The Impact of ERP Investments on Organizational Performance

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Abstract

Enterprise resource planning (ERP) systems affect organizations and are implemented to enhance organizational effectiveness. However, ERP implementation is complex, costly and the research to date on the results of ERP investments on organizational performance have been inconclusive. This study examined the impact of ERP systems implementation on financial performance of public companies over a period of four years. Data analysis showed that ERP implementation did not affect significantly financial performance of the firms that had implemented ERP. This study adds to the existing research and its results can contribute to improved decision-making and setting ERP expectations at the time of ERP purchase.
Introduction and Background

In order to remain viable and competitive in today’s business environment, it is necessary to invest in information technology (IT). Investment in information technology is an expensive and ongoing process. IT is more than a tool for automating existing processes. The main role IT plays is as an enabler for organizational change that can result in productivity (Dedrick, Gurbaxani, & Kraemer, 2003) or other gains, such as service enhancements.

Enterprise resource planning (ERP) systems affect organizations and are implemented to enhance organizational effectiveness. ERP systems are information systems packages that are configurable and integrate information and information-based processes within and across functional areas in organizations (Allen, Kern, & Havenhand, 2002; Gattiker & Goodhue, 2004). ERP systems automate and structure an organization’s business processes by furnishing reference models and process templates across the enterprise (Allen et al.). Hanseth, Ciborra, and Braa (2001) stated that the main purpose for deploying ERP systems is to improve control over organizational processes. However, ERP implementation is complex, costly and the research to date on the results of ERP investments on organizational performance have been inconclusive.

ERP systems improve decision-making speed, enhance control of operations and costs, reduce costs, and boost enterprise-wide information dissemination. The complexity of ERP systems implementations; the drastic organizational, cultural, and human changes; the typical high customization expenses; and implementation problems all contribute to new customers’ reconsidering their ERP implementation plans (Allen et al., 2002). As Hossain, Patrick, and Rashid (2002) noted, since ERP systems replace other systems, an economic rationale should be available to justify ERP deployment. Willcocks and Sykes (2000) noted that an ERP is competitively and technically necessary for many organizations. However, they stated that there is contradictory evidence in justifying an ERP economically and there is difficulty in rationalizing the associated costs and implementation complexity for achieving lasting business advantage.

Even though mature ERP systems have been used for over a decade, there remains dearth of research on the impact of ERP on organizational performance. The empirical research (as opposed to user perception) on the impact of ERP systems on organizational performance includes studies by Poston and Grabski (2000); Hunton, Lippincott, and Reck (2003); and Nicolaou (2004). The reviewed research on the impact of ERPs on organizational performance has produced contradictory results. Furthermore, no studies have been performed on the financial impact of ERPs on organizational performance using a well-established methodology for firms that have adopted ERP after 1998.

This study was the first that measured the long-term financial impact of ERP on performance for firms that have adopted an ERP after 1998. Various critical success factors have been identified for ERP systems in the ERP implementation literature. Some of these factors include the choice of ERP vendor, anticipated benefits and justification for ERP implementation, scope or degree of ERP implementation, and the extent of business process change (Nicolaou, 2004). However, the primary objective for this study was to investigate the effects of ERP adoption on the bottom line of a firm using financial measures. This study also investigated the effects of the scope of ERP implementation on firms’ performances. As Nicolaou (2004) noted there are no empirical results
on the effects of ERP implementation scope on a firm’s performance. Using a well-established methodology, this study contributed to better understanding the effects that ERP systems have on organizations and will potentially enhance the decision making process for purchasing these systems.

**Literature Review**

ERP systems, similar to other business solutions, should be implemented to address specific needs and conform to the business characteristics of an organization (Gefen & Ragowsky, 2005). ERP systems might be suitable under many situations but less so under others. Benefits of ERP systems could include better coordination among subunits and administrative efficiencies. The more interdependent the sub-units in an organization are, the more benefits will accumulate (Gefen & Ragowsky).

Benefits from ERP implementation generally could be categorized into tangible and intangible benefits (Nicolaou, 2004). Important intangible benefits are associated with internal integration, improved information and processes, enhanced customer service (Nicolaou), better knowledge processing, decision reliability, decisional substantiation, competitiveness, decision-making speed, and treatment of large scale and complex problems (Holsapple & Sena, 2005). Examples of tangible benefits include reduced inventory, reduced personnel, and increased profitability. In general, ERP systems contribute to organizational efficiency, improved management, and inter-organizational integration (Sacco, Pedron, Cazella, Macadar, and Neto (2003).

As Holland and Light (2001) noted, ERP systems started to have substantial presence in organizations in the 1990s, and that a decade of practice was necessary to provide an insight into the usage of ERP systems. A sufficient usage period is especially important when considering the maturity of usage in contrast to implementation success. The reason is that organizations take time to shift in their perspectives and utilize new ideas and technologies (Holland & Light). As Holland and Light observed, ERP systems have the potential of either supporting high-level decision making in organizations or just being utilized as simple transaction processing systems.

Some studies on the impact of an ERP on organizational performance were exploratory in nature and based on users’ perceptions. Hitt, Wu, and Zhou (2002) noted that the majority of the studies on the impact of ERP systems are interviews, case studies, a collection of case studies, or industry surveys. Empirical research on the impact of ERP systems on organizational performance, which was not based on user perception, included the studies by Poston and Grabski (2000), Hunton et al. (2003), and Nicolaou (2004). These three studies compared the performance of public firms that adopted ERP with a matching group of non-adopting firms. Various financial indicators available through Compustat were used to measure organizational performance.

ERP systems have been widely used for over a decade now and there was a dearth of research on the impact of ERP on organizational performance. The three major studies by Nicolaou (2004), Poston and Grabski (2000), and Hunton et al. (2003), although using the same general methodology, have resulted in contradictory conclusions. The studies by Poston and Grabski and Hunton et al. used three years of post-adoption financial data, while the study by Nicolaou used four years of post-adoption data. As Poston and Grabski noted, the three-year longitudinal study
might not have been enough to capture the impact of ERP on firm performance. A four-to-five year study might have demonstrated return for ERP implementation. This study employed the methodology used by the above three studies. In order to investigate the full impact of ERP adoption, four years of post-adoption data was used.

**Methodology**

The methodology used in this study has already been employed in the studies of firm performance by Balakrishnan, Linsmeier, and Venkatachalam (1996); Barber and Lyon (1996); Hayes, Hunton, and Reck (2001); Poston and Grabski (2001); Hunton et al. (2003); and Nicolaou (2004). They all performed their studies on public companies with financial data available through Compustat. The studies by Poston and Grabski, Hunton et al., and Nicolaou focused on the impact of ERP implementation on financial performance of firms.

First, LexisNexis Academic Universe newswires was searched for locating a sample of ERP-adopting firms from the ERP implementation announcements after 1998 with four years of post-ERP implementation financial data. After extracting data about firms from LexisNexis that had adopted ERP systems after 1998, each firm was matched by industry and size at the year preceding the ERP adoption year with a company that had not adopted ERP. Compustat was used for the matching process. The four-digit Standard Industrial Classification (SIC) code was used primarily for matching industry types. The three-digit SIC code was used when a four-digit SIC code match could not be found. Total assets were used to match company size.

Various factors are involved in the success of an organization. Although it is not possible to control all the success factors, this study, following prior research (Bharadwaj, 2000; Balakrishnan et al., 1996; Barber & Lyon, 1996; Poston & Grabski, 2001; Hunton et al., 2003; and Nicolaou, 2004), used differential return to control industry and economic factors and the effects of management practices. Differential return includes both relative return and controls for industry and economic effects via matching with a non-adopting ERP firm. Relative return expresses a firm’s performance after adoption of ERP relative to its pre-adoption performance (Nicolaou). Relative return addresses the effects of management practices on a firm. Having a group of ERP adopters and a group of non-adopters (control group) allows comparisons of differential returns of ERP adopting firms with those of competing non-adopting firms.

In order to measure the impact of ERP systems on firm performance, each firm that had deployed an ERP system was compared to a comparable firm (by size) that had not deployed an ERP system from the same industry. The performances of each ERP adopting firm and the matched non-adopting firm from the same industry were compared prior to implementing an ERP system and in every year, up to four years, after the deployment of the ERP system. The overall differential performance then also was compared in various years. Financial performance data for the ERP-adopting and non-adopting firms was extracted from Compustat for the year before adoption and up to four years after adoption. Results were discussed and conclusions were written up.

**Performance Measures**

The variables selected for measuring the impact of an ERP on organizational performance for this study was based on the review of prior research. Organizational performance was of primary
interest and is represented by four dependent variables, which represent ERP implementation and ERP implementation scope.

Independent Variables
The first independent variable separates institutions that have deployed an ERP system from the ones that have not and are still using their legacy systems. This variable was termed “ERP implementation status” and has two levels. One level corresponds to the institutions that have implemented an ERP system and the other level is associated with the institutions that have not implemented an ERP system. Firms that have implemented components of an ERP system were included in the ERP adopters group. The second independent variable, “scope,” differentiates ERP adopters based on the installed ERP components.

For this study, ERP systems were classified into two categories of primary and support modules (Porter and Millar, 1985; Brown and Vessey, 1999; Hitt et al., 2002; and Nicolaou, 2004). Primary activities were defined as activities that deal with physical creation of products, marketing and delivery of products to buyers, and their support and servicing after sale. Support activities were defined as activities that are associated with the inputs and infrastructure that permit primary activities. Support modules included the financial and human resource management modules. Primary modules were defined as support supply chain activities and include all other modules except financials and human resources. Degree or scope of implementation for this study depends on whether primary or support modules were implemented. Scope will have three levels. The three levels of scope are implementation of primary modules, implementation of support modules, and implementation of both primary and support modules.

Dependent Variables
As Hu and Plant (2001) noted, in the corporate world, chief executive officers and chief financial officers with their eyes on the balance sheet are demanding to see the expected payback in financial terms before approving funds for major IT projects. Therefore, measuring organizational performance in economic terms might help various firms justify investment in ERP systems. As pointed out in the literature review, reducing costs and increasing revenues are among the motivating factors for deploying ERP systems (Allen et al., 2002; Poston & Grabski, 2000; Sacco et al., 2003).

This study employed accounting measures that represent profitability and cost. These measures are based on relationships of financial statement items. Four measures of financial performance are used to examine the impact of ERP systems on firm financial performance. Nicolaou (2004) and Hunton et al. (2003) used three of the financial performance measures, which include return on assets (ROA), return on investment (ROI), and return on sales (ROS). Nicolaou and Poston and Grabski (2000) used the fourth measure, which is Cost of Goods Sold over Sales (CGSS). ROA and ROI measured return on invested capital. ROS measured profitability; CGSS measured cost.

The definition for each financial measure is shown below (Nicolaou, 2004; Compustat):
1. Return on asset is income before extraordinary items - available for common, divided by total assets, multiplied by 100.
2. Return on investment is income before extraordinary items - available for common, divided by total invested capital, multiplied by 100. Total invested capital is the sum of total long-term debt, preferred stock, minority interest, and total common equity.
3. Return on sales is income before extraordinary items - available for common, divided by net sales, multiplied by 100.
4. Cost of goods sold over sales is all costs directly allocated by the company to production, such as material, labor and overhead, divided by net sales, multiplied by 100.

Compustat defined “income before extraordinary items - available for common” as income after preferred dividend requirements, but before adding savings due to common stock equivalents and before extraordinary items and discontinued operations.

Theoretical Framework

As Kudyba and Diwan (2002) reported, investment in various forms of IT has made important contributions to productivity and gross revenue. Hitt et al. (2002) noted that firms that implemented ERP showed higher performance than firms that did not implement ERP across a wide array of financial metrics. Therefore, based on previous research, ERP implementation should contribute positively to organizational performance.

Previous research also indicates that ERP scope has a clear impact on firm performance. One study indicated that deploying the human resources and financials modules had more impact on performance than deploying either all modules or just the primary modules (Nicolaou, 2004). The other study by Hitt et al. (2002) indicated that implementing financials, human resources, manufacturing, and data warehousing/mining had more impact on firm performance than any other combination. When all ERP modules (financials, human resources, manufacturing, data warehousing/mining, and project management) were deployed, the firm performance was less than other ERP module combinations. Both studies (Hitt et al. and Nicolaou) agree that deploying the financials and human resources modules have the most impact on firm performance when compared to implementing all ERP modules. Based on prior research, ERP implementation status and ERP scope both affect organizational performance.

Hypotheses

Hypotheses 1: ERP implementation affects organizational performance positively when measured by financial performance ratios.

Hypotheses 2: For institutions that have implemented ERP, varying scope of ERP implementation has varying effects on organizational performance.

Results

Data Analysis

Distribution of ERP adopters was not clustered around a particular industry type. The business services industry type had the highest number of ERP adopters. As table 1 shows the distribution
of ERP implementations by year for firms with ERP announcements from 1999 to 2001. As shown, years 1999 and 2001 have the most number of ERP implementations. Table 2 shows the distribution of ERP adopters by ERP vendor. Oracle and SAP had the largest number of ERP implementations followed by PeopleSoft and Lawson. Among ERP adopters, there were 15 with primary, 27 with support, and 37 with primary and support scopes. Many of the ERP vendors consolidated in post-2001 years. The major ERP acquisitions occurred from 2003 to 2007. For example, Oracle acquired PeopleSoft in December 2004, Siebel in 2005, and Hyperion in March 2007. SSA Global Technologies acquired BAAN in July 2003. PeopleSoft acquired JD Edwards in July 2003. Finally, Lawson acquired Intentia in April 2006.

Table 1. Distribution of ERP Implementation by Year

<table>
<thead>
<tr>
<th>Year of implementation</th>
<th>No. of ERP Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>23</td>
</tr>
<tr>
<td>2000</td>
<td>14</td>
</tr>
<tr>
<td>2001</td>
<td>24</td>
</tr>
<tr>
<td>2002</td>
<td>18</td>
</tr>
<tr>
<td>Total:</td>
<td>79</td>
</tr>
</tbody>
</table>

Table 2. Distribution of ERP Companies by ERP Vendor

<table>
<thead>
<tr>
<th>ERP vendor</th>
<th>No. of ERP adopters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baan</td>
<td>1</td>
</tr>
<tr>
<td>Epicor</td>
<td>1</td>
</tr>
<tr>
<td>Intentia</td>
<td>2</td>
</tr>
<tr>
<td>JD Edwards</td>
<td>2</td>
</tr>
<tr>
<td>Lawson</td>
<td>7</td>
</tr>
<tr>
<td>Oracle</td>
<td>29</td>
</tr>
<tr>
<td>PeopleSoft</td>
<td>10</td>
</tr>
<tr>
<td>QAD</td>
<td>1</td>
</tr>
<tr>
<td>SAP</td>
<td>25</td>
</tr>
<tr>
<td>SCT</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
</tr>
</tbody>
</table>

Findings
The first research question for this study was:

- How do ERP implementation and use affect the long-term financial performance of an organization?

Data Analysis indicated that ERP adoption does not affect a firm’s financial performance significantly when measured over a four-year post-adoption period.

The second research question for this study was:
How does the scope of ERP implementation affect financial performance of an organization?

Data analysis showed that ERP scope does not have a significant effect on financial performance for ERP adopters over a four-year post adoption period. It was also shown that that pre-adoption differential performance is a better predictor of post-adoption performance than ERP scope.

Conclusions

This study investigated the effect of ERP deployment on financial performance of organizations over a four-year post-adoption period. 79 firms that adopted ERP in the post-1998 period were compared with 79 non-adopters. The results achieved from analysis of data showed that deployment of ERP systems do not affect financial performance of organizations significantly when measured over a four-year post-adoption period. Moreover, ERP scope did not affect financial performance of the firms that had implemented ERP significantly.

The results of this study contribute to the understanding of the long-term financial impact of ERP systems on organizations. The results of this study are significant from the academic research point of view as well as the administrative and business point of view. From the academic research perspective, this study adds to the body of knowledge in the area of information technology and ERPs. Consequently, the results of this study contribute to research on the topic. From the administrative and business point of view, the results of this study can contribute to improved decision-making and setting ERP expectations at the time of ERP purchase.

The results of examining the impact of ERP scope on organizational performance helps to further understanding of how ERP scope affects organizational performance. Knowing how ERP scope affects organizational performance provides for better decision making on the purchase and implementation of ERP modules. This study has generated results based on empirical data and conclusions that can provide business leaders with research based information for making ERP related decisions. Future researchers can use the financial performance measures used in this study to develop formal measures to assess the financial performance of future adopters of ERP systems.

In light of the findings from this study and the high costs involved with major IT projects, it might be beneficial for organizations to analyze and evaluate their IT investments before proceeding with their IT projects. One way to analyze an IT project investment and to evaluate its merit in real world business setting is by using options pricing analysis (Benaroch & Kauffman, 1999). IT projects embed a real option when offering management the opportunity to take some future action such as abandoning, deferring, or scaling up the project in response to events occurring within the firm and its business environment. IT projects, such as ERP deployments, that entail infrastructure development and wait-and-see deployment opportunities are most suitable for options pricing analysis. Options pricing models can assist in getting the timing right, scaling up, or even abandonment of the IT project as the organization learns about its business environment with the passage of time (Benaroch & Kauffman).
Reference List


