that P1 addresses benefits in general. A more in-depth examination of specific ERP-related changes is provided in the section to follow. Tukey's Honestly Significant Difference (HSD) test for differences of means indicates that the mean for reduced cost of operations is significantly greater for firms using SAP only than for firms using PeopleSoft only, and that the mean for any combination of software type is greater than for firms using PeopleSoft only at the $\alpha = 0.05$ level (Table 3b). One explanation may be the discrepancy in the extent of functionality implemented across firms that chose different packages. Although it may be tempting to conclude that one software package is better than another, further assessment of our findings does not support that conclusion.

In this study, organizations that had only SAP implemented an average of 9.27 modules/functions, whereas those that had only PeopleSoft implemented an average of 4.67 modules/functions. The average was 4.83 for those using only Oracle and 7.17 for those using a combination. Firms that are using only PeopleSoft may not be realizing as significant a reduction in cost of operations because they have not implemented across a wide enough range of functions to do so. Therefore, rather than serving as an advertisement for a given vendor, these findings suggest that the extent of functionality implemented may be a key indicator of the benefits an organization realizes from its ERP implementation. Although at first this may appear to be tautological, many firms choose not to implement the majority of ERP modules available in a package. While their decisions may be based on a variety of factors, including resources, financial constraints, and current needs, the underlying philosophy of ERP is that it provides the capability to integrate the majority of processes organization-wide (Welti, 1999). ERP was not meant to be implemented piecemeal, and these findings suggest that ERP

Table 5. Factor analysis of changes after ERP implementation

	Factor 1	Factor 2	Factor 3	Factor 4
Factor Stats:				
Eigenvalue	2.97	2.42	1.69	1.63
% variance explained	22.86%	18.62%	13.00%	12.50%
Cronbach's alpha	0.84	0.73	0.41*	0.45*
ERP Change (factor scores in columns)				
Reorganization of Processes	0.84			
Greater Collaboration Among Functional Areas	0.78			
Better View of Big Picture	0.78			
Greater Integration of Processes Across the Organization	0.77			
Reduced Silo Behavior Across the Organization	0.51			
Easier Access to Resources in Other Areas for Cross-Cutting Projects		0.78		
More Projects that Cut Across Divisions/Functional Areas		0.76		
Reduced Cost of Operations		0.66		
Greater Collaboration Among Functional Areas in Divisions		0.61		
Reduced Silo Behavior Within Divisions of the Organization			0.81	
Greater Integration of Processes Within Divisions			0.75	
Organization More Receptive to Change				0.87
More Teamwork in the Organization				0.75

* Pearson product moment correlations were used for these two factors rather than Cronbach's alpha because they only had two items each. The correlations were each significant at a = 0.01. For factor 3, p = 0.0038 and for factor 4, p = 0.0013.

benefits are best realized when a greater number of modules are implemented. Further research is needed to compare the impacts of packages across equivalent scope of functionality implemented.

Specific ERP-Related Changes

In order to examine benefits more closely, we included questions on the survey that tapped respondents' perceptions of specific ERP-related changes in the organization (Table 4). The greatest changes include greater collaboration among functional areas within divisions and reorganization of processes. The least realized change is easier access to resources in other areas for cross-cutting projects. Thus, it appears that even though firms

are doing more integration of processes across the organization and reducing silo behavior, there still may be hoarding or guarding of resources within units. One explanation for this is that the collaboration and reorganization that firms have experienced have not been in place long enough to alter this type of behavior. Another explanation is that the reorganization has not been managed so that it impacts the deeper structure of organizational behavior. Thus, things may have appeared to change, but fundamentally they did not.

A closer inspection of these specific changes indicates that they may be grouped into distinct categories of change. For example, some relate to the organization as a whole (e.g., greater integration of processes across the organization),

whereas others relate more to divisions within the organization (e.g., reduced silo behavior within divisions). Much research about ERP-enabled change addresses the changes in terms of the impact of each change item or in terms of somewhat arbitrary groupings of items (Shang & Seddon, 2002). Although identifying specific items may provide useful guidance to managers, any given item or combination of items may not apply to every organization. A list of individual items also is not likely to be comprehensive, so that information about specific ERP enabled change may not inform our understanding of the impact of ERP as much as a validated grouping of items. Therefore, it seems best to examine individual items in terms of where they might fit in terms of larger groupings.

With this in mind, exploratory principle components factor analysis using Varimax rotation was used to determine whether and where these grouped together (Table 5). Factor analysis enables the reduction of a larger number of items to a smaller, more manageable, and perhaps more informative set (Hair et al., 1998). Factor analysis is a powerful tool for this, because it facilitates better assessment of the properties of sets of measures than simpler tools such as correlations. It not only allows assessment of the correlation among items but also uses the correlation matrix to derive factor loadings that represent the correlation between an item and the construct it is thought to measure. Although factor analysis does not directly constitute a test of construct validity, it does offer a way to construct an interrelated set of indicators meeting one of the conditions for construct validity—dimensionality. If one or more indicators measures more than one construct (i.e., the measure is multidimensional), then it is difficult to establish reliability, which is also a necessary component of construct validity. Thus, factor analysis provides a stronger basis on which to group items than either simple correlations or arbitrary groupings (Hair et al., 1998).

Although the sample size in this study is somewhat small, factor analysis can be conducted reliably when the number of items multiplied by four or five is equal to the sample size (Hair et al., 1998). Our set of 13 roughly meets these criteria. However, findings should be interpreted in light of this potential limitation.

Using a standard criterion of Eigenvalue $>= 1$, there appear to be four distinct factors that explain 66.98% of the variance. A factor solution that explains at least 60% of the variance is considered sound when the underlying data are drawn from or are based on human perceptions, as they are in this study (Hair et al., 1998). Cronbach's alpha is a commonly used measure of reliability. This measure addresses reliability through the internal consistency, or homogeneity, of the items (Kerlinger, 1986). Using Nunnally's criteria of 0.70, Cronbach's alpha indicates that the first two factors have adequate internal consistency (Nunnally, 1978). Their Cronbach's alphas are 0.84 and 0.73, respectively. The next two factors have only two items each; thus, Cronbach's alpha could not be used. However, the Pearson product moment correlations for these indicate that the items are correlated significantly within each of the two factors (0.41 and 0.45, respectively). Items were grouped into factors based on having factor scores of 0.50 and above within the factor and not having factor scores of 0.40 or above on any other factor (Hair et al., 1998). All of the items in each factor had factor scores above 0.50 for that factor and less than 0.40 for the other three factors. Furthermore, the items that load together seemed to be logically consistent. In other words, it seems to make sense that the items that loaded together did so. For example, the items that loaded on Factor 1 all seem to address issues at a broader scope of the organization than other factors. Thus, there is both statistical support and logical support for the strength of each of the four factors.

Factor 1 appears to measure items related to the organizational level, such as reducing silo

behavior across the organization and integrating processes across the organization. Factor 2 appears to measure items related the operational or functional level of the organization, such as *more projects that cut across functional areas* and *greater collaboration among functional areas*. Factor 3 is related more to the divisional level of the organization with the items *reduce silo behavior within divisions* and *greater integration of processes within divisions*. Factor 4 seems to be related more to the individual (e.g., reception to change and teamwork).

Relationship Between Organizational Configuration and Benefits/Changes

Organizational configuration refers to whether the firm is organized by centralized headquarters control, lateral control by divisions, headquarters coordination of operations, headquarters control of financials only, or total divisional autonomy (Markus et al., 2000). A profile of the organizational configuration at the time of ERP implementation is shown in Table 6.

The relationship between organizational configuration and realization of benefits is examined to assess whether a given configuration(s) is better suited to realize ERP benefits (P2a). In addition, the relationship between organizational configura-

tion and specific ERP-related changes is examined to assess the link between configuration and type of change (P2b).

A one-way analysis of variance (ANOVA) was used to assess the relationship between the five levels of organizational configuration and benefits. Again, unequal sample sizes among categories indicated a concern for violation of the assumption of homogeneity of variance necessary for interpreting ANOVA results. Brown and Forsythe's test of homogeneity of variance indicated that this assumption held at $\alpha = 0.05$ for all variables. Therefore, standard ANOVA tests were used to assess the relationships. However, Wilks' lambda for overall effect is not significant (F=1.32, p=0.1784). Therefore, organizational configuration is not related directly to the extent to which firms realize ERP benefits in general, and P2a is not supported.

Next, we assess whether organizational configuration is related to the specific type of ERP-related change that firms achieve. Brown and Forsythe's test indicates that the homogeneity of variance assumption holds for all variables except operational-level change (p = 0.0063). However, the Welch's ANOVA provided results consistent with the standard ANOVA at $\alpha = 0.01$ and $\alpha = 0.05$. Therefore, the standard ANOVA results are reported below and in Table 7a.

Table 6. Profile of implementations

Organizational Configuration at time of ERP Implementation*	Percent of Respondents
Almost all decisions made centrally by headquarters	26.53
Lateral coordination among divisions without a high degree of control from headquarters	22.45
Headquarter coordination of operations with high degree of autonomy at the division level	40.82
Headquarter control only at the financial level	6.12
Total divisional autonomy 4	.08

Sample size = 50
* 20% indicated they implemented ERP to achieve a different organizational configuration; of these, 80% indicated that the new configuration had been achieved, and 20% indicated that they were still working on the new configuration.

Table 7a. Overall analysis of variance results for assessment of relationship between ERP changes and organizational configuration*

Dependent Variable F	-value (overall)	P (overall)	Significant Difference on Individual ANOVAs
Organization-Level Changes 5	.04	0.0069 S	ignificant (F = 5.04, p = 0.0020)
Operational-Level Changes	0.56 0	.6901 N	ot significant
Division-Level Changes 0	.46	0.7624 N	ot significant
Individual-Level Changes 0	.30	0.8783 N	ot significant

Sample size = 50
* Wilks' Lambda for overall effect of organizational configuration = 0.57, F = 1.59, p = 0.0819

Table 7b. Mean and standard deviations of organization-level changes for each category of organizational configuration

Organizational Configuration	μ *	σ
Almost all decisions made centrally by HQ	4.00 0	.71
Lateral coordination among divisions without a high degree of control from HQ	4.07 0	.83
HQ coordination of operations with a high degree of autonomy at the division level	3.29	0.69
HQ control only at the financial level	4.00 0	.20
Total divisional autonomy 2	.30	0.14

* Tukey's HSD test for differences of means indicates that the mean for organizational-level changes is significantly greater lateral coordination among divisions without a high degree of control from HQ than either HQ coordination of operations with a high degree of autonomy at the division level and total divisional autonomy at a = 0.05.
The mean for organizational-level changes is also significantly greater for firms where almost all decisions are made centrally by headquarters than total divisional autonomy at a = 0.05.

Wilks' Lambda for overall effect is significant at F = 1.59, p = 0.0818. This indicates that change does differ among organizational configurations. Organizational-level change is the only change that varies significantly with organizational configuration (Table 7a). Tukey's HSD test for differences of means indicates that the mean for organizational-level change is significantly greater for firms that have lateral coordination among divisions without a high degree of control from HQ than either those with HQ coordination of operations with a high degree of autonomy at the division level and total divisional autonomy at α = 0.05 (Table 7b). Tukey's HSD test also indicates that the mean for organizational-level change is greater for firms that have almost all decisions made centrally by HQ than for those that have total divisional autonomy. Thus, P2b is supported. This is not surprising, because it is expected that highly centralized firms are focused on organizational-level change, whereas autonomous divisions are expected to be focused on change at the divisional level. Another explanation for this may be that some organizational configurations do not benefit necessarily from ERP at the organizational level. None of the firms in the HQ control only of financials or in the total divisional autonomy configurations indicated

that they had plans to change their configurations. Thus, it is not surprising that these highly decentralized, autonomous firms are less focused on organizational-level changes than ones with more centralized or integrated configurations. However, this does not mean that the former do not benefit from ERP, just because they are not changing and integrating their entire organization around a single package. This is partly supported by the findings that there was no difference among configurations on either the organizations' abilities to realize benefits in general or on the realization of change at the operational, divisional, and individual levels.

CONCLUSION, FUTURE RESEARCH, AND IMPLICATIONS FOR PRACTICE

This study provides an exploratory assessment of ERP usage in large organizations from a cross section of implementation size. Factors examined include both the extent to which overall benefits are realized and the types of changes firms are realizing from ERP, as well as the relationship among benefits/changes and organizational configuration. Findings provide several implications that both support and extend what is known about ERP. However, one caveat in interpreting these findings is that they should be interpreted in light of a small sample size. Another caveat is that this was an exploratory study; therefore, the findings should be interpreted as starting points, or thought provoking ideas, for future exploration.

Limitations and Directions for Future Research

One limitation of this study is that it provides only one perspective in each organization—that of either the CIO or the senior ERP manager. One avenue for future research is to examine the issues raised in this study from multiple perspectives.

For example, an examination of the perspectives of users from a cross section of functional areas or business units in addition to that of managers may be useful. Another avenue for future research is to assess the various types of changes (as illustrated in Table 5) across industries or perspectives in order to determine both the antecedents of them and the conditions under which they are influenced most. Another limitation is that the organization is the unit of analysis. Our findings suggest that there are differences in ERP-enabled changes among various levels of the organization. Therefore, an examination of the constructs in this study using either the levels suggested in this study or others, such as business units or processes, may provide deeper insight into ERP usage. Furthermore, a cross section of users, line managers, and executives could be surveyed within each level of analysis. Another avenue for future research is to do a cross-industry comparison of ERP usage with an emphasis on whether there are differences among organizations based on software packages and the extent to which the package was implemented.

Implications for Practice

However, regardless of the limitations, this study does extend our current knowledge of ERP usage. It confirms some intuitive and/or widely accepted knowledge about ERP, and it provides some nonintuitive or surprising insights. One of the more widely held conclusions that is supported by these findings is that the largest percentage of functionality implemented is for financial activities and for purchasing. Although this finding may seem trivial at first, it does have implications for practice. The information we hold largely about the functionality implemented is based on the early days of ERP implementation before it became as widely used as it is today and when reports of ERP focused largely on what was being done rather than on the long-term impacts. One might expect that as ERP has matured as a technology,

and as more and more firms have adopted it, they might be using it more for management activities such as strategic management or to integrate project management across the organization. The implication for practice is that although the breadth of ERP usage has increased, perhaps it is not being used as deeply as it could be to attain even greater benefits.

Another finding that is consistent with current knowledge about ERP is the extent to which various packages are used. However, although some ERP packages are used more widely than others, they are not necessarily better in terms of the benefits a firm is able to realize with them. The number of modules implemented may be a better indicator of the ability to attain ERP benefits. One lesson for practitioners from this is that the extent to which they are able to integrate and leverage key processes may impact the success of the ERP more than choosing a popular package. An implication is that if they are not realizing the benefits they expected, then they may need to assess their benefits in light of the extent of the integration that their implementation allows.

One finding that does not support widely held beliefs about ERP is that a substantial number of firms are using traditional financial metrics such as ROI or NPV to assess the investment they have made in ERP. One lesson for practitioners that arises out of this finding is that organizations find these metrics important. An implication from this is that if other firms are assessing their ERP investments in this way, then they may have a different, perhaps more measurable, view of ERP that could give them an advantage in managing it.

Another finding is that realization of benefits is not tied to organizational configuration; any configuration can realize benefits from ERP. However, organizational configuration may influence the types of changes that an organization can affect with ERP, if those changes are viewed at different levels of the organization. One level that seems particularly impacted by configuration is the or-

ganizational level. One lesson for practitioners is that ERP may not be a one-size-fits-all solution. An implication of this is that if a firm is not able to bring about the changes it believed it would, it may do well to examine these changes in light of its organizational configuration. Another implication is that firms may need to look more closely at where ERP is affecting change and benefits. Perhaps some failures are not necessarily failures at all but simply an indication that the changes and benefits that ERP enables are at lower levels or in different pockets of the firm.

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ENDNOTES

[1] SAP AG is a registered trademark of SAP AG in Germany and several other countries. Peoplesoft is a registered trademark of Peoplesoft, Inc., Pleasanton, California. JDEdwards is a registered trademark of J.D. Edwards World Source Company, Denver, Colorado. Oracle is a registered trademark of Oracle Corporation, Redwood, California. Baan is a registered trademark of Baan Company, Barneveld, the Netherlands.

[2] Return on investment (ROI) and Net present value (NPV) are commonly used financial ratios that allow for evaluation of investments in terms of the current value of future cash flows from the investment. NPV uses a rate of return determined by the company's actual cost of capital. ROI is the ratio of the net cash receipts of the investment divided by the cash outlays of the investment.

APPENDIX A

Questions to Measure Study Variables

1. Which of the following Enterprise Resource Planning (ERP) packages does your organization currently use?

❏ SAP ❏ PeopleSoft ❏ Baan ❏ Oracle ❏ JDEdwards
❏ Other (please specify) _____

If you checked more than one option above, please answer the following questions; otherwise, skip to Question 2.

1a. Did your organization choose functionality based on "best of breed"? ❏ yes ❏ no

1b. Is there one package that is predominant in your organization? ❏ yes ❏ no

1c. If you answered *yes* to 1b, please specify which one and answer the rest of the survey about that package _____

If you answered *no* to 1b, please answer the rest of survey about your overall use of ERP.

2. Which ERP functionality has your firm implemented?

❏ financial accounting (e.g., general ledger, accounts receivable, etc…)
❏ controlling (e.g., profitability analysis, product costing, etc…)
❏ asset management (e.g., depreciation, planning and acquisition of capital assets, etc…)
❏ project management (e.g., project planning, project tracking, etc…)
❏ sales and distribution (e.g., customer order management, product/service pricing data, etc…)
❏ production planning (e.g., master scheduling, bill-of-materials, etc…)
❏ materials management (e.g., master inventory data, materials tracking, etc…)
❏ purchasing (e.g., requisitions, purchase orders, goods receipt, etc…)
❏ plant maintenance (e.g., maintenance schedules, equipment histories, etc…)
❏ service management (e.g., service contracts, warranty coverage, etc…)
❏ human resources management (e.g., time accounting, payroll, employee evaluation, etc…)
❏ strategic management (e.g., strategic planning & simulation, balance scorecard, etc…)
❏ data warehousing (e.g., central storage of business data, etc…)
❏ other (please specify) _____

3. How long ago did you complete implementation of your ERP package?
❏ < 12 months ago
❏ 1 year to 18 months ago
❏ > 18 months ago, but < 2 years ago
❏ > 2 years ago, but < 3 years ago
❏ > 3 years ago, but < 5 years ago
❏ > 5 years ago

4. How many upgrades have you completed since the original implementation? _____

5. Approximately how many ERP users does your organization have? _____

APPENDIX A.

Questions to Measure Study Variables (cont.)

6. Which of the following best describes the configuration of your organization?

❏ almost all decisions made centrally by headquarters
❏ lateral coordination among divisions without a high degree of control from headquarters
❏ headquarter coordination of operations with high degree of autonomy at the division level
❏ headquarter control only at the financial level
❏ total divisional autonomy

7. Was ERP implemented to achieve a different organizational configuration?
If you answered *yes* to question 7, please answer the following question; otherwise, skip to question 9.
8. Has this been achieved?
❏ yes, for the most part
❏ no, we're still working on this
❏ no, we've decided either to postpone this or not to do at all

Please mark the choice that most closely describes your organization with regard to the following:
9. Benefits of ERP have lived up to original expectations
10. Benefits of ERP have been greater than we originally expected
11. We have revised our projected ERP benefits downward since implementation
12. ERP has enabled us to realize significant cost savings

Our organization has used ERP to
13. more tightly integrate processes across the entire organization
14. more tightly integrate processes within one or more divisions
15. reduce silo behavior across the organization
16. reduce silo behavior in pockets of the organization
17. reorganize processes (e.g., movement to purchasing by family of items)
18. reduce cost of operations
19. have greater collaboration across units
20. have greater collaboration across functions
21. place more emphasis on team efforts
22. be more receptive to change
23. make it easier to get access to people or resources in other units for projects that may overlap departments/functions
24. place more emphasis on projects that cut across functions/departments
25. place more emphasis on making sure everyone understands the big picture rather than just their own tasks

26. Which of the following do you use to evaluate ERP success?
❏ return on investment ❏ change in return on assets ❏ net present value ❏ not applicable
❏ other (please specify) _____