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The Systemic Diffusion of Enterprise Systems

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Abstract

In this study, we empirically examine the diffusion of enterprise systems (ES) systems, and the influence of competency factors on firm performance. A model, based on systems and innovation diffusion theories, was developed and a survey instrument used to gather data from a sample of production firms to test the hypothesized model relationships. The results of the multivariate analyses indicate that ES subsystem implementation statuses influence firm performance differently, and that competency factors play an important role in augmenting firm performance. The findings suggest that an adopter-subsystem-systemic diffusion and competency-based approach to ES implementations can help firms obtain increased benefits from their deployments.

Keywords: Enterprise Systems, Systemic Diffusion, Competency Factors, Firm Performance. Categories: Research, Mixed, Management/Management Information Systems

Introduction

Enterprise Systems (ES) are technological innovations that enable firms to hone and optimize their data and process flows and improve performance (Hendricks, Singhal, & Stratman, 2007; Davenport & Harris, 2007). Past studies (Karimi, Somers, & Bhattacherjee, 2007; Chou & Chang, 2008) suggest that firms face difficulties in leveraging their ES and in achieving effective integration, due to a failure to focus on competency factors in tandem with their technical deployments. There is evidence in innovation diffusion literature (Quinn, Baruch, & Zien, 1997; Rogers, 2003), and systems literature (Scott, 2002; Galbraith, Downey D., & Kates, 2002), that suggests that innovation or system facilitators (e.g., competency factors) impact the adoption and the diffusion of innovations (e.g., ES), and hence system or innovation outcomes (firm performance). Researchers have examined the impact of different competency factors on the implementation and diffusion of ES, and hence firm performance, such as top management (Wang, Chou, & Jiang, 2005), communication (Finney, 2011), organizational culture (Ke & Wei, 2008), and consultants (Wang & Chen, 2006).

Past innovation research (Rogers, 2003) and innovation-based research on ES (Elbertsen, Benders, & Nijssen, 2006) identified the direct precursors (such as innovation features, and competency factors) of innovation, and examined the effect of each precursor on firm performance. There is, however, a paucity of research on the interaction between the precursors of innovation such as innovation features and competency factors. We believe that this is a research gap that has not been adequately addressed by researchers. The interaction between innovation features and competency factors could be the missing link that influences firm performance. In this study we seek to move this research stream forward by examining the relationship between ES implementation (diffusion of an innovation) and firm performance

(the outcome of the diffused innovation), and the moderating role of competency factors (innovation or system facilitators).

In this paper, we first provide theoretical arguments for the development of a research model. Next, we test the model with survey data obtained from a sample of production firms that have deployed ES. Lastly, we provide an overall summary of our findings, and discuss implications for researchers and practitioners.

Theoretical Background

Diffusion is the process by which an innovation is communicated over time among members of an organization (Rogers, 1962). Rogers (2003) indicates that "innovativeness" is at the heart of this diffusion process. At any point in time "innovativeness" represents the degree to which a firm is earlier in adopting an innovation relative to other firms. Hence, the diffusion process over time facilitates the grouping of firms into innovation adopter categories. Past studies (Hitt, Wu, & Zhou, 2002; Bendoly & Jacobs, 2005; Stratman, 2007) further indicate that that a "systemic" concept underlies ES modules that support various intra and inter-firm activities. Their findings suggest that the linkages between the various ES modules facilitate a systems deployment approach that would enable firms to enhance their performance. Kwon and Zmud (1987), and Zmud and Apple (1989) tie implementation status to the diffusion of information technology systems; their studies indicate that systems (and hence firms) follow an adaptive cycle based on innovativeness. This suggests that the time element of the diffusion process facilitates the classification of deployments into four adopter subsystems: adaptation, acceptance, routinization, and infusion; in this study we adapt these to describe and classify ES adopter subsystem deployments. With the adaptation subsystem, during the early stages of ES deployment, firms focus on ES module-business process alignment; with the acceptance subsystem, when the ES deployment stabilizes, firms become more innovative and tweak ES modules to better meet their business needs (Cooper & Zmud, 1990). With the routinization subsystem, firms use the stabilized ES and leverage ES modules for carrying out daily transactional activities; and with the infusion subsystem, firms innovate to leverage the strategic capabilities of ES modules to enhance performance (Palaniswamy, 2002).

As innovations are largely technology-based, Coopers & Zmud (1990) suggest that an ES deployment is an organization-wide effort to diffuse the innovation (i.e., ES) within and beyond the firm. A unique characteristic of ES implementations is that firms tend not to deploy all ES modules simultaneously; instead, they do so systemically over a period of time. Hence, in an ES implementation context, we can classify a firm's "innovativeness" systemically into adopter subsystems based on when firms began deploying modules, and measure it in terms of the years since implementation of the innovation first began, i.e., in terms of ES "implementation status." Past studies suggest that to obtain maximum advantage from an ES, firms must work to rapidly diffuse the ES within the organization (Gattiker & Goodhue, 2004; Stratman, 2007). Galbraith (1977), and Rogers (2003) suggest that diffusions should be managed so as leverage the strength of system elements (e.g., ES modules) and system facilitators or organizational members (i.e., competency factors).

ES Attributes & Outcomes

Past research studies largely used attributes of innovations to investigate their diffusion, and influence on firm performance (Rogers, 2003; Cooper & Zmud, 1990). Rogers (2003) indicates that five attributes can significantly explain the diffusion of innovations: relative advantage, compatibility, complexity, trialibility, and observability. Relative advantage refers to whether an innovation is regarded as better than the one it replaces (Rogers, 2003; Cooper & Zmud, 1990). ES possess relative advantage as they

extend material planning systems, and manufacturing resource planning systems, beyond the firm to include supply chain members. Compatibility refers to the extent an innovation is compared with past, existing, and potential needs of adopters (Rogers, 2003; Bradford & Florin, 2003). ES deployments need to be compatible with previously introduced ideas (i.e., each additional module deployed be compatible with the rest of the ES thus adding to the systemic effect), existing socio-cultural values (i.e., innovation facilitators or competency factors that influence their diffusion), and the needs for the innovation (i.e., each additional module implemented meets specific business needs of the firm).

Complexity refers to the extent an innovation is challenging to learn and use (Bradford & Florin, 2003; Elbertsen et al., 2006). The adoption of one innovation element (e.g., a single ES module) triggers the adoption of other innovation elements (e.g., more and more ES modules to form a complete ES) and such innovation clusters (e.g., ES adopter subsystems), due to their inter-relatedness, facilitates system usage and thereby reduces complexity (Rogers, 2003). Trialability refers to the extent an innovation is initially deployed (Rogers, 2003; Ben & Papazafeiropoulou, 2004). Firms leverage the modular nature of the ES to progressively deploy modules that systemically best meets their evolving intrafirm and inter-firm business needs. Observability refers to whether an innovation's "early wins" are visible to others (Rogers, 2003; Ruivo, Oliveira, & Neto, 2012). Past studies (Mabert, Soni, & Venkataramanan, 2001; Olhager & Selldin, 2003) suggest that early informational and transactional benefits from ES deployments are visible through operational improvements such as the availability of quality information, and streamlined and standardized processes.

ES Facilitators & Outcomes

Innovational attributes are a significant factor in describing innovation diffusion; an equally significant factor is facilitators of innovations. Rogers (2003) suggests that there are four significant facilitators that influence the diffusion of innovations: innovation decision (i.e., top-down or top management driven decision-making), communication avenues (i.e., mass media and interpersonal communication within the firm), social system (i.e., the firm's organizational culture), and change agents' (i.e., consultants'). From a systems theory perspective, Galbraith, Lawler III, & Associates (1993), Mohrman, Galbraith, Lawler III, & Associates. (1998), and Scott (2202) suggest that firms focus on facilitators such as top management support, communication, organizational culture, and change agents to successfully integrate and deploy modular information systems. The findings of these studies, in the context of this research study's objectives, suggest that facilitators or competency factors influence the diffusion of ES through the organization.

Rogers (2003), and Leonard-Barton & Deschamps (1988) argue that innovation supported by an "authority source" leads to its rapid diffusion. Their findings indicate that technology implementation is an internal diffusion process that is best driven by top management support. As ES deployments change the way that firms do business, Liang, Saraf, Hu, & Xue (2007) suggest that top management direction and support are critical to align technology and business needs, which in turn improves firm performance. The use of mass media as well as interpersonal communication channels influence the diffusion of innovations (Davenport, 1993; Rogers, 2003). Their findings indicate that a combination of mass media and interpersonal communication increases the rapid diffusion of an innovation across the firm. Researchers such as Finney (2011) suggest that open communication within the firm through the ES deployment leads to rapid acceptance and productive usage of the ES, and hence positively affects firm performance.

The nature of a social system such as its norms and communication network structures affects the diffusion of innovations (Quinn, et al., 1997; Rogers, 2003). Their findings suggest that organizational culture is critical in managing employees linked by patterned and systemic flows of information. Past studies (Ke & Wei, 2008; Madapusi, 2019) indicate that information transparency and organizational practices resulting from interconnected communication networks help firms effectively align organizational culture and ES deployments, thus positively influencing firm performance. An innovation's diffusion is influenced by a change agent's efforts (Rogers, 2003). Past studies (Wang & Chen, 2006; Madapusi & Ortiz, 2014) indicate that consultants are a critical resource who aid in implementation support, promote conflict resolution among ES stakeholders, and have a direct bearing on firm performance.

Research Model

The preceding discussion suggests that an innovation (i.e., ES) implementation impacts firm performance, and this relationship is moderated by innovation or system facilitators (competency factors). The ES and its relationship to firm performance, and the role of competency factors in influencing the above relationship is presented in Figure 1. In the section below, we develop hypotheses related to our research model.

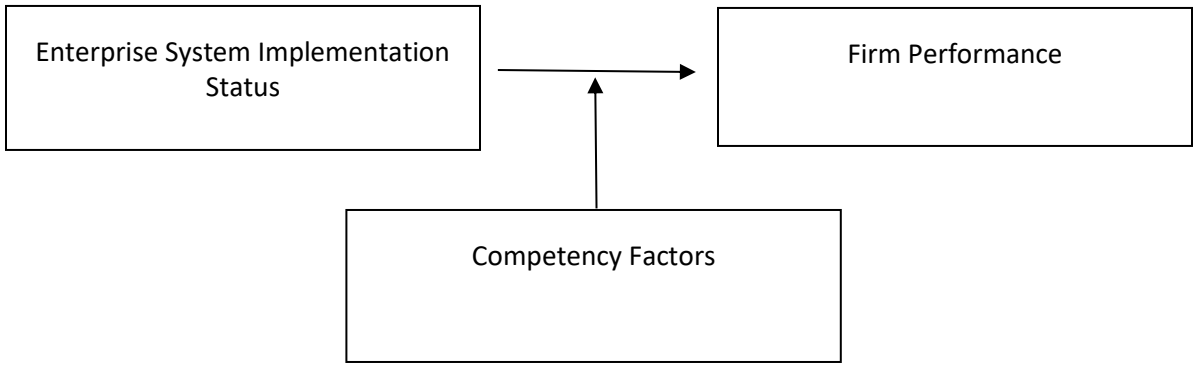

Figure 1. The Moderating Influence of Competency Factors in ES Implementations

Fichman (2004), and Karimi et al. (2007) indicate that innovation quantity influences firm performance; in the context of ES , the modules deployed in an adopter subsystem, and the time since implementation influence firm performance. Researchers (Ranganathan & Brown, 2006; Karimi et al., 2007; Zhu, Kraemer, & Xu, 2006) suggest that the scope of the ES deployment impacts its diffusion and hence firm performance. Madapusi & D'Souza (2012) indicate that the ES implementation status influences firm performance; their findings suggest that firms derive benefits from the "implementation status" (the length of time modules have been implemented) of an adopter subsystem that they believe will contribute to firm performance. The first model linkage in Figure 1 suggests a relationship between ES implementation status and firm performance. H1: The implementation status of ES adopter subsystems are positively and significantly correlated with firm performance.

Rogers (2003), and Fichman (2004) suggest that diffusion influences organizational changes, and that innovation facilitators convert innovation quantity into performance gains. Studies show that, most often,

firms face difficulties with ES deployment success due to their inability to institute organizational changes that complement the technical deployment of their ES (Osei-Bryson, Dong, & Ngwenyama, 2008; Koh, Gunasekaran, & Goodman, 2011). Firms that effectively manage competency factors, which support organizational change have been found to reap benefits from their ES (Bendoly and Jacobs, 2005; Tsai, Shaw, Fan, Liu, Lee, & Chen, 2011). These findings suggest that performance gains are enhanced when competency factors are leveraged to facilitate ES adopter subsystems. The second model linkage in Figure 1 suggests that competency factors moderate the relationship between ES implementation status and firm performance. H2: Competency factors moderate the relationship between implementation status of ES adopter subsystems and firm performance.

Methodology

A field survey was used to obtain data from a sample of Indian production firms. The survey was implemented using postal and email procedures. Data were analyzed using factor analysis, and multiple regression analysis.

Survey Questionnaire

The survey instrument, developed from ES and other relevant literature, went through a three step validation process: focus groups from academia and industry, pre-test in a graduate ES class, and a production firm which had implemented an ES. The final instrument included items that gathered information on firm and respondent characteristics, ES implementation status, competency factors, and firm performance.

Model Variables

ES Implementation Status. A synthesis of ES literature and major ES vendors' websites yielded 14 modules frequently cited by researchers as comprising the ES (Mabert, Soni, & Venkataramanan, 2003; Olhager & Selldin, 2003; Madapusi & D'Souza, 2012; www.sap.com; www.oracle.com). The 14 modules identified are financials, controlling, plant maintenance, materials management, production planning, project management, sales and distribution, logistics, quality management, human resources, supply chain management (SCM), customer relationship management (CRM), electronic commerce (E-Commerce), and advanced planner optimizer/advanced planner scheduler (APO/APS). Data for these 14 modules were obtained using a scale (White, Pearson, & Wilson, 1999; Madapusi & D'Souza, 2012) with the following ranges of ES implementation statuses: 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+).

Firm Performance. A synthesis of ES and management literature yielded 10 measures commonly used in evaluating firm performance arising out of ES deployments (Mabert et. al., 2003; Soja, 2006; Wang, Shih, Jiang, & Klein, 2008; Madapusi & Ortiz, 2014) – inventory management, information availability, information quality, standardization, on-time delivery, profitability, return on investment (ROI), user satisfaction, customer satisfaction, and competitive advantage. A 7-point Likert type scale ranging from 1 (disagree) to 7 (agree) was used to obtain data for each of the 10 performance measures.

Competency Factors. A synthesis of ES and management literature yielded four competency factors believed to facilitate ES deployments (Wang et al., 2005; Ke & Wei, 2008; Finney, 2011; Hofstede, Neuijen, Ohayv, & Sanders, 1990; Madapusi, 2019) – top management, communication, organizational

culture, and consultants. A 7-point Likert type scale ranging from 1 (disagree) to 7 (agree) was used to obtain data for each of the four competency factors.

Data Collection

The sample for the study comprised of 900 production firms forming part of the Confederation of Indian Industry (CII) member list. The member firms are from varied industries such as basic metal, automotive, machinery and equipment, fabricated metal, electronic, travel, food products, etc. The CII member list indicates that the members represent a balanced mix of production firms and hence can be broadly regarded as representative of the Indian production sector. A two-wave survey was conducted using postal mail and email, and an effective sample of 203 firms were obtained. As many of the sampled firms were not publicly traded and hence public information was not available, follow-ups with a sample of non-respondents indicated no systematic non-respondent bias in survey completion. Methods to avoid common method bias (Podsakoff & Organ, 1986) were followed to the extent possible, such as scale re-ordering, use of a purposive sampling technique, and a two-wave multi-mode survey administration.

The data were examined to assess their suitability for performing multivariate analyses. The correlation matrices for the model variables indicated that most correlations were greater than 0.30 and that the correlations in the anti-image correlation matrix were small. The measures of sampling adequacy were found to be between .60 (mediocre) to 0.91 (meritorious), and the Bartlett's tests of sphericity were significant, suggesting the data were apt for performing factor analysis. An evaluation of the correlation matrix between the independent variables in the model indicated that multicollinearity was not an issue. No violation of the regression assumptions were noted; further, a regression test indicated that demographic data did not influence the hypothesized relationships, thereby suggesting that the data were apt for conducting regression analysis.

Analyses & Results

Demographic & Respondent Profile

The survey questionnaire collected data on firm size, type of firms, origin of firms, industry type, ES vendor, and respondent attributes. The sample comprised of firms of different sizes, from a variety of industries, using different types of production processes, and hence can be broadly considered to reflect the characteristics of the Indian production sector. A perusal of respondent profiles indicated that about 90% of the respondents were top and middle level managers. Firms with over 1000 employees comprised about 41% of the sample. Firms in the automotive industry accounted for about 22% of the sample, followed by machinery and equipment (10%). Firms that deployed a single vendor ES formed 65% of the sample, with SAP 's share being 30%.

Performance Scale

The data for the performance measures were factor analyzed and the results given in Table 1 indicate that all the measures had factor loadings exceeding 0.70 and loaded onto a single ten-factor solution. Internal consistency analysis resulted in a Cronbach's Alpha of .91 for the performance summated scale.

Performance Measures	**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

Table 1. Performance Component Analysis Factor Matrix

Competency Factors Scales

The data for the competency factors were factor analyzed and the results given in Table 2 indicate that all the measures had factor loadings exceeding 0.65. Cronbach's Alpha resulting from internal consistency analysis for each of the competency factors summated scale are given in the table.

Competency Factors	**Factor Loadings**
Top Management	*Cronbach's Alpha 0.916*
Top management has invested the time needed to understand how ES will benefit the business unit.	0.875
The need for long-term ES support resources is recognized by top management.	0.853
Top management mandates that ES requirements have priority over unique functional concerns.	0.813
Top management has clearly defined the ES project's business goals.	0.878
All levels of management support the overall goals of the ES project	0.855
A cross-functional steering committee periodically reviews the ES project's progress.	0.796
Communication	*Cronbach's Alpha 0.848*

Open and honest communication throughout the business unit facilitates the ES system implementation process.	0.839
Communication is an ongoing process among employees throughout the ES system project.	0.925
Managing user input in the communication process results in greater understanding of organizational needs and quicker acceptance of the ES system.	0.867
Consultants	*Cronbach's Alpha 0.633*
Involvement of external consultants in the ES system implementation is an ongoing effort.	0.691
The role of external consultants should be phased out by capturing and transferring their expertise to the in-house team.	0.842
External consultants help streamline our implementation effort and achieve quicker ES project success	0.749
Organizational Culture	*Cronbach's Alpha 0.633*
It is very easy for my coworkers to access the ES system to see the status of my work performance.	0.657
Job descriptions and task procedures in our business unit is highly specific and detailed.	0.653
The ES system enables tight control by providing very reliable information on how well or badly employees do their work.	0.830
The ES system has enabled our business unit to be more market-driven and customer-oriented.	0.786
The ES system has enabled me to identify myself more clearly with my job.	0.708

Table 2. Competency Factors Component Analysis Factor Matrix

Significant ES Modules based on Innovativeness

ES deployments were classified into adopter subsystems (adaptation, acceptance, routinization, and infusion) using the mean of years since implementation of the ES modules. The results of the classification are presented in Table 3.

Implementation Status of ES Modules	Mean of years since Implementation	ES Adopter Subsystems
> 0 to < 1 year		*Adaptation*
Project System	.92	
E-commerce	.45	
APO/APS	.42	
CRM	.38	
> 1 to < 2 years		*Acceptance*
Logistics	1.84	
Human Resources	1.72	
Plant Maintenance	1.55	
SCM	1.02	
> 2 to < 3 years		*Routinization*
Production Planning	2.96	
Quality Management	2.24	
Controlling	2.23	
> 3 to < 4 years		*Infusion*
Materials Management	3.66	
Financials	3.61	
Sales & Distribution	3.40	

Table 3. Significant ES Modules based on Innovativeness (i.e., ES Implementation Status)

Adopter Subsystem Scales

The data for the modules in each of the adopter subsystems were factor analyzed and the results given in Table 4. An examination of the factor loadings indicates that all the modules items loaded onto their respective adopter subsystems with factor loadings exceeding .49. The Cronbach's alpha for the adaptation subsystem was .48, acceptance subsystem .55, routinization subsystem .80, and infusion subsystem .94. The Cronbach's alpha for the 14 modules forming the ES was 0.87. Past research (Tuan, Chin, & Shieh, 2005; Taber, 2018) suggest that in exploratory research, lower values of Cronbach's alpha are permissible.

Implementation Status of ES Modules	Factor Loadings	ES Adopter Subsystems
> 0 to < 1 year		*Adaptation*
Project System	.489	
E-commerce	.775	
APO/APS	.589	
CRM	.630	
> 1 to < 2 years		*Acceptance*
Logistics	.542	
Human Resources	.729	
Plant Maintenance	.705	
SCM	.616	
> 2 to < 3 years		*Routinization*
Production Planning	.846	
Quality Management	.866	
Controlling	.824	
> 3 to < 4 years		*Infusion*
Materials Management	.951	
Financials	.943	
Sales & Distribution	.930	

Table 4. ES Adopter Subsystems Component Analysis Factor Matrix

Regression Models

Hypothesis H1. A test for hypothesis H1 was conducted using regression analysis and the results given in Table 5 indicate full support for the hypothesis. The table shows the significant parameter estimates of the fitted models.

Implementation Status of ES Adopter Subsystems	Firm Performance		
	β	**R^2**	**F**
Adaptation	0.173**	0.030	6.223**
Acceptance	0.260***	0.068	14.612***
Routinization	0.276***	0.076	15.522***

Infusion	0.210**	0.044	9.319**

Table 5. Relationship between Implementation Status of ES Adopter Subsystems and Firm Performance based on Innovativeness (i.e., ES Implementation Status)

Note

1) All β values are standardized regression coefficients 2) Significance: * p < .05, ** p < .01, *** p < .001

As seen in Table 5, all four ES adopter subsystems are significantly related to firm performance; the routinization adopter subsystem has the most significant impact on firm performance, followed by the acceptance adopter subsystem.

Hypothesis H2. A test for hypothesis H2 was conducted using regression analysis and the results given in Table 6 indicate partial support for the hypothesis. The table shows the significant parameter estimates of the fitted models.

Interaction Effects **Competency Factor x Implementation** **Status of ES Adopter Subsystems**	**Firm Performance** **β**	**R^2**	**F**
Top Management x Routinization	0.605***	0.038	12.009***
Organizational Culture x Infusion	0.622*	0.012	3.864*
Consultants x Routinization	0.341*	0.021	4.793*
x Infusion	0.316**	0.034	7.518**

Table 6. Interaction Effects of Competency Factors on the Relationship between Implementation Status of ES Adopter Subsystems and Firm Performance

Note

1) All β values are standardized regression coefficients

2) Significance: * p < .05, ** p < .01, *** p < .001

As seen in Table 6, the results indicate interactions between three competency factors (top management, consultants, and organizational culture) and the implementation status of various ES adopter subsystems. No significant interaction effects were found for the communications competency factor.

Discussion

In this research study, we sought to examine the relationship between ES implementation (diffusion of an innovation) and firm performance (the outcome of the diffused innovation), and the moderating role of competency factors (innovation or system facilitators). We then used systems and innovation diffusion theories to develop a theoretical framework and the ensuing model represented our hypotheses that the implementation status of ES adopter subsystems are positively and significantly correlated with firm performance with competency factors moderating the relationship. The results of our empirical examination indicate broad support for the hypothesized relationships. The findings of our empirical analysis that have implications for both researchers and practitioners is presented below.

ES Implementation Status & Firm Performance

The findings suggest that a significant and positive relationship exists between the ES implementation status of adopter subsystems (innovation diffusion) and firm performance (innovation outcomes).

Infusion Adopter Subsystem. The data indicates that three modules (materials management, financials, sales and distribution), exhibit a significant relationship to firm performance. Firms with deployments in the infusion adopter subsystem have taken a calculated risk in the early launch of their ES deployment. As all other ES modules posts transactions to and through the infusion adopter subsystem modules, this subsystem serves as a lynchpin to increase the modular compatibility of the ES, thereby integrating and streamlining business activities. In that respect, our findings support past research (Mabert et al., 2003) which suggests that firms in the infusion adopter subsystem can realize a distinct advantage in later years through self-sustained operations, enhanced control and lowered systems complexity through a nodal positioning of the infusion adopter subsystem modules in regular business activities.

Routinization Adopter Subsystem. The data indicates that three modules (production planning, quality management, controlling), exhibit a significant relationship to firm performance. Firms with deployments in the routinization adopter subsystem look to achieving a decisive point in the diffusion process so that it then later becomes selfsustaining. In this context, our findings suggest that the deployment of the routinization adopter subsystem helps employees gain “respect” for the ES by demonstrating the system’s ability to decrease complexity and uncertainty thereby enhancing diffusion of the innovation (i.e., ES) itself.

Acceptance Adopter Subsystem. The data indicates that four modules (logistics, human resources, plant maintenance, supply chain management), exhibit a significant relationship to firm performance. Firms with deployments in the acceptance adopter subsystem have typically deployed these modules recently, with instances also where they have not been fully deployed nor the ES reached steady state yet. Not surprisingly most ES modules that were significant for firms in the acceptance adopter subsystem were those that The Systemic Diffusion of Enterprise Systems 19 predominantly relate to boundary spanning activities of the firm. Past research (Su & Yang, 2010; Hsu, 2013) suggests that ES (with deployments in the “infusion” and “routinization” adopter subsystems) lay the groundwork for the deployment of boundary spanning modules (such as SCM) in firms in the “acceptance” adopter subsystem.

Adaptation Subsystem Category. The data indicates that four modules (project system, E-commerce, APO/APS, CRM), exhibit a significant relationship to firm performance. Firms with deployments in the adaptation adopter subsystem continue to deploy modules (such as CRM) that expand boundary spanning activities. Past research (Lin, Hwang, & Wang, 2007; Rudberg & Cederborg, 2011) suggests that SCM module deployments are followed by decision-support tools (such as APO/APS) geared towards ensuring efficient planning and control of production and distribution across the supply chain.

Role of Competency Factors

The findings suggest that competency factors moderate the relationship between the ES implementation status of adopter subsystems and firm performance.

Top Management. Past studies (Quinn et al., 1997; Leonard-Barton and Deschamps, 1988) suggests that the most crucial element in the diffusion of an innovation is top management’s outlook. Their findings suggest that top management support helps to routinize the diffusion process so that it become self-sustaining in later years. Their findings further suggest that top management support turns into a power

tool when adequate resources are provided to support a technological innovation followed by efforts to diffuse the innovation across the firm. Past studies (Ettlie, Perotti, Joseph, & Cotteleer, 2005; Wang et al., 2005) also suggest that continuous advocacy of the ES helps ensure that ES and business process needs are aligned through integration, effective system usage, and fine-tuning.

Organizational Culture. Rogers (2003) views technological diffusion as a social process than a technical matter, and suggests that infusion occurs when the innovation is The Systemic Diffusion of Enterprise Systems 20 compatible with organizational culture. The flow of experience that comes with ES deployments provides an experiential basis for commitment (Tyrell, 2000; Madapusi, 2019), and commitment-based coordination augments the benefits that innovations offer (Quinn & Rohrbaugh, 1983). The strengthening of organizational culture has a multiplier effect, which contributes to the quick infusion of the innovation.

Consultants. Davenport (2000) indicates that consultants play a critical role in the diffusion of the ES. Consultants use a socio-technical approach that includes the "technical" and the "people" components working in tandem with each other to guide and facilitate routinization of the ES deployments (Wang & Chen, 2006; Madapusi & Ortiz, 2014). Ko, Kirsch, & King (2005) suggest that in the post-implementation phase, it is essential that firms ensure that consultants transfer knowledge back to the firm. The findings suggest that consultants, through steering system upgrades and skills transfer, lay the groundwork for infusion of the ES deployments across the firm.

Conclusion & Future Study

In this study, we developed a research model to examine the relationship between ES implementation and firm performance, and the moderating role of competency factors. The results indicate that different implementation statuses of ES adopter subsystems result in different performance benefits for firms; and different competency factors influence the ES adopter subsystems implementation status and firm performance relationship. From a research angle, the study contributes to systems and technological diffusion literature through use of systems and innovation diffusion theoretical bases to examine ES, and moves this body of research forward by investigating the innovation features-facilitators interaction effect on the outcomes of innovation diffusion. From a practitioner perspective, our study suggests that firms direct their attention to top management, organizational culture, and consultants competency factors so that the ES diffusion is routinized and infused across the organization. Sustained focus on these competency factors would help firms rapidly diffuse modules belonging to the routinization and infusion subsystems. Swanson and Ramiller (2004) suggest that such a "mindful" ES deployment, grounded in innovation features and innovation or system facilitators, diffuses rapidly and provides for lasting improvements in performance. The lack of interactions of the ES adopter subsystems with the communication competency factor was unexpected given the importance accorded to communication in systems, innovation diffusion, and ES literature (Galbraith et al., 2002; Rogers, 2033; Finney, 2011). We surmise that firms could be using informal channels and networks and as such communication may not be captured formally, this manifests itself as a lack of interaction effect for the communication competency factor.

Future research could investigate the dynamic matching and the effective usage of various ES subsystem configurations to different types of business environments. The lack of support for the communication competency factor needs further fine-grained investigation. Some caution should be exercised when interpreting the results of this study. The findings from this study pertain to a production environment;

service environments may however require different emphasis on the various model variables, and hence the generalizability of this study's findings may not be fully applicable to service firms.

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