The Influence of Technical Competence Factors in ERP System Implementations

Arun Madapusi
Drexel University

Daniel A. Cernas Ortiz
Universidad Autónoma del Estado de México

In this research study, we develop a theory-based model to assess the influence of technical competence factors on the relationship between enterprise resource planning (ERP) systems implementation status and firm performance. The systemic concept that underlies ERP system implementations suggests that as firms implement ERP systems (intra-firm as well as inter-firm module sub-systems) their business performance increases. Moreover, firms that incorporate technical competence factors into their implementation model, achieve superior business performance.

INTRODUCTION

In the past two decades or so, information management has become a powerful driver of business performance. The twin pressures of globalization and competition has forced firms to invest heavily in enterprise resource planning (ERP) systems to coordinate activities within the firm as well as across the supply chain. The global ERP market has registered explosive growth over the past two decades, from $1 billion in the year 1990 (Mabert et al., 2000) to $ 43 billion for the year 2010 (Martins et al., 2011). Many studies report that ERP system deployments result in improvements in firm performance (Hitt et al., 2002; Hendricks et al., 2007; Seddon et al., 2010). Early ERP system implementations comprised of modules that catered primarily to a firm's internal needs such as finance, logistics, and human resources (Hernandez, 1998; Mabert et al., 2000; Koch, 2001). As these early deployments stabilized, firms turned their attention to adding modules that addressed inter-firm activities (Bendoly & Jacobs, 2005; Davenport et al., 2004; Hendricks, et al., 2007).

That said, various studies indicate that most ERP system implementations face problems and fail to achieve their stated objectives (Poston & Grabski, 2001; Nucleus Research, 2003; Vemuri & Palvia, 2006). Many firms, technically successful in implementing the ERP system were, however, unable to reap the expected benefits from their deployments. Studies show that two main reasons could be attributed to this high incidence of problematic implementations and the non-achievement of stated objectives by even technically successful implementations. The first one is the failure of firms to consider ERP systems as module sub-systems (as opposed to individual modules) in meeting their intra and inter-firm information processing needs (Gattiker & Goodhue, 2004; Stratman, 2007; Koh et al., 2011); and the second one is failing to focus on technical competence factors in parallel with their system deployments (Mabert et al., 2003; Tarafdar & Roy, 2003; Masini & Wassenhove, 2009).

Researchers such as Bendoly and Jacobs (2005), Stratman (2007), and Bendoly (2013) indicate that a systemic concept underlies ERP system deployments. Their findings suggest that the inter-linking of modules facilitates adopting a systems approach to implementing ERP systems; i.e. adopting a view of an ERP system as one that supports various intra-firm (through the intra-firm module sub-system) and inter-firm (through the inter-firm module sub-system) activities. Mabert et al. (2003), Tarafdar and Roy (2003), and Masini and Wassenhove (2009) indicate that substantial performance benefits accrue to firms that focus on technical competence factors in tandem with their ERP system deployments. Their findings suggest that firms that leverage technical competence factors in systemic ERP implementations will maximize their benefits. In this research study, we seek to advance the above systemic stream of research.

The rest of the paper is organized as follows. First, we first provide a brief literature review which leads to the development of a conceptual model. Next, we test the model through a field study using a sample of production firms in India that have implemented ERP systems. Data collected from the field study were then analyzed and evaluated to test the relationships between the implementation status of ERP module sub-systems and changes in firm performance, and then test the moderating influence of technical competence factors on the above relationship. Lastly, we provide an overall summary, discuss the limitations of the study, and suggest directions for future research.

LITERATURE REVIEW

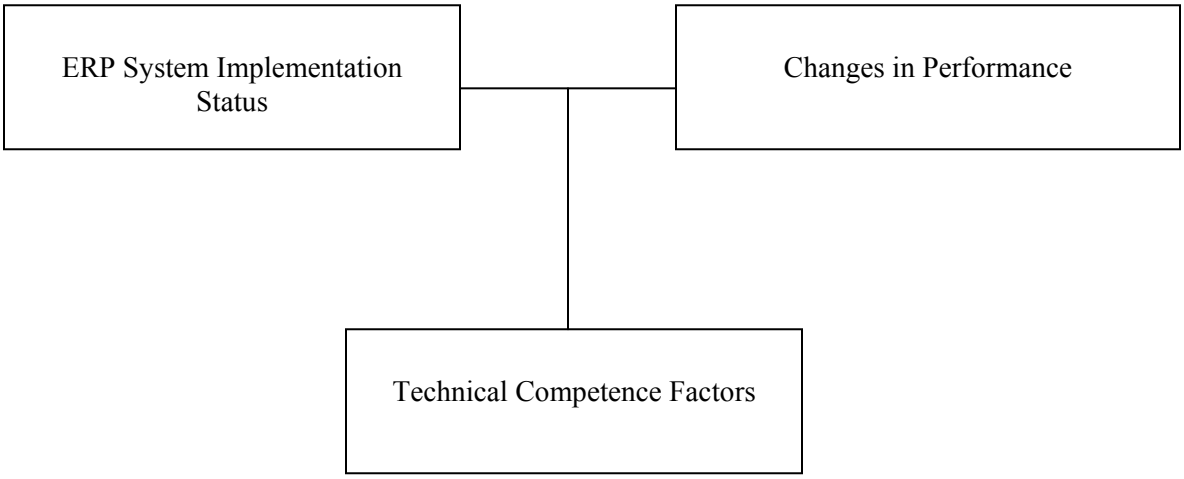
Past studies predominantly indicate that single module or sub-module implementations result in increased efficiency benefits accruing to firms (Klaus et al., 2000; Hitt, et al., 2002; Cotteleer & Bendoly, 2006). There has been a growing realization, however, that firms derive enhanced benefits by implementing all the modules of the ERP system (Gattiker & Goodhue, 2004; Davenport et al., 2004; Stratman, 2007). The latter research stream suggests that systemic ERP deployments, which represent the integration of modules that cater to a firm's intra and inter-firm activities, over a number of years, enhance business performance. Also, firms facilitate the implementation process by effectively managing technical competence factors in parallel with their ERP system deployments (Xu et al., 2002; Tarafdar & Roy, 2003; Masini & Wassenhove, 2009).

The early ERP system deployments typically addressed intra-firm activities through modules targeted at the financial, logistics, and human resources functions, and enabled firms to integrate and streamline their data and process flows to provide transactional benefits (Davenport, 1998; Mabert et al., 2001; Mabert et al., 2003). Firms then addressed inter-firm activities by deploying modules targeting suppliers and customers, thus extending their ERP systems across the supply chain (Poston & Grabski, 2001; Tyler, 2002; Hendricks et al., 2007). Various studies indicate that firms obtained mainly transactional benefits such as information availability, information quality, standardization, on-time delivery, and improved inventory management from their early intra-firm implementations (Davenport, 1998; Mabert et al., 2001; Drayer & Wight, 2002). Firms then leveraged their early efficiencies to obtain organizational benefits such as increased profitability, return on investment (ROI), user satisfaction and customer satisfaction, and competitive advantage (Johnson, 2000; Willis & Willis-Brown, 2002; Gefen & Ragowsky, 2005).

Though various studies suggest that ERP system deployments increased performance benefits, there are many incidences of difficulties and failures in implementing these systems (Hong & Kim, 2001; Umble & Umble, 2002; Vemuri & Palvia, 2006). Most firms focused on a host of competency factors to overcome these difficulties. Among several such competency factors emphasized, technical competency factors such as implementation team support (Stratman & Roth, 2002; Kumar et al., 2003; Osel-Bryson et al., 2008), the use of expert consultants (Teltumbde et al., 2002; Kumar et al., 2003; Chang et al. 2013), and ensuring of data accuracy (Vosburg & Kumar, 2001; Xu et al., 2002; Koh et al., 2011) were accorded prime importance. The findings from the above studies suggest that those firms which effectively managed their technical competency factors can shorten their implementation time and gain substantial benefits from their ERP systems.

The ERP system and its relationships to changes in performance, and the moderating influence of technical competency factors on the above relationship are shown in the Figure 1 below.

FIGURE 1
THE INFLUENCE OF TECHNICAL COMPETENCE FACTORS ON ERP SYSTEM IMPLEMENTATIONS



Researchers as well as ERP vendors have classified the ERP system modules into module categories in different ways based on a firm's functional needs – financials, logistics, human resources, extensions, and so on (Hernandez, 1998; Mabert et al., 2000, www.sap.com. www.oracle.com). Recent studies (Gattiker & Goodhue, 2004; Stratman, 2007; Koh et al., 2011), however, contend that ERP implementers should move away from functional module classifications and instead view ERP systems as an aggregation of inter-related modules that support various intra and inter-firm activities. We follow the lead of the latter researchers and using an organizational information processing approach classify ERP systems as comprising of two module sub-systems; the first one pertains to modules that address intra-firm activities, and the second one to modules that cater to inter-firm activities. Such a classification helps us think about the ERP system as helping firms meet their intra and inter-firm information processing needs.

THEORETICAL BACKGROUND

The deployment of module sub-systems and their integration and usage over time helps firms achieve synergistic performance benefits (Stratman, 2007; Bendoly, et al., 2009; Bendoly, 2013). Gattiker and Goodhue (2005), Chou and Chung (2008), and Galbraith (2000; 2002), use organizational information processing theory to examine information system deployments such as ERP implementations. Galbraith et al. (1993) and Galbraith (2000; 2002) suggest that uncertainty lies at the heart of the organizational information processing in organizations. Uncertainty is the difference between the amount of information required to perform a task and the amount of information already possessed by the firm. Firms typically handle high uncertainty by either decreasing (through environmental management, creation of slack resources, and creation of self-contained tasks) or increasing (through investment in vertical information systems, and creation of lateral relations) the need for information processing.

Galbraith (2000; 2002) suggests that modular information technology systems, such as ERP systems, offer options to both reduce and increase the need for information processing, and that their integration and usage over time will result in performance benefits accruing to firms. Firms can handle their complex and uncertain environments by using ERP module sub-systems to integrate their front and back office operations with their supply chains (Galbraith, 2000; Davenport et al., 2004; Hendricks et al., 2007). ERP module sub-systems provide vast amounts of information that helps reduce bottlenecks and variability and hence obviate the need for firms to create slack resources (Galbraith, 2002; Cotteleer & Bendoly,

2006; Bendoly, 2009). ERP module sub-systems can be configured at various levels to support self-contained tasks (Mohrman et al., 1998; Koch, 2001; Madapusi & D'Souza, 2005). The use of modular vertical information systems, such as ERP module sub-systems, caters to the increase in need for information processing (Galbraith 2000; Markus et al., 2000; Koch, 2001). ERP creates lateral resources cutting across module sub-systems through the linking of process and coordination needs (Galbraith, 2002; Bendoly & Jacobs, 2005; McGaughley & Gunasekaran, 2007). The overall effect of both these modes is to effectively balance the amount of uncertainty faced by organizations and the amount of information processing done in organizations, and thereby increase performance. The findings of the above studies, in the context of this research study's objectives, suggest that:

> *H1: The implementation status of ERP module sub-systems contributes to changes in overall performance.*

Galbraith et al. (1993), as part of their organizational information processing theory approach, suggest that firms focus on competence factors to achieve successful information system implementations. Mohrman et al. (1998) suggest that firms should focus on competence factors that affect external partners so that modular information systems could be successfully deployed across the supply chain. Galbraith et al. (2002) provides further support to the findings of the above studies and suggests that firms leverage technologies such as e-coordination to manage competence factors that are critical to modular information system deployment success. A synthesis of ERP system research indicates that, in tune with the organizational information processing approach, firms that effectively manage their technical competency factors can successfully implement their ERP systems (Stratman & Roth, 2002; Koh et al., 2011; Chang et al. 2013). Such an approach in tandem with the ERP system deployment helps firms fine-tune their systems in accordance with evolving business and user needs. This in turn results in substantial performance benefits flowing to firms (Mabert et al., 2001; Tarafdar & Roy, 2003; Masini & Wassenhove, 2009). The findings of their studies, in the context of this research study's objectives, suggest that:

> *H2: Technical competency factors moderate the relationship between the implementation status of ERP module sub-systems and changes in overall performance.*

METHODOLOGY

This research study used a cross-sectional field survey to obtain data from firms in India across a variety of production environments. The survey questionnaire was initially developed from a synthesis of ERP system research considered relevant to this study's objectives. The questionnaire development involved a three-step process – inputs from an international focus groups of academicians and practitioners, a pre-test in a graduate ERP class, and a pilot study in a production firm that had implemented ERP. At each step of the questionnaire development process, feedback was incorporated. The final questionnaire collected information pertaining to firm and respondent demographics, the implementation status of the ERP system, performance changes obtained from the ERP deployment, and the technical competence factors that influence the ERP implementation.

Operational Definitions

Independent Variables

A synthesis of different types of methodological studies – descriptive, case, and survey – yielded fourteen modules commonly cited by researchers as comprising the ERP system (Appelrath & Ritter, 2000; Mabert et al., 2000; Olhager & Selldin, 2003). The data for each of the modules were obtained using a scale consisting of the following ranges of implementation status: not implemented (NI), implementation started within the last year (0 to < 1 year), implementation started 1 or more but less than

3 years ago (1 to < 3 years), implementation started 3 or more but less than 5 years ago (3 to < 5), and implementation started 5 or more years ago (5+).

Dependent Variables

A synthesis of different types of methodological studies – descriptive, case, and survey – yielded ten performance measures commonly cited by researchers as used to evaluate the performance of ERP systems (Poston & Grabski, 2001; Mabert et al., 2003; Tarafdar & Roy, 2003). The data for each of the performance measures were obtained using a 7-point Likert type scale ranging from 1 (disagree) to 7 (agree).

Moderating Variables

A synthesis of different types of methodological studies – descriptive, case, and survey – yielded three technical competence factors commonly cited by researchers as used to facilitate ERP system implementations (Mabert et al., 2001; Teltumbde, et al., 2002; Stratman & Roth, 2002). The data for each of the technical competence factors were obtained using a 7-point Likert type scale ranging from 1 (disagree) to 7 (agree).

Data Collection

To obtain data on the implementation of ERP systems, production firms that formed part of the Confederation of Indian Industry (CII) member directory (n = 900) was identified as the sample for this study. The survey questionnaire was mailed out in two waves and a total of 231 responses were returned for a response rate of 25.67% (231/900). Fifteen questionnaires with incomplete data and 13 questionnaires pertaining to service firms were discarded. The effective sample used for analysis was 203 firms (203/900 – response rate of 22.56%). The data were examined and no non-response and common method biases were detected.

ANALYSIS AND RESULTS

The survey questionnaire gathered demographic data pertaining to the size of the firm, firm type and origin, industry type, the type of ERP system implemented, and respondent characteristics.

Firm and Respondent Characteristics

The number of employees over 500 was the category most frequently represented and accounts for about 65% of the sample. More than half the organizations in the sample have a mix of both unionized and non-unionized environments and represent 54% of the sample. A majority of the organizations are of Indian origin (78% of the sample) and belong to the private sector (82% of the sample). Make-to-order was the primary production system used by organizations in the sample (62%), with a repetitive type production flow being the one most frequently represented (26%). A wide variety of industries are represented in the sample. The majority of industries (67% of the sample), however, fall into one of ten major industry groups with the automotive industry accounting for 21% of the sample.

The majority of the respondents possess more than 10 years of work experience accounting for 92% of the sample and about 57% have been with the present organization for more than 10 years. More than half the respondents belong to the top management category and account for 51% of the sample. This is closely followed by the middle management category (40% of the sample). A majority of the respondents work in the information technology/systems area and represent 85% of the sample. 99% of the respondents possess a bachelor's degree and above, with nearly 59% having a master's degree.

The majority of the organizations in the sample implemented a single vendor ERP system representing 68% of the sample. SAP is the dominant ERP system implemented by 29% of the sampled organizations. In-house developed ERP systems represent the second most dominant ERP system implemented among the sampled firms accounting for 26% of the sample.

Factor Analysis Results

The data were first examined and their suitability for conducting factor analysis was established. The fourteen modules forming part of the ERP system were first factor analyzed. Based on a priori criterion the number of factors to be extracted was entered as two (i.e. intra and inter-firm module sub-systems) as discussed earlier in the literature review section. The total variance extracted by the two factors was 50.31%. Table 1 indicates that 10 modules loaded onto factor one and the remaining four modules onto factor two.

TABLE 1
MODULE SUB-SYSTEM COMPONENT ANALYSIS FACTOR MATRIX

ERP System Modules (Intra-firm module sub-system) Loadings	(Inter-firm module sub-system) Loadings	Factor 1	Factor 2
Financials		**.902**	.044
Materials Management		**.899**	.042
Sales and Distribution		**.859**	.067
Production Planning		**.807**	.217
Quality Management		**.713**	.216
Controlling		**.677**	.191
General Logistics		**.537**	.191
Plant Maintenance		**.519**	.280
Human Resources		**.475**	.321
Project Systems		**.384**	.097
CRM		.078	**.710**
SCM		.161	**.698**
E-Commerce		.142	**.604**
APO/APS		.132	**.583**

As per the a priori criterion, factor one (intra-firm module sub-system) consists of modules that firms implement to address intra-firm activities and factor two (inter-firm module sub-system) comprises of modules that firms deploy to address inter-firm activities. The factor loadings for the 10 modules in the intra-firm module sub-system range from 0.384 to 0.902 and those for the four modules in the inter-firm module sub-system from .583 to .710. The internal consistency of the two module sub-system scales was estimated using Cronbach's Alpha and yielded a reliability coefficient of 0.888 for the intra-firm module sub-system scale and .578 for the inter-firm module sub-system scale. We follow Hair et al.'s (1998) suggestion that Cronbach's alpha of around 0.60 be considered acceptable in exploratory research and hence include the intra-firm module sub-system scale in further analysis.

The ten performance measures were then factor analyzed and the results are presented in Table 2. The latent root criterion as well as the scree test criterion indicates that all the ten performance measures loaded onto a single factor accounting for 57.26% of the total variance. The results in the table indicate that all the ten performance measures had factor loadings exceeding 0.70 and these varied within a narrow range from .734 to .799. The internal consistency of the aggregate performance scale was estimated using Cronbach's Alpha and yielded a reliability coefficient of 0.914 for the overall performance scale.

TABLE 2
PERFORMANCE COMPONENT ANALYSIS MATRIX

Performance	Factor Loadings
Return on Investment	**.799**
Information Availability	**.788**
On-Time Delivery	**.763**
Profitability	**.757**
Competitive Advantage	**.756**
User Satisfaction	**.751**
Customer Satisfaction	**.751**
Inventory Management	**.740**
Standardization	**.735**
Information Quality	**.734**

The items belonging to the multi-item technical competence factors were factor analyzed and the results are given in Table 3. The implementation team factor comprised of items with factor loadings ranging from .476 to .758. The internal consistency of the implementation team factor was estimated using Cronbach's alpha and yielded a reliability coefficient of .868.

TABLE 3
TECHNICAL COMPETENCE FACTOR COMPONENT ANALYSIS FACTOR MATRIX

Technical Competence Factors	Factor Loadings	Cronbach's Alpha
Implementation Team		.868
a. The implementation team has the ability to implement, maintain, and upgrade the ERP system.	.758	
b. The implementation team actively builds relationships with business managers.	.711	
c. The implementation team offers suggestions on how the ERP system can be used to achieve business goals.	.705	
d. The implementation team is responsive to end-user needs.	.600	
e. ERP improvement suggestions are regularly collected from multiple employee levels	.476	
Data Accuracy		.730
a. Data integrity in the ERP system affects the efficiency of our operations and the quality of our business decisions.	.752	
b. Data integrity requires awareness and control of dirty data right from the pre-implementation stage of the ERP system.	.806	

c. Maintaining data integrity is an ongoing process that needs to be ensured by all employees.	.729	
Consultants		.633
a. Involvement of external consultants in the ERP system implementation is an ongoing effort.	.713	
b. The role of external consultants should be phased out by capturing and transferring their expertise to the in-house team.	.531	
c. External consultants help streamline our implementation effort and achieve quicker ERP project success.	.766	

The data accuracy factor comprised of items with factor loadings ranging from .729 to .806. The internal consistency of the data accuracy factor was estimated using Cronbach's alpha and yielded a reliability coefficient of .730. The consultants factor comprised of items with factor loadings ranging from .531 to .766. The internal consistency of the consultants factor was estimated using Cronbach's alpha and yielded a reliability coefficient of .633. Hair et al. (1998) suggests that the reliability criterion may be decreased to 0.60 in exploratory research and hence consultants scale was included in this study.

Regression Models

The data were first examined and their suitability for conducting multiple regression analyses was established. An analysis of residuals, partial regression plots, scatter plots, and an examination of the histograms of residuals indicate that the data were fit for carrying out regression analyses.

Testing Hypothesis H1

As indicated earlier, two ERP module sub-system factors (intra and inter-firm module sub-systems) and one overall performance factor were obtained from the factor analysis of the fourteen ERP system modules and ten performance measures respectively. Summated scales were constructed to measure the two module sub-systems of the ERP system and the overall change in performance. Regression models were developed to analyze the overall change in performance resulting from the implementation of the intra-firm and inter-firm module sub-systems. The results of the regression analysis are shown in Table 4. The results indicate support for H1.

The percentage of total variance in the overall change in performance that is explained by the intra-firm module sub-system is 7.9%. The results indicate that firms experience overall change in performance when they implement the ten modules forming part of the intra-firm module ERP system. The results in Table 4 indicate that the percentage of total variance in the overall changes in performance that is explained by the inter-firm module ERP system is 2.5%. The results further indicate that firms obtain overall change in performance when they implement the four modules comprising the inter-module ERP system.

TABLE 4
TESTING HYPOTHESIS 1: SIGNIFICANT RELATIONSHIPS BETWEEN TWO ERP MODULE SUB-SYSTEMS AND OVERALL CHANGE IN PERFORMANCE

Implementation Status of ERP Module Sub-system	Overall Change in Performance (Factor - 10 Performance Measures) β	R^2	F
Intra-Firm Module Sub-system	.281***	.079	17.215***
(Factor - comprising of 10 modules - Financials, Controlling, Plant Maintenance Materials Management, Production Planning, Project Systems, Sales and Distribution, General Logistics, Quality Management, Human Resources)			
Inter-Firm Module Sub-system	.159*	.025	5.208*
(Factor - comprising of 4 modules - (SCM, CRM, E-commerce, APO/APS)			

Note:
β : All values are standardized regression coefficients
Significance: * $p < .05$, ** $p < .01$, *** $p < .001$

Testing Hypothesis H2

Summated scales were constructed for each of the three technical competence factors. Regression models were developed to analyze the overall change in performance resulting from the interactions between the three technical competence factors and the intra-firm and inter-firm module sub-systems. The results of the regression analysis are shown in Table 5. The results indicate partial support for H2. The results indicate that there are interaction effects between the intra-firm module sub-system and the implementation team and the consultants factors on the overall change in performance. The interaction effect of the consultants factor is, however, negative indicating that as elements of this factor increases there is a decrease in overall firm performance.

The results in Table 5 also indicate that there are significant interactions between the inter-firm module sub-system and the data accuracy factor on the overall change in performance. The interaction effects of the data accuracy factor is, however, negative indicating that as elements of this factor increases there is a decrease in overall firm performance. The results indicate that firms obtain overall performance benefits when they focus on the implementation team factor while implementing the intra-module sub-system. Also, firms that focus on the consultants and the data accuracy factors will obtain decreased performance benefits when implementing the intra-module and inter-module sub-systems respectively.

TABLE 5
TESTING HYPOTHESIS 2: SIGNIFICANT INTERACTION RELATIONSHIPS BETWEEN TWO ERO MODULE SUB-SYSTEMS AND OVERALL CHANGE IN PERFORMANCE

Implementation Status of ERP Module Sub-system X Technical Competence Factors	Overall Change in Performance (10 Performance Measures)		
	β	ΔR^2	ΔF
Intra-Firm Module Sub-system X			
Implementation Team	.870*	.015	4.542*
Consultants	-.757*	.027	6.108*
Inter-Firm Module Sub-system X			
Data Accuracy	-.836*	.026	6.092*

Note:
β : All values are standardized regression coefficients
Significance: * $p < .05$, ** $p < .01$, *** $p < .001$

DISCUSSION

This study used a theory driven approach to field-test an ERP system implementation model in the Indian ERP market. The findings suggest that the implementation of the ERP module sub-systems leads to overall performance improvements. Moreover, firms obtained increased benefits from their intra-module sub-system when they focused on the implementation team technical competence factor. The focus on the consultants and the data accuracy factors in intra and inter-firm module sub-systems respectively, however, leads to a decrease in performance benefits.

Hypothesis 1 was supported by the results of the regression analyses. Past research suggests that firms typically implement modules to take care of their internal activities and then as these deployments stabilize they implement modules that pertain to inter-firm activities. The findings from our study support the above findings. Firms obtain increased performance benefits from deploying the modules pertaining to the intra-firm module sub-system; this is because firms integrate and fine-tune these modules over time to better suit their changing business needs and hence this results in the accrual of enhanced benefits. As firms gain experience in integrating and fine-tuning these intra-firm modules, they then turn their attention to deploying inter-firm modules so as to bring more and more inter-firm activities under the gambit of their ERP systems.

Hypothesis 2 was partially supported by the results of the regression analyses. In the case of the implementation team factor, the interaction suggests a strengthening of an already existing relationship between the intra-firm module sub-system and overall performance outcome. This finding suggests that implementation team members play a vital role in ensuring the success deployments targeted at internal firm operations. Firms probably deploy their best information technology and functional resources in accordance with implementation and user needs.

The consultants and the data accuracy factors, however, exhibit a significant weakening of the intra and inter-firm sub-systems to performance relationships respectively. These findings suggest that, contrary to accepted belief, consultants exert a negative influence on the implementation process. This could be due to the paucity of consultants with the requisite product, business, technical, and inter-personal skills to

guide the deployment process. The above suggests that firms should invest resources in developing the skill of their implementation team members rather than outsourcing these skills.

The negative interaction for the data accuracy factor suggests that firms' lack control over information that comes into the ERP system from supply chain partners. This finding suggests that firms should take care of deficiencies in their data collection processes and take cognizance of data integrity issues in the ERP system as bad data affects decision-making quality and can 'make or break' implementations. Firms should foster an information quality culture that ensures that supply chain partners understand the concept and value of integrated ERP information.

Some caution should be exercised when interpreting the results of this study. The cross-sectional design of this research study doesn't denote causality but indicates that a correlation exists between ERP systems, technical competence factors, and changes in performance. This study further examined ERP system implementations in a production environment; a survey of service firms may yield different results due to varied emphasis placed on ERP system module configurations, and the performance measures focused on; therefore, the generalizability of the study's findings may not be fully applicable to them. Future research should use of longitudinal designs to capture over time the effects of differing ERP system implementation statuses, upgradations, and increased performance. The performance measures and the technical competence factors used in this study represent those that are typically in use; future research could help identify performance measures and technical competence factors that take into account those that are critical to all of a firm's stakeholders.

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