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Post-implementation practices of ERP systems and their relationship to financial performance

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ABSTRACT

Using econometric analysis, this study provides empirical evidence to support a cause-and-effect relationship of managerial actions to financial performance in a post-ERP implementation stage. Senior information systems managers reveal the state of affairs, providing a snapshot reference during that time period. Financial figures were collected for firms who were matched to our survey instrument. Regression analysis establishes that increased technological competence affects net sales, relationships with outside experts affect earnings, return-on-assets and return-on-investment, top management support affects net sales and net income, long-range planning negatively affects earnings, and the sharing of information between departments affects net income, return-on-assets and return-on-investments.

1. Introduction

A company implements an information system with the expectation that it will produce financial benefits and that these benefits can be maximized using proper managerial techniques. The accountability of investments in information systems is a frequent subject of study. Answers to the question of the return-on-investment in information technologies have created controversy because of the varied definitions of firm performance. One category of operationalization of firm performance, and the one used in this study, is defined in financial terms, thereby emphasizing the central question of whether the information system has improved profits and financial ratios. Because achieving success using Enterprise Resource Planning Software (ERP) is difficult, studies on ERP abound in various fields, ranging from the technological, operational, and strategic to accounting fields. However, there is a clear lack of empirical evidence of the cause-and-effect relationship between managerial practices that lead to the success of ERP systems and the financial returns of such systems [59]. This study contributes to the literature by providing empirical support for such relationships in a timeframe that encompasses a post ERP-implementation stage. This study considers the time necessary to exploit and receive financial returns following an ERP implementation project. There is a great need for continued improvement and assessment as ERP use evolves over time, and one of the most important issues in measuring ERP success is exactly when one measures it [36]. Hence, firms that adopt ERP systems must be concerned with success, not just at the point of adoption but also in post-implementation.

ERP systems require a great degree of coordination and complex technological infrastructure within a firm. While Top Fortune 500 businesses and multinational organizations initially adopted ERP, small- to medium-sized businesses (SMBs) around the world are now implementing this software. ERP, as the name implies, is an integrated system that meets the information needs of an entire enterprise. "Enterprise Systems" is a term used to describe systems that integrate data from different departments into one system and one database. They allow seamless integration of information flows and business processes and support information sharing for operational efficiency [33]. ERP systems have transformed organizational processes by streamlining planning with up-to-date data that are integrated across departmental lines that include production information and customer input [5]. Notwithstanding the sizable amount of ERP literature from an array of different perspectives, the level of understanding of how and why some companies succeed and some fail in their implementation of ERP is inadequate [49].

Studies indicate that ERP implementation is viewed as a project, which, by definition, has a beginning and ending date. Implementing an ERP system usually takes a little over one year

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[29]. Once implemented or live, the ERP project does not end. Rather, it continues indefinitely. Thus, research into post-implementation success is relevant. The belief that an ERP project is complete when the system goes live is common but misleading [49].

Few studies combine financial performance measures with managerial and organizational measures. Mithas et al. [38] developed and tested a theoretical model that measured the influence of the information management capability on financial results using the following financial metrics: revenue, profits, market position, cash-to-cash cycle time, and earnings per share in firms that had installed various enterprise systems, including ERP. The authors found a significant link between information management capability and financial results that was moderated by three management capabilities: performance management, process management, and customer management. However, other research has identified contradictory effects from ERP implementations. Furthermore, ERP systems have garnered many complaints because they demand organizational discipline and strict adherence to standardized processes. In general, information technology (IT) can come to be viewed by business leaders as either a liability or an asset [21]. Management that has experienced difficulty in establishing profitable IT strategies and is disappointed with the company's IT tends to perceive IT as a liability and may undervalue its importance to organizational growth. Alternatively, management that perceives IT as an asset tends to consider IT necessary to the organization's success and as a mechanism for transformation [21].

This study provides empirical evidence of the predictability of the financial performance of companies that exercise certain managerial actions recommended in the literature as key determinants for the successful implementation of ERP software. Our study focuses on the following constructs identified in the IS literature as predictors of ERP success: technological competence, relationships with outside experts or consultants, top management support, long-term planning and objectives, strategic direction, and the sharing of knowledge.

This paper proceeds as follows. Section 2 provides a literature review and synopsis of ERP performance measures and the factors that may lead to ERP success. This review serves as the basis for the research hypotheses in this study. Section 3 presents the research methodology used to test the hypotheses and includes a description of the financial ratios used as dependent variables for the five regression equations used in this study. Section 4 analyzes the data and offers the results, and Section 5 discusses those results. A final section concludes the paper.

2. Literature review

2.1. Performance expectations

There are various performance expectations of the software that can be categorized into dimensions that follow the management pyramid categories: operational, tactical or managerial, and strategic benefits. These expectations are explained in detail so that a picture begins to form as to why ERP projects are purchased and implemented in organizations. The operational benefits of ERP software include efficiency measures of reduced turn-cycles in the elaboration of reports, swiftness in data sharing, and improvements in data quality due to reduced redundancies [45]. ERP is tied to cost cutting performances that lead to improved supply-chain efficiency, faster financial reporting, more visible data and a higher capacity for producing high-quality analytics and a process-centered mentality [45]. Additionally, ERP is noted for other efficiencies, such as reduced inventory, decreased labor costs, and faster financial closings. Managerial outcomes are derived from the improved decision making of managers, who can access comprehensive, up-to-date reporting mechanisms and drill down capabilities using ERP [49]. Managerial expectations include better resource management and better performance control [49]. In terms of the strategic dimension, the primary expectations of ERP software are that it support business growth through information sharing with suppliers, customers and other business alliances, reduce costs under a cost-leadership strategy or promote differentiation and increased sales through customer relationship modules and e-commerce capabilities. Qu et al. [44] suggest that an organization's long-term plans and decisions should be driven by the company's internal and industry dynamics that affect their strategic policies and implementation. A properly implemented ERP supports the strategic plan of an organization by optimizing its business processes and creating competitive advantages [1,9].

Frequently, we find that there is a distinction between the financial and non-financial benefits of ERP. Financial benefits are defined as those that have the ability to achieve profits, whereas non-financial benefits are intangible, such as customer satisfaction, product quality, and user satisfaction. Seddon et al. [47] developed a model outlining key organizational benefits in enterprise systems in both short-term and long-term timeframes in which they list integration, process-optimization, and improved access to information as key long-term benefits. Integration refers to the merging of information systems or making processes transparent and unifying data from multiple sources. Process-optimization has a strategic impact and is defined as an attempt to improve the efficiency and effectiveness of a process [47]. The third benefit, improved access to information, can be described as providing timely, accurate, and relevant information to decision makers [47].

2.2. ERP costs

The benefits of an ERP system are vast and enticing for CIOs. However, how well these benefits translate into financial gains for a company is controversial. ERP systems are costly, complicated, and require extensive planning to be successfully implemented, used, and exploited [4]. The expenditures associated with an ERP system include the purchase of software, hardware, network investments, and consulting fees [4]. Post-implementation adjustments are common. Although the costs differ for each company, the bigger the company and the more integrated the ERP system, the larger the expense [4]. In 2010, the mean ERP implementation cost was $5.48 million, and the average implementation timeframe was 14.3 months [29]. With so much time, money and human resources that must be invested, ERP projects pose significant business risks for organizations [24].

In project management terms, a successful project is defined as one that has a positive impact on the organization, is completed on time, and remains within the allotted budget [6,25]. It is surprising to find that many ERP investments are unsuccessful. Muscatello and Parente [39] believe ERP failure rates can be as high as fifty percent [6]. Only thirty-four percent of IT projects initiated by Fortune 500 businesses prove to be successful, and ERP implementation projects appear to have the same failure rate [6,40]. Fox-Meyer Drug, Mobile Europe, Dell and Applied Materials had unsuccessful and discarded ERP projects [6,13]. Other unsuccessful ERP ventures were recorded by Whirlpool, Hershey, Waste-Management, Inc. and W.L. Gore & Associates [6,54]. Brown and Vessey [7] explained that ERP project failure can ruin the entire business. Nelson [40] detailed how Nike's ERP implementation in 2000 created a major inventory problem that cost the company $100 million in profits. Bradley [6] concluded that ERP projects are very risky. Due to their comparatively high

failure rates, ERP systems may cause the organization to enter bankruptcy [4].

Nonetheless, the demand for ERP systems from SMBs continues to grow [6,17]. Regardless of the recorded problems encountered in ERP implementation, business investments in ERP systems increased from $20 billion in the 1990s [6,11] to $47 billion in 2001 [6,11]. According to Forrester Research, these investments are projected to reach $50.3 billion in 2015 [27]. Obviously, these companies see the long-term advantages of ERP investments but must ensure that the cost does not exceed the benefits to the organization.

2.3. Post ERP-implementation stage

Enterprise systems require business process reengineering (BPR), change management, and organizational learning. This emphasis that ERP places on BPR has changed the focus of IS's impact from operational to strategic [45]. Companies must focus on organizational adaptation in terms of process, structure and culture to exploit the ERP environment and manage the knowledge the system produces [34]. Thus, in ERP post-implementation, it is helpful to think in terms of organizational learning stages [18] or ERP life-cycle phases. These phases are referred to by Markus et al. [36] as the "project" phase, the "shakedown" phase, and the "onward and upward" phase. To extend into the "optimization" organizational learning stage or the "onward and upward" phase in the ERP life-cycle, where benefits are expected to manifest themselves, this study extends into the fourth year of the post-ERP implementation experience.

Web [57] examined the linkages between financial and nonfinancial performance measures as part of implementing strategic performance measures for companies and found that the cause-and-effect relationship between the two types of measures must be strong. Additionally, the relationship must be widely communicated to managers because the better the link that is established, the better the financial measurements will be. When the cause-and-effect link is evident, managers' confidence in their ability to successfully achieve financial goals will lead to a stronger commitment to those financial goals [57]. Wier et al. [59] used the cause-and-effect theoretical framework provided by Webb [57] to study the relationship between financial and non-financial measures in ERP usage in firms and confirmed that a manager should apply both financial and non-financial performance indicators and clearly establish the relationship between them because knowledge of the cause-and-effect relationship will improve corporate performance.

2.4. Financial performance

Zhu [60] observed that IT and company resources must work closely together because failure to do so could understate the impact of IT investments on financial measurements. Lee et al. [35] explained that organizational performance may be classified into two categories, nonfinancial and financial. They found that profitability ratios, such as return on assets (ROA) and return on investments (ROI), are two of the most commonly applied accounting indicators of financial performance.

Tam [52] used four financial ratios, ROA, Return on Equity (ROE), Return on Sales ROS), and Total Stockholder Return (TSR), in an economic analysis of IT investment on firm performance in four countries over a nine year period and obtained mixed results. Tam cautioned against using TSR because it measures future intent rather than historical data. Others have similarly used ROS, ROE and ROA to study financial performance in the implementation of ERP modules [23,41,51,59]. Stank et al. [51] found a positive correlation between ROA and relationships between suppliers and customers in their analysis of the supply chain management module.

Nicolaou [41] examined whether the implementation of ERP systems influences the long-term financial performance of a firm by comparing 247 companies that adopted enterprise-wide systems with a matched control group of non-adopters before and after adoption. Eight financial performance indicators, including ROA and ROI, were utilized to measure operational performance. Their findings indicate that the ROA differential performance was significantly higher for firms adopting ERP than for the control group four years after installation of the system. ROA performance for adopters was significantly worse in the year of and the year following installation. The results further indicate that in the year of and the year following system completion, ROI was negatively affected by ERP adoption. Two years after the system completion, a positive ERP effect on a firm's total ROI performance was observed.

Masli et al. [37] reviewed empirical studies published after 2000 that investigated the links between information technology investment and business value. The authors found that various performance variables were used in the studies. The following articles included ROA in their performance variables: Dehning and Richardson [14] indicated that ROA is often used as a measure of IT value. However, the authors explained that this broad type of organization-level performance outcome measure possesses several problems. These problems may include confounding economic and competitive factors, timing issues, and eliminating alternative explanations that may lower the financial results linked to the ERP investment. Hitt and Brynjolfsson [24] found no relationship between IT capital and ROA, resulting in an IT-productivity paradox discussion [58]. Kobelsky et al. [31] utilized operating ROA and ROS to measure IT budget levels and found them positively associated with organizational performance and shareholder returns. Shin [48] explored the interaction of IT budgets with strategic direction. He employed ROA, ROE, and gross margin (Revenue minus Cost of Goods Sold divided by Revenue) in his performance analyses and suggested that the interaction enhances the financial performance of a company, particularly gross profit (Revenue minus Cost of Goods Sold).

Aral and Weill [3] surveyed large publicly traded companies and analyzed their respective IT budgets using numerous performance variables, including ROA, net margin (Net Profit divided by Revenue), and cost of goods sold (COGS). Their findings indicate that investment in certain IT assets explains differences in organizational performance. Hendricks et al. [23] included ROA as one of the performance variables in their analysis of long-term returns and the earnings of firms investing in ERP, SCM, and customer relationship management (CRM) software. Their research points to improvements in performance for firms investing in ERP and SCM. Wang et al. [55] employed both ROA and ROI as their performance variables and suggested that IT outsourcing affects performance at the process level rather than at the firm level.

Fryer [16] described how Tec Labs employed ROI to measure the financial benefits of IT plans, highlighting the importance of identifying a metric that correctly measures performance. Fryer [16] argued that IT plans are similar to business plans. Cassidy [8] stated that the organization's technologies plan must analyze all of the company's processes to be capable of providing quality recommendations. Further, the plan should be measured with metrics that analyze efficiency and effectiveness. These metrics must support the mission, values, objectives, and strategic plans of the company. Wier et al. [59] devised an accounting-based and market-based formula combining ROA, EBIT, interest expense, corporate tax rate and average total assets as their dependent variable in their study examining ERP success.

2.5. Technological competence

In a survey conducted by Hasibaun and Dantes [22], a total of 234 executives in the process of ERP implementation revealed that technology infrastructure has a 38.4% role in determining the success of the ERP implementation project. The term "absorptive capacity" is used to describe the firm's reserves of relevant knowledge necessary to exploit new IT technologies. ACAP has been cited as one of the most important variables in the adoption of IT technologies [10,19,32]. An ERP system must be installed into the proper hardware/telecommunications equipment and operating system. Additionally, the database management systems software must be compatible with the ERP system and any remaining legacy systems [36], making the transition process technically complex. Therefore, the following hypothesis is proposed:

H1. Strong technological competence in a firm adopting ERP will have a direct effect on financial performance ratios.

2.6. Relationship with outside experts

Companies adopting ERP interact with many outside experts, including ERP vendors, vendors of ERP product extensions, vendors of supporting hardware, software and telecommunications capabilities, implementation consultants, and others [36]. Because of the adopting company's inexperience, the vendors can decide to make software modifications to tailor the ERP product in an early stage of implementation, later realizing that doing so was a mistake. An implementation consultant with vast experience can give useful advice and avoid such problems [36,42]. Defining a proper consultant for the project and the selection of such a person is important. The literature indicates that the consultant should be someone who possesses proper knowledge in the industrial field and the ERP system and who can help the company develop and implement a system aligned with its business needs. Thus, the following hypothesis is stipulated:

H2. A relationship with outside experts or consultants will have a direct effect on financial performance ratios.

2.7. Top management support

Top management support is the most frequently cited critical success factor in ERP implementation. Top management support emphasizes that it is necessary for management to provide emotional support by nurturing and maintaining a high level of employee morale and motivation. In fact, lack of employee morale and motivation is considered one of the most important factors in the failure of ERP projects [2]. However, the empirical evidence for top management support is inconclusive, and its relationship to the success of the ERP implementation is not always apparent. Law and Ngai [33], for example, found this variable to be statistically significant for business process improvements due to ERP but not statistically significant for IS user satisfaction. According to Law and Ngai [33], the concept of project champions is essential, and the champion's leadership status, such as that of the CEO, encourages the adoption of technology and change. Bradford and Florin also obtained mixed results, concluding that user satisfaction was a moderating variable between management support and ERP success. Although it is recognized that top management sets an example and provides focus and credibility to a project, the types of action by top management that constitute support vary. Sarker and Lee [46] found that a strong and committed leadership at the top management level and of the IS function is significant, but open and honest communication between them was not shown to support ERP success [46]. The following hypothesis was formulated to investigate this controversy:

H3. Engaged top management support measured by time, knowledge of project success and emotional support will have a direct effect on financial performance ratios.

2.8. Long-range plans and written objectives

Clear goals and objectives are essential to guiding the organization to a successful ERP implementation. As specified in the project management literature, successful implementation includes the development of both a work plan and a resource plan and careful tracking of the project. Amid et al. [2] separated the success factors of ERP projects into two categories: "The first category defines success or failure by focusing on select project factors, like project cost or time, while the second category defines success in terms of achieving implementation goals like integrating organizational information, better decision making, improving inter-organizational communications and decreasing operational bottlenecks" (p. 228). Thus, the following hypothesis was formulated:

H4. Long-range plans and written objectives will have a positive direct effect on financial performance ratios.

2.9. Strategic emphasis

To fully exploit the financial benefits of an ERP system, old processes of legacy systems must be changed. In fact, a firm must undergo intense change management procedures. A change-oriented model proposed by Grabski et al. [20] calls for strategic alignment and strategic management to adapt processes. Amid [2] concurred, stating that strategic requirement identification is an essential element of an ERP project. This study focuses on three strategies: promotion and advertising above industry average, new product development, and influence over channels of distribution. Seeking to determine whether financial returns are influenced by a firm's strategic focus, the fifth hypothesis is stated as follows:

H5. Knowledge of the strategic emphasis of a company will have a direct effect on financial performance ratios.

2.10. Increased sharing of information

Data integration and the sharing of information is a fundamental benefit of ERP systems. This is accomplished through a centralized data center for the entire firm, which allows each user direct access to all system information for which he has been granted access [20]. Thus, the following hypothesis is presented:

H6. The increased sharing of information between departments resulting from ERP will have a direct effect on financial performance ratios.

3. Methodology

The sample includes a set of 55 companies that implemented ERP before 2003 and have since been in the process of optimizing their use of ERP systems. The companies were selected from a larger sample of 264 companies that responded to this study's questionnaire, which asked about their organizational learning as a result of implementing ERP. Data were successfully matched with

a complete set of financial data dating one year prior to the recorded ERP implementation date to four years following their implementation date for 55 of these companies. The financial ratios were gathered from Standard & Poor's Compustat Database [50] and Thompson Reuters' DataStream [53]. The variables that were extracted from the database were Net Sales, Net Income before extraordinary items and preferred dividends, Earnings before Interest & Taxes, ROA and ROI. We selected these ratios for several reasons. ROA and ROI are the most obvious choice because they are frequently used in the literature. These ratios are commonly recommended for justifying investment in all software products, including ERP software. NS, NIB, and EBIT are not commonly used but we believe these factors are important to portray a complete picture. NS, NIB, and EBIT cross-validate the results but also add points of distinction due to the differences in the formulas that are used.

Accordingly, NS, NIB, EBIT, ROA and ROI were used in this study to gauge the financial success or failure of ERP implementation. We used data ranging from the year prior to the ERP software implementation to four years immediately following execution. Kallunki et al. [28] stated that ERP performance must be investigated over the course of several years because ERP is a long-term capital investment that affects the entire organization. Nicolaou and Bhattacharya [42] stated that ERP implementation is a strategic investment decision. Therefore, the payback will be experienced over several years. Over a three-year time span, Hunton et al. [26] found that ROA and ROI were significantly better for ERP adopters than for non-adopters of ERP. The long-term effect of ERP software is our particular interest. Thus, the literature indicates that four years is a reasonable amount of time to discover whether the implementation effort has been a financial success or failure.

Both measures, ROA and ROI, are available on Compustat, a commercial database that holds the financial data of numerous companies. As presented in Table 1, Compustat defines ROA as Income before Extraordinary Items-Available for Common (Stock) divided by the total assets, multiplied by 100 [41]. It is a measure for determining how a firm generates income utilizing its assets. However, this measure does not consider whether the assets were financed by credits or by shareholders. [56]. ROI is the sum of the Total Long-Term Debt, Preferred Stock, Minority Interest, and Total Common Equity [41] multiplied by 100 and is a widely used profitability measure that utilizes revenues, expenses, and invested assets in its computation [56]. The higher the ROI, the better the organization uses its assets to generate income. ROA measures the profitability of a firm's total assets [56].

We examined the change in various financial performance figures post-ERP implementation. Following the literature, this study applied the formulas shown below using a period of four years after the year of implementation. Four years is an adequate amount of time to achieve a positive return on investment in successful implementations. We agree with Nicolau [41] that, given the nature of ERP investments, performance benefits cannot be expected quickly. In other words, in evaluating the success of these investments, a longer time period must be considered [41].

Table 2
Dependent variables.

$$\Delta NS = \frac{NS_{i+4} - NS_{i-1}}{NS_{i-1}}$$
$$\Delta NIB = \frac{NIB_{i+4} - NIB_{i-1}}{NIB_{i-1}}$$
$$\Delta EBIT = \frac{EBIT_{i+4} - EBIT_{i-1}}{EBIT_{i-1}}$$
$$\Delta ROA = \frac{ROA_{i+4} - ROA_{i-1}}{ROA_{i-1}}$$
$$\Delta ROI = \frac{ROI_{i+4} - ROI_{i-1}}{ROI_{i-1}}$$

The formula for the percentage change in the dependent variables is the variable's amount four years after the year of ERP implementation $(i+4)$ compared to one year prior to the implementation $(i-1)$. The difference is then divided by the variable's $(i-1)$ amount. The formulas are explained in Table 2.

In 2003, an ERP post-implementation questionnaire was sent to top-ranking Information Systems executives, such as CIOs, operations managers, and information technology managers, at companies across the US and Canada who were reported to have implemented ERP software, according to the 2002 Directory of Top Computer Executives published by Applied Computer Research, Inc. The executives received a mailed invitation to participate and could do so by returning the mailed questionnaire or by accessing the questionnaire online. Non-respondents were those who were contacted but were unwilling to participate in the research. To ensure that the responses of those who did respond were representative of those who failed to respond, a wave analysis was conducted [12,15]. Once data were collected for the main study, non-response bias was determined by comparing the summated scores for a set of questions in the survey, including the satisfaction rating of early responses to subsequent responses using wave analysis.

The questionnaire contained sets of questions asking the executives to rate their technical and managerial capacity to absorb the ERP technology. Questions were asked about the post-implementation process. Several key indicators were present in the questionnaire to capture how much employees had learned how to use and exploit ERP to the benefit of the entire organization, how much management supported the change management effort and how flexible the company had become to adapt to changes in the flow of information, the sharing of information, and the timeliness of information. Additionally, the questionnaire asked about the direction of the firm's marketing strategy in the form of control of the channels of distribution, advertising and promotion,

Table 1
Definition of financial variables.

Model	Variable	Name	Definition
1	Net sales	NS	Net sales or revenues represent gross sales and other operating revenue less discounts, returns and allowances
2	Net income before extra items/PFD DIVS	NIB	Net income before extraordinary items/preferred dividends represents income before extraordinary items and preferred and common dividends, but after operating and non-operating income and expense, reserves, income taxes, minority interest and equity in earnings
3	Earnings before interest and taxes	EBIT	Represents earnings of a company before interest expense and income taxes. It is calculated by taking pre-tax income and adding back interest expense on debt and subtracting interest capitalized
4	Return on assets	ROA	Income before extraordinary Items – available for common, divided by Total Assets, multiplied by 100
5	Return on investment	ROI	Income before extraordinary items – available for common, divided by total investment capital, which is the sum of the following items: total long-term debt; preferred stock; minority interest; and total common equity. This item is then multiplied by 100

Standard and Poor's [50] and Thompson Reuters [53].

Table 3
Independent variables.

No	Variable	Question
V1	Tech	There is technological competence to absorb ERP.
V2	Consult	The ERP project team has good relationships with outside experts in ERP.
V3	Objectives	To what extent does the ERP project have written objectives?
V4	Time	To what extent do superiors provide time to the project team?
V5	Know	To what extent do superiors know about project team's performance?
V6	Emotion	To what extent do superiors contribute emotional support?
V7	Plans	Measured in years, to what extent does the ERP project have long-term plans?
V8	Promo	To what extent has management had promotion and advertising expenses above industry average?
V9	Channels	To what extent does the firm have an influence over the channels of distribution?
V10	NewProd	To what extent has management emphasized new products?
V11	Sharing	To what extent has the sharing of information between departments increased through ERP?
V12	Employees	Number of employees working for the company interviewed
V13	PCs	Number of personal computers (PCs) that the company was using at the time of EPR implementation

new products and customer service. Questions also ascertained the formality of ERP plans into the future. All of the questions used a five-point Likert scale, ranging from strongly disagree to strongly agree or from no extent to great extent. Table 3 presents the selected list of independent variables used in this study.

The correlation statistics are shown in Table 4, which also contains the mean, standard deviation and response size for each of the questions used as independent variables in the regression models. Multicollinearity refers to the correlation shared between variables in such a way that the variables affect the independent contribution to any single variable. A statistically significant correlation higher than .900 would be considered a problem. The correlation matrix presented in Table 4 does not display such high correlations. Our highest correlation was between the number of employees and the number of computers. Both of these variables were included to indicate size, and neither were significant in any of our regression models.

3.1. Sample

Table 5A indicates that the majority of the sampled companies implemented ERP before the turn of the millennium, and only eight companies implemented it in 2000 or 2001. Fifteen companies in this sample used SAP as a single provider of Enterprise Systems, twelve companies used Oracle (JD Edwards & People Soft included), two companies used a combination of both SAP and Oracle, and the remaining 17 companies used another vendor.

Table 5B indicates the size of the companies in the sample by presenting the net sales ranges of the companies. At the date of ERP implementation, 53% of the companies were considered SMBs.

Table 5
Information about the companies interviewed for the study.

Date	Frequency	Percent
(A) Date of ERP implementation		
1993	2	3.6
1995	6	10.9
1996	6	10.9
1997	15	27.3
1998	11	20.0
1999	7	12.7
2000	3	5.5
2001	5	9.1
Total observations	55	100.0
Sales	**Frequency**	**Percent**
(B) Net sales at date of ERP implementation		
Small (under $50 million)	3	5.5
Medium ($50-$500 million)	14	25.4
Medium ($500 million–$1 billion)	12	21.8
Large (over $1 billion)	26	47.3
Total observations	55	100.0
Number of employees	**Frequency**	**Percent**
(C) Company employees		
Below 1000	21	38.2
1000–5000	11	20.0
5000–10,000	8	14.5
10,000–50,000	4	7.3
50,000+	5	9.1
Missing	6	10.9
Total observations	55	100.0
Number of computers	**Frequency**	**Percent**
(D) Count of computers in companies		
Below 500	27	49.1
500–1000	8	14.5
1000–10,000	12	21.8
10,000+	5	9.1
Missing	3	5.5
Total observations	55	100.0

Table 4
Descriptive Statistics and Pearson Correlation.

Variables		Mean	Std. Dev	N	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
V1	Tech	4.710	1.0090	58	1												
V2	Consult	4.840	1.0050	58	.266*	1											
V3	Objectives	1.370	1.0190	41	−.258	.216	1										
V4	Time	4.991	0.5938	57	.262*	.319*	.003	1									
V5	Know	5.069	0.6174	58	.329*	.399**	−.130	.561**	1								
V6	Emotion	4.893	0.5933	56	−.013	−.034	−.464**	.213	.214	1							
V7	Plans	5.120	0.8070	49	−.255	.067	.440**	−.160	−.359*	−.463**	1						
V8	Promo	4.388	0.8118	49	−.229	−.054	.077	.011	−.030	−.050	−.213	1					
V9	Channels	4.991	0.6479	54	−.308*	.076	−.047	.121	.141	.260	−.045	.205	1				
V10	NewProd	4.782	0.8485	55	−.041	.021	.088	−.014	−.167	.068	.276	.187	.215	1			
V11	Sharing	5.121	0.8497	58	.236	.166	−.228	.055	.210	.171	−.007	−.064	.169	.724**	1		
V12	Employees	10,217	20,846.01	52	.166	.293*	−.160	.346*	.379**	−.034	−.018	−.152	.025	−.130	.210	1	
V13	PCs	3080.4	7839.187	55	.052	.055	−.138	.158	.232	−.119	.155	−.131	−.030	−.154	.130	.774**	1

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Similarly, company size is presented in Table 5C in terms of the number of employees in 2003. More than 60% of the companies had more than 1000 employees. Another interesting statistic concerns the number of computers. These figures are presented in Table 5D. Approximately half of the companies possessed less than 500 computers, half possessed more than 500 computers, and 10% possessed more than 50,000 computers.

Multiple regression analysis is a widely used statistical and linear modeling technique with broad research applicability. Its main purpose is to predict or explain the dependent variable with a set of independent variables, maximizing the overall predictive power of a linear combination of independent variables. Once a regression model is run, it must be confirmed through the goodness of fit of the model, such as *R*-squared, analysis of the pattern of residuals and hypothesis testing. The model's statistical significance can be checked by an F-test of the overall fit, followed by *t*-tests of individual parameters. In our study, the independent variables used to predict a change in financial ratios is the set of questions presented in Table 3. A regression test was run for each of the dependent variables. The independent variables' abilities to predict the change in Net Sales four years after the ERP implementation date are presented in Regression Model 1. The second regression model was run to indicate the predictability of the same set of questions to predict or explain the change of NIB four years after the ERP implementation date. Similarly, a third regression model was run for the change in EBIT, a fourth model for the change in ROA and a fifth model for the change in ROI. Using five different models adds to the validity of the process and compounds the value of the results. The fact that these questions stem from the literature review and use scales used in previous studies confirm and support the theory-building process.

The R^2 (*R*-squared) of a multiple regression refers to the probability that the regression equation will explain or detect a statistically significant relationship. This regression coefficient is affected by sample size and the number of independent variables. This is referred to as power. For a sample size of 50 and 13 independent variables at a .05 significance level, our R^2 must be above .36 to have power.

A spurious explanation of improvement or downturn in economic figures is controlled by the fact that we used running dates. We controlled the influence of economic phenomena occurring in a certain year by including a range of dates of implementation and gathered statistics one year before and four years after that date. Our varying implementation dates range from 1993 to 2001, which means that our financial data ranges from 1992 to 2005. This variable is therefore controlled.

A second measure used to control for differences in the sizes of the companies is the dependent variables as a percentage of change and not the actual change in the numeric amounts of the dependent variables. The percentage of change will equate small and large companies in terms of NS, NIB, EBIT, ROA and ROI. What is important here is how the ERP impacted the figures because it is the only constant in all of these cases. It would not matter if a company already had exceptional financial ratios prior to the ERP implementation because we are only concerned with the change in these figures.

4. Results

Regression models were run using the questions displayed in Table 3 as predictors for the dependent variables in Table 2. All of the regression models used the forward regression method. The company size, measured in both the numbers of employees and computers, was used as a control variable that was shown to be statistically insignificant in all regression models. The year of the ERP implementation was also used as a control variable and was not statistically significant.

The regression for ΔNS, which was run in Model 1 and is presented in Table 6, is significant ($p < .01$) and has an adjusted *R*-squared value of .474. A strong technological competence produces a positive change in NS. Top management support garnered mixed results in this model because it made a distinction between the knowledge of progress, which produced a negative change in NS, and providing emotional support. These variables explained nearly 47% of the variance in the change in NS. The explanatory power is extraordinary and makes a significant contribution to the literature. In summary, the NS model supports H1and H3.

The regression for ΔNIB, which was run in Model 2 and is presented in Table 6, is statistically significant ($p < .01$) and has an adjusted *R*-squared value of .379. The model supports the concept that support from top management and the increased sharing of

Table 6
Significant contributions to *R*-square.

Independent variables	Dependent variables				
	Model 1 ΔNS	Model 2 ΔNIB	Model 3 $\Delta EBIT$	Model 4 ΔROA	Model 5 ΔROI
Tech	0.542***				
Consult			0.434**	0.431***	0.548***
Objectives					
Time					
Know	−.713***	.487**			
Emotion	.492***				
Plans			−0.529**		
Promo					
Channels					
NewProd					
Sharing		.405**		.613***	.587***
Employees					
PCs					
Adjusted R^2	0.474	0.379	0.458	0.576	0.611
Model *F*	10.007	7.417	9.874	14.600	16.722
F-probability	0.000	0.004	0.001	0.000	0.000

All statistically significant standardized coefficients are presented.
Probability levels are indicated as follows:
* $p < .10$.
** $p < .05$.
*** $p < .01$.

information resulting from ERP implementation produces a positive change in NIB. The NIB model supports H3 and H6.

The regression for $\Delta EBIT$, which was run in Model 3, is statistically significant ($p < .01$) and has an adjusted R-squared value of .458. A strong relationship with outside experts produced a positive change in EBIT. It is interesting to note that there is an inverse relationship with the possession of long-term ERP plans. The more years that were included in the plans, the more negative the change in EBIT. The EBIT model empirically supports H2 and H4.

The regression for ΔROA, run as Model 4 and presented in Table 6, is statistically significant ($p < .01$) and has an adjusted R-squared value of .576. The module provides empirical evidence for a strong relationship with outside experts and increases the sharing of information because ERP produces a positive change in ROA. The ROA model empirically supports H2 and H6.

The regression for ΔROI, run as Model 5 and presented in Table 6, is statistically significant ($p < .01$) and has an adjusted R-squared value of .611. This is the third model that empirically supports the finding that a strong relationship with outside experts produces financial gains. Additionally, the increased sharing of information due to ERP produced a positive change in ROI. The ROI model empirically supports H2 and H6.

The research model shown below illustrates the relationships between the independent and dependent variables that were found to be statistically significant. In summary, our study found empirical evidence for Hypotheses. Our study found empirical evidence using econometric methods that contribute to both the information and management literature. We found that increased technical competence directly affects the prediction of net sales. We found that having a strong relationship with outside experts, frequently referred to as consultants, produces changes in EBIT, ROA, and ROI. Therefore, reliance on outside consultants and developing a sound relationship with them is extremely valuable to the ERP effort [30]. Top management engagement, in terms of knowing about the project team's performance and providing emotional support, was significantly affected by NS and NIB. The results revealed a distinction between top management knowing about the ERP implementation's progress and top management providing emotional support. These results are counterintuitive in that knowing about the progress can produce negative results for NS. Additionally, it was surprising to find that top management providing time to the ERP project did not significantly affect any of the financial rations.

As expected, the sharing of information between departments resulted in significant in changes in NIB, ROA, and ROI. However, a startling finding was that having long-range plans was inversely significant, meaning that the longer the plan, the more negative the change in EBIT. It is important to note that the mean for the number of years included in the plan was 5.1 and that the frequency distribution was 12 companies with a four-year plan, 20 companies with a five-year plan, 16 companies with a six-year plan, and one company with a seven-year plan.

We were unable to empirically prove that a strong preference in strategic direction, in terms of having promotion and advertising expenses above the industry average, having an influence over distribution channels or an emphasis on new product development, is statistically related to changes in NS, NIB, EBIT, ROA or ROI. Therefore, Hypothesis 5 was not supported (Fig. 1).

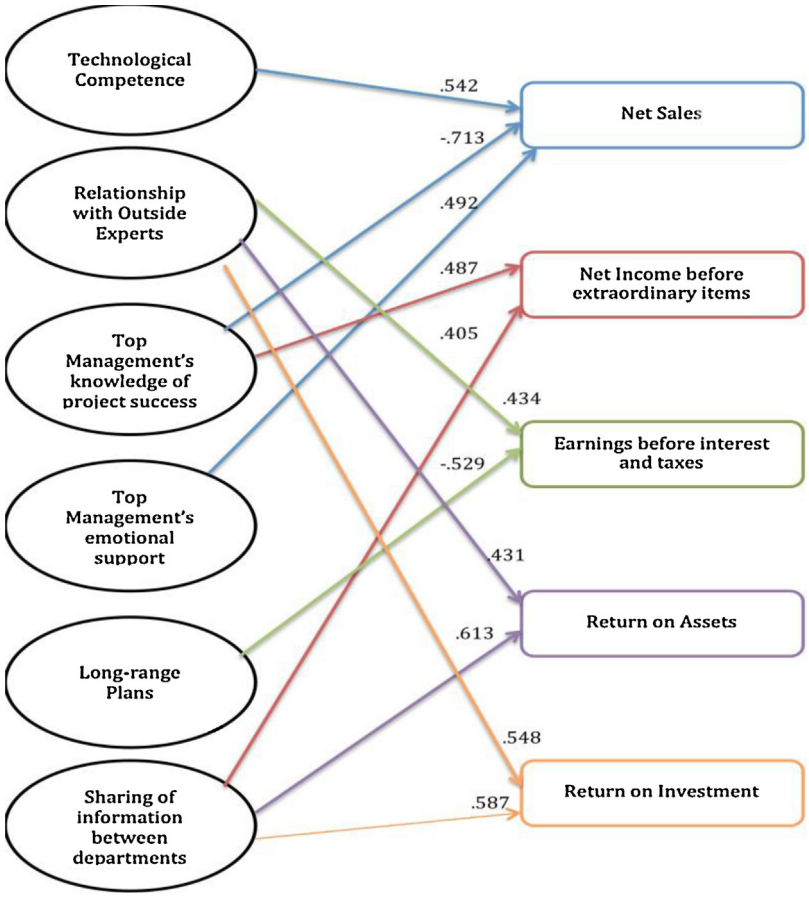

Fig. 1. Research model.

5. Discussion and implications

Companies undoubtedly analyze the inherent risk in ERP investment before committing thousands or millions of dollars to it. Peppard and Ward [43] explained the IT strategy process for submitting an investment proposal for a new enterprise system to a board of directors of a business organization. The in-house team charged with developing the ERP proposal spends approximately four months learning from the business managers the requirements and expectations, attending seminars to enhance their knowledge, and visiting vendors and reference sites. The group then holds a series of internal workshops with the key stakeholders involved in the anticipated ERP system [43]. ROI and ROA calculations are often subsequently utilized to decide whether to proceed with the business venture [56]. Many times, the ROI and ROA calculations do not financially justify the ERP investment, particularly if the board of directors is seeking an immediate return and guarantee for the monetary outlay [43]. Unfortunately, ERP does not always yield an immediate return despite pre-investment assurance calculations.

This study's contribution to the literature lies in the support of various managerial techniques that make a difference in long-term success. Our study investigated the likelihood that the financial performance of organizations displaying the aforementioned elements would be successful. We found that financial ratios signal a high predictability of successful ERP implementation. However, these ratios are not improved by the same managerial practices. This finding can be explained by the varying expectations of the ERP software spread throughout the management pyramid of the organization. ERP is expected to reduce the costs of operations, which would seem to follow the sharing of information goals, as expressed in the ROA and ROI models. However, ERP is expected to increase sales, but here we see that other aspects become important, such as technical competence and emotional support from top management. In the NS model, we find that the knowledge of ERP support of top managers and the CIO's satisfaction of the ERP system have an inverse relationship with the change in the sales ratio.

This study contributes to the literature by highlighting that studies examining the success of ERP must delve into the intricacies of the software to measure success on both sides of the profit equation, including revenues and costs on a long-range longitudinal basis. Whereas the companies' bottom lines may improve, thereby producing CIO satisfaction due to the efficiency of reduced costs, the sales may require continued support. Therefore, the theoretical implications are compounded by the fact that managerial practices for reducing costs versus increasing sales are different. Currently, the ERP success literature presents various performance variables, which include both financial and non-financial success matrices.

A secondary contribution of this study is the call for research on the support of top management. This study's findings indicate that providing emotional support is important. Knowing about the progress of the ERP team has mixed results when emotional support is not provided. Therefore, the construct of top management support in both cheerleading and oversight capacities should be further explored.

6. Limitations

Our study is limited in that although the financial data are longitudinal, the corresponding CIO attitudes and perceptions are a snapshot view of a year within the ERP project. Perhaps various stages of interviews would present a better picture of organizational learning. Another limitation is that only one high-level IT executive from each company was interviewed. Future research should provide corresponding views of ERP users from a bottom-up perspective.

7. Conclusion

With so much investment in ERP software, further research is recommended to determine which factors contribute to the highest success and failure rates. Using financial data, we suggest it may be possible to forecast which IS managerial practices present the greatest predictability for ERP implementation success. Perhaps additional ERP studies using financial data will lead to better choices for companies that wish to maximize ERP use. The literature has shown that establishing a clear cause-and-effect relationship between managerial practices and financial returns results in higher commitment to implementing these practices.

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