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# Increasing Process Improvement through Internet-based e-Business Innovations

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## ABSTRACT

This research proposes and empirically tests a model of post adoption process improvements realized through use of partners' Internet-based e-business applications. We identify constructs proposed within adoption and post-adoption use theoretical models as well as presented in existing inter-organizational systems research. Our analysis reveals purely organization-based factors; namely, information systems/technology infrastructure and propensity for like innovations; shape perceptions of process improvement, while technology, or innovation, based and external factors, i.e., ease of use and facilitating conditions respectively, serve as moderators of the relationships between predictors and process improvement.

## Keywords

IT innovation, complementarities, Internet-based e-business applications, process improvement, post-adoption behaviors, supply chain management.

## INTRODUCTION

As organizations increasingly rely on information technology (IT) for many of their products, processes, and services (Sambamurthy, Bharadwaj and Grover 2003), understanding the factors that facilitate or inhibit the adoption and diffusion of IT innovations constitutes an important area in information systems (IS) research and practice. Despite the attention given to organizational adoption, assimilation, and diffusion of IT innovations, in the end, organizations adopt IT innovations to improve some dimension of their performance. Thus, it is also important to understand the conditions under which IT innovation-related factors impact organizational performance (Fichman 2004). To do so researchers must link innovation-related variables to performance impacts. Such an examination requires an understanding of how investing, deploying, and leveraging IT creates business value, a key area of IS research in its own right.

IS researchers and practitioners have long investigated how IT can create corporate value. Early research indicated a weak relationship between IT investment and productivity, thereby initiating the term "productivity paradox" (Brynjolfsson 1993). More recent studies have found positive and stronger linkages between IT investments and organizational performance (Brynjolfsson and Hitt 1998). These studies often attribute their findings to IT's enabling role in the improvement of business processes, practices, and structures (Bharadwaj 2000). A principal finding is that IT is valuable, but its extent and dimensions are contingent on complimentary organizational resources (Wade and Hulland 2004).

The current study attempts to shed some light on this issue by exploring the conditions under which organizations perceive process improvements derived from post-adoption use of Internet-based applications. Specifically, we examine process improvements through inter-organizational e-business application initiatives. In doing so, we ask, *what organizational resource-related factors influence post-adoption perceptions of process improvements using partner deployed e-business applications?* Moreover, *what resource conditions serve to moderate the relationship between organization-related factors and process improvement?*

To answer these questions, we develop a theoretical framework grounded in the theory of complementarities. Based on this framework, a series of hypotheses are developed to test whether organization-innovation factors, in conjunction with innovation ease of use and facilitating conditions, are associated with process improvement. We derived organization-innovation factors (namely, IS/IT infrastructure and propensity for like innovations) from the diffusion of innovation and organizational innovation literature. Ease of use is modeled as a technology, or innovation, based factor and facilitating conditions, an external factor.

We conduct our empirical analysis in the healthcare industry, a setting often overlooked across a broad spectrum of management disciplines. This industry as a whole still completes in excess of half of all transactions each year utilizing paper, phone, and/or facsimile (Shortliffe 2005). While medical treatment innovations through technology advances thrive,

evolutions in business models aimed at developing both horizontal and vertical integration lag far behind (Herzlinger 2006), as healthcare traditionally adopts administrative technological innovations slowly (Middleton 2005). As the industry is faced with the challenge of increasing service quality while pursuing greater operating efficiencies through cost reductions, suppliers have begun adopting Internet-based purchasing applications. Existing costly sales forces facilitate a labor intensive vendor managed inventory environment. Here, supplier representatives often initiate purchase orders on behalf of individual medical practices through recurring on-sight contacts (Huckman 2003). Hence, we explore post-adoption process improvements through the use of Internet-based purchasing applications, surveying 253 independent small business level organizations.

The balance of this manuscript proceeds in the following order. The next section presents a review of the study's theoretical foundations and relevant background literature specific to proposed research hypotheses. The subsequent section details the research design, including measurement development, conduct of the empirical survey, and review of sample data. Finally, the results of the analysis are presented and discussed. The paper then concludes with a review of the research, study limitations, and future research directions.

## **THEORETICAL BACKGROUND AND RESEARCH MODEL**

### **Resource Complimentarities and the Business Value of IT**

IT business value is defined as "the organizational performance impacts of IT at both the intermediate process level and organization-wide levels, as well as comprising both efficiency impacts and competitive impacts" (Melville, Kraemer and Gurbaxani 2004, p. 287). Researchers have devoted substantial effort to determine the business value of IT (Kohli and Devaraj 2003). Relevant theoretical perspectives in examining IT business value include industrial organization theory (Belleflamme 2001), microeconomic theory (Brynjolfsson and Hitt 1996), the resource-based view of the firm (Mata, Fuerst and Barney 1995), and transaction cost theory (Clemons and Row 1991). A principal finding is that IT is valuable, but its extent and dimensions are contingent on complimentary organizational resources (Wade et al. 2004).

According to the economic theory of complementarities (Milgrom and Roberts 1995), a set of resources is complementary when returns to a resource vary in the levels of returns to other resources. These distinct yet interdependent resources support and mutually influence each other. For instance, recent work examines the impact of cross-unit IT synergies on firm performance from a complementarities perspective (Tanriverdi 2006). With respect to the organizational adoption of innovations, firms are better able to exploit value from the adopted innovation if they have the necessary complementary resources in place (Stieglitz and Heine 2007).

Recognizing that performance impacts of IT investments may not always occur at the firm level of analysis (Kohli et al. 2003), our study investigates the performance impacts of IT innovation at the process level following prior work (Pavlou and Sawy 2006). Process improvement constitutes a noted component of total quality management (Powell 1995) with work examining its effect on manufacturing goal achievement (Narasimhan and Jayaram 1998). We assess realized improvements from the processes surrounding the focal innovation. Process improvement is defined as the extent to which the focal business process in the post-adoption stage is superior relative to the pre-adoption stage. Within our study, an organization adopts an Internet-based purchasing application to improve its purchasing process. Process improvement captures the degree to which the IT-enabled purchasing process performs better than the old (i.e., non IT-enabled) process.

### **Information Technology Innovation**

The IT innovation field attempts to understand the factors that enable or inhibit the adoption of emerging IT-based processes or products within a population of potential adopters (Swanson 1994). The majority of IT innovation research is based on a diffusion of innovation framework (Rogers 1995), where organizations that have a greater quantity of innovation-related needs and abilities are more likely to exhibit a greater quantity of innovation (Grover, Fiedler and Teng 1997). Innovation-related factors include compatibility, complexity, and relative advantage (Tornatzky and Klein 1982), while organizational factors include related knowledge, diversity of knowledge, and task-technology compatibility (Fichman and Kemerer 1997).

Prior research focuses on organizational adoption, assimilation, and diffusion of IT innovations. This notwithstanding, organizations ultimately adopt IT innovations with the objective to improve some dimension of their performance. However, there are two ways in which the realized performance impacts of IT innovation can diverge from expectations (Fichman 2004). One is that the innovation can fail to produce expected, if any, value. Second, the innovation could produce some value, but not enough to recover implementation costs. We attempt to gain insight into these potential dilemmas, particularly the former, by constructing a model in which innovation-related resource conditions enable or inhibit potential performance impacts of Internet-based purchasing applications.

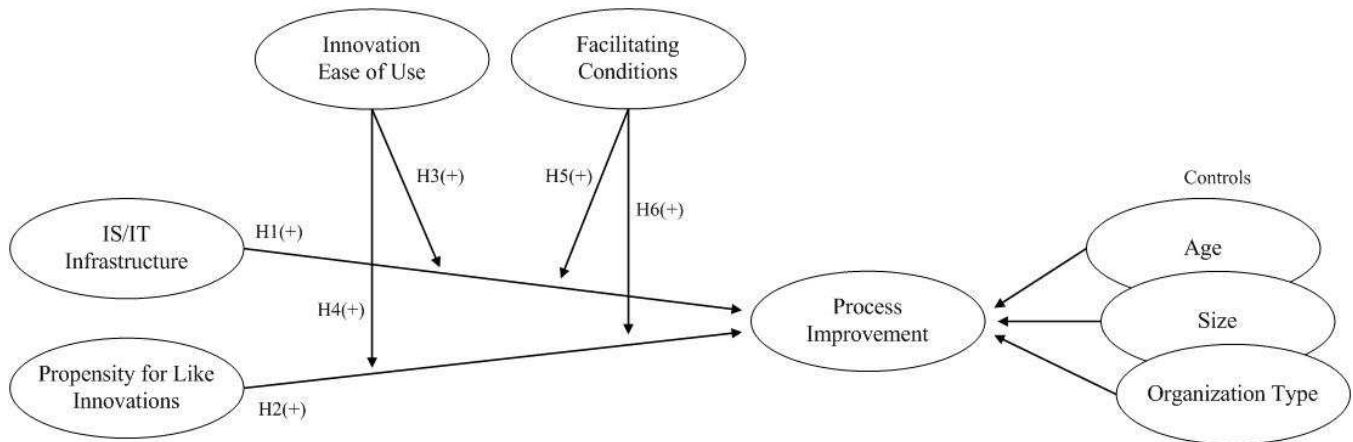
**RESEARCH MODEL AND HYPOTHESES**

Internet-based purchasing applications represent a form of inter-organizational systems (IOS) that enable suppliers to interact with small business clients through technology that aims to duplicate some of the capabilities of suppliers’ electronic data interchange (EDI) systems typically found within larger technologically advanced customers (Zhu and Kraemer 2005). Existing EDI research provides insights into IOS adoption (e.g., Premkumar, Ramamurthy and Crum 1997). With respect to the study of IOS post-adoption use, EDI efforts also present a significant body of work (e.g., Premkumar, Ramamurthy and Nilakanta 1994).

**Organizational Resource Factors**

IS/IT infrastructure assesses the presence of requisite technological infrastructure supporting implementation and subsequent use of a given innovation. Empirical research finds IS/IT infrastructure strongly differentiating adopters from non-adopters of customer-based IOS (Grover 1993). Since a firm’s IS/IT infrastructure is relatively static and difficult to change (Weill and Vitale 2002), such resources will likely have an effect on the innovation’s adoption and diffusion within the organization. Accordingly, as depicted in Figure 1, we predict that the presence of the requisite level of IS/IT infrastructure will be associated with greater organizational process improvement.

Hypothesis 1 (H1). IS/IT Infrastructure will have a significant positive impact on process improvement.



**Figure 1. Research Model**

We further draw on the organizational innovation literature to conceptualize an organization’s propensity for like innovations. Innovations may be categorized as radical or incremental (Dewar and Dutton 1986). Radical innovations “produce fundamental changes in the activities of the organization and represent clear departures from existing practice” (Damanpour 1988, p. 550). Incremental innovations are minor improvements to existing practice or simple adjustments in technology. The primary difference between radical and incremental is the degree of new knowledge embedded in the innovation. Adoption and assimilation of radical innovations often requires higher levels of new knowledge, thus erecting high knowledge barriers to learning (Attewell 1992). These knowledge barriers, however, can be reduced through the level of prior related knowledge, thereby facilitating the assimilation of complex, radical innovations (Ravichandran 2005). Similarly, we posit that an organization’s propensity for like innovations reduces the knowledge barriers posed by the focal innovation.

With respect to Internet-based purchasing applications, like innovations include other Internet-based applications (e.g., Internet banking, claims processing, prescription order services, electronic journals). Many organizations manage their IT applications as a portfolio of assets, similar to a financial portfolio (Jeffery and Leliveld 2004). Hence, the likelihood that an organization will adopt an innovation that conforms to existing platform and technological resources increases as organizations strive to manage IS in a homogenous manner. Therefore, organizations with the requisite propensity for like innovations are more likely to realize process improvements, as stated.

Hypothesis 2 (H2). Propensity for like innovations will have a significant positive impact on process improvement.

**Moderating Factors**

One distinctive aspect of an IT innovation is its ease of use. Innovation ease of use is defined as the degree to which an innovation is perceived as relatively easy or difficult to understand or use (Rogers 1995). Innovation complexity has been

widely recognized as an inhibitor to adoption (Tornatzky et al. 1982) and diffusion (Premkumar et al. 1994). In developing and deploying Internet-based purchasing applications, developers bear the burden of assessing potential users' needs and abilities, thereby integrating the appropriate functionality and technologies while minimizing potential application complexity. Prior research notes that the presence or absence of the adopter's technological skills and experience bear the potential to hinder innovation adoption (Cooper and Zmud 1990). Hence, we would expect to see a range of variability with respect to perceptions of application ease of use in the presence of varying technological skill levels.

From a complementarity perspective, innovation ease of use may interact with organization-innovation factors to produce a synergistic effect on performance outcomes. Synergy is defined in terms of super-additive value or sub-additive cost (Tanriverdi and Venkatraman 2005). In the context of our study, the focal adopting unit enjoys super-additive value synergies if the joint value of organization-innovation factors and the innovation ease of use conditions is greater than the sum of their individual values:  $\text{Value}(a, b) > \text{Value}(a) + \text{Value}(b)$ . In turn, we predict that innovation ease of use exhibits a moderating effect on each of the relationships outlined, namely organizational resource factors and process improvement.

Hypothesis 3 (H3). IS/IT Infrastructure will have a more significant impact on process improvement when innovation ease of use is higher than when it is lower.

Hypothesis 4 (H4). Propensity for like innovations will have a more significant impact on process improvement when innovation ease of use is higher than when it is lower.

Facilitating conditions are defined as the degree to which an organization believes that an organizational and technical infrastructure exists to support use of the system. Prior research contends that application support, through training and customer support, serves to reduce or eliminate potential barriers to utilization (Thompson, Higgins and Howell 1991). Work demonstrates that training and technical support positively influence users' attitudes toward information systems (Robey 1979; Lucas Jr. and Spider 1999). In other words, the flow of value will depend to some extent on the presence of beneficial moderators (Davern and Kauffman 2000). One potentially beneficial contingency that often complements IT innovation adoption is an appropriate level of training on the part of users of the newly installed software application.

Accordingly, the focal adopting unit enjoys similar super-additive value synergies if the joint value of organization-innovation factors and facilitating conditions is again greater than the sum of their individual values. Hence, within the current study we posit that the presence of facilitating conditions made available through external parties will have a positive moderating effect on the relationship between organization-innovation factors (i.e., IS/IT infrastructure and propensity for like innovations) and post-adoption process improvement.

Hypothesis 5 (H5). IS/IT Infrastructure will have a more significant impact on process improvement when facilitating conditions are higher than when they are lower.

Hypothesis 6 (H6). Propensity for like innovations will have a more significant impact on process improvement when facilitating conditions are higher than when they are lower.

## RESEARCH METHODS

Following an exploratory case study to gather qualitative data specific to the healthcare industry setting and to facilitate measurement development, a confirmatory field study surveyed individual medical practices regarding their adoption and use of Internet-based purchasing applications for the sourcing of medical supplies. Information obtained in the exploratory phase served as the basis for the development of measures for propensity for like innovations and process improvement. We incorporated established measures for IS/IT infrastructure (Premkumar and Ramamurthy 1995), ease of use (Thompson et al. 1991), and facilitating conditions (Thompson et al. 1991). In an effort to safeguard against common method bias, the study employs different and some reverse scale types across measures, as prescribed within the methodological literature (Podsakoff and Organ 1986). Pilot studies established construct validity and validated measures adopted from prior research along with those developed within the current work.

The field study surveyed 1,285 medical business/office/practice managers from independent practices registered with a U.S. medical association. We identified business/office/practice managers as the most knowledgeable informants in an approach generally recommended for minimizing key-informant bias. In total we received 268 responses from adopters, for a response rate of 20.9%. The initial analysis resulted in the discarding of 15 surveys, yielding 253 usable responses. Of these respondents 98.3% identified themselves as having primary responsibility for practice purchasing activities.

## ANALYSIS AND RESULTS

The quantitative analysis focused on data collection assessment, measurement validation, and hypothesis testing. While the data collection assessment evaluated non-response bias, the measurement validation phase assessed the reliability and validity of constructs.

### Data Collection Assessment

Analysis of variance (ANOVA) compares construct means between the early wave of respondents and those who responded during the fourth and final week of data collection providing a means for assessing non-response bias. This wave technique treats late respondents as a proxy for non-respondents. Exactly 64 of the 253, or 25.3%, of the total respondents completed the survey during the latter period. Differences across the respondent waves were examined with respect to the study variables as well as demographic data. ANOVA results show no significant differences ( $p < .01$ ), by which we infer that non-response bias is not an issue.

### Measurement Validation

Table 1 reports our findings related to reliability and validity analyses as well as construct means, standard deviations, and inter-correlations. With respect to assessing reliability, our measures see Cronbach's  $\alpha$  exceeding the prescribed .7 threshold. To further assess discriminant validity we conducted a principal components factor analysis (PCA), which revealed standard correlational patterns among items. Items load cleanly, and at high levels, on factors aligned with posited constructs, demonstrating both convergent and discriminant validity (Campbell and Fiske 1959). Cumulatively, these results suggest sufficient measurement validity.

	Mean	Std.Dev.	Cron. $\alpha$	(INF)	(PLI)	(IEU)	(FC)	(PI)	(AG)	(SZ)
IS/IT Infrastructure (INF)	5.12	1.45	.761							
Propensity for Like Innovations (PLI)	4.75	1.12	.756	.12						
Innovation Ease of Use (IEU)	3.07	1.41	.928	-.15	.01					
Facilitating Conditions (FC)	5.31	1.54	.83	.08	.16	.02				
Process Improvement (PI)	4.14	1.59	.711	.35	.33	.18	.24			
Age (AG)	7.68	2.18	1	.14	-.1	.07	.13	.11		
Size (SZ)	3.61	2.01	1	.09	.08	.12	-.03	.03	-.06	
Organization Type (OT)	NA	NA	NA	.01	.12	-.08	.01	.11	.09	.04

Table 1. Measurement Validation

### Hypothesis Testing

We employ regression analysis to evaluate the direct effects of predictor variables on the outcome and use a hierarchical approach to evaluate our moderation hypotheses (Venkatraman 1989). Given low inter-correlations (see Table 1) between organizational factors and potential moderators, ranging from -.15 to .01 and .08 to .16 ( $p < .01$ ), multicollinearity does not appear to be an issue with our data. However, in order to avoid further issues we centered independent variables (Cortina 1993). With the hierarchical approach, we employ Cohen's  $f^2$  statistics to assess the effect size and significance of the change in  $R^2$ , namely  $(R^2_{\text{moderated}} - R^2_{\text{non-moderated}}) / (1 - R^2_{\text{moderated}})$ , for the addition of the interaction term.

As reported in Table 2, our regression analysis supports hypotheses that IS/IT infrastructure (H1) and propensity for like innovations (H2) have a direct positive effect on process improvement. We find innovation ease of use and facilitating conditions significant moderators of propensity for like innovations (H5 and H6), with facilitating conditions also moderating IS/IT infrastructure (H4). Our analysis finds no support for a moderating role of innovation ease of use on IS/IT infrastructure and process improvement.

	Independent Variables Only	Independent Variables & Controls	Independent Variables & Interactions	Independent, Interactions, & Controls
Constant Term	.139	.211	.18	.215
IS/IT Infrastructure (INF)	.282**	.271**	.265**	.262**
Propensity for Like Innovations (PLI)	.356**	.348**	.291*	.296*
Innovation Ease of Use (IEU)	.121	.119	.12	.121
Facilitating Condition (FC)	.1	.09	.111	.12
INF x IEU			.103	.091
INF x FC			.322**	.345**
PLI x IEU			.365**	.353**
PLI x FC			.21*	.196*
Age		-.023		-.111
Size		.135		.132
Organization Type		-.04		-.019
Adjusted- $R^2$	.261			
F-Statistic	10.175**			
Degrees of Freedom	4,250	7,247	8,246	11,243
Change in $R^2$		.007	.068	.071
F-Statistic		2.343	24.727**	25.615**
* $p < .05$ , ** $p < .001$				

Table 2. Hypothesis Testing

## DISCUSSION

This research sought to explore the effects of organizational, technology, and external resource-based factors on post-adoption process improvement through the use of e-business applications. We empirically test hypotheses against Internet-based purchasing applications adopted within the healthcare industry. Our work provides insight into the critical issue of post-adoption process improvement, adding to our existing understanding of performance impacts and factors influencing application use. The results suggest a number of implications for both academic research and practice.

We find a number of organizational resource-based factors influence perceptions of process improvement. IS/IT infrastructure shows significant effects within our work. When considering the adoption of an innovation, firms incorporating a holistic view of their IT assets are more likely to see process improvements as a result of the innovation. Similarly, propensity for like innovations shows a strong effect, demonstrating that where buyers have experience and an inclination for a specific type of technology, as with Internet applications, greater process improvements emerge. Our conceptualization, development, and testing of the propensity for like innovations construct represents a contribution of this work, as we believe it will inform other research examining adoption, use, and performance with respect to innovations.

These findings hold significant implications for practice, as firms developing and deploying Internet-based applications might be best-served targeting adoption and use toward partners predisposed to embracing such technology. Consider as an example WebMD. The firm maintains numerous Internet portal ventures, like Medscape publishing and professional services venture and medical device supplier Porex. Marketing executives within WebMD note the success realized in targeting providers frequently using these portals as potential adopters of other Internet-based applications. Rather than invest advertising dollars in print ads in trade and professional publications or space at shows, money and effort might be better directed at online advertising, promotion, and solicitation.

Ease of use emerged as a moderator of propensity for like innovations within our study. Clearly, suppliers must understand and accurately assess the technical proficiency of their client base. By doing so, they can better develop and deploy appropriate technology to specific buyers. Additionally, from a managerial perspective, adopting firms must effectively gauge the technical aptitude of their own users in selecting applications that ultimately impact core processes. Having the wrong individual utilize an innovation might serve to inaccurately bias the organization's perception of an application that could actually yield significant benefits.

With respect to facilitating conditions, our work demonstrates that ensuring the presence of requisite training and support structures, in conjunction with both IS/IT infrastructure and propensity for like innovations, fosters improved organizational processes. Many firms assume minimal need for end user support and training for Internet-based systems. Moreover, few

ensure that partners using applications have access to support for hardware and networks that might ultimately impact the operations and, potentially, performance of inter-organizational Internet-based applications. Such conditions clearly serve to shape partners' perceptions of process enhancements using the application. Findings support the need for and value of supplier investments in user support and training.

An additional important contribution of this research lies in our examination of the healthcare industry. The pressure exerted on the overall industry by business and government to achieve cost reductions has only escalated. Yet despite the industry's innovative orientation, efforts directed at business improvements and operating model enhancements lag far behind (Middleton 2005). Our work provides some insights into the dynamics potentially hindering initiatives aimed at reshaping how organizations interact within the industry as a whole. Moreover, as the industry grows, attracts new suppliers, and reinvigorates existing ones, this research should serve to inform strategies aimed at managing interactions, assessing partner firms, and devising support strategies.

### Limitations and Further Research

Our research bears several limitations which warrant consideration. First, our examination of the healthcare industry may limit generalizability of findings to similarly structured industries and institutional settings. Healthcare markets outside the U.S. may also realize different results as government intervention within the industry varies significantly across national borders. Moreover, the current study focuses on small businesses and may not see similar results with large firms. Prior works within management disciplines predominantly focus on large firms; hence, our examination of small businesses constitutes a contribution as limited empirical work examines small business markets, which makes up over half of the employed U.S. labor force. As an additional note, with few exceptions (Boyer and Olson 2002), existing empirical efforts do not focus on understanding the inter-organizational interactions of large supplier organizations and small businesses. Finally, future research should depart from the assumption of innovation adoption and utilization theories, incorporating constructs put forth by other theoretical perspectives.

### CONCLUSIONS

This research explores post adoption process improvements resulting from use of e-business applications. We empirically test our hypotheses surveying 253 independent small business-level medical practices. We identify constructs proposed within adoption and post-adoption use theoretical models as well as existing studies of IOS as relevant to innovation outcomes and use impacts. The analysis finds organizational resource-based factors; namely, IS/IT infrastructure and propensity for like innovations; positively influencing process improvement. Additionally, innovation-related and external factors, i.e., innovation ease of use and facilitating conditions respectively, serve as moderators of the predictors and process improvement.

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