IT Infusion and its Performance Impacts: An Empirical Analysis of eProcurement in the Service Industry

Seunghee Yu  
*Hong Kong University of Science and Technology, shyu@ust.hk*

Abhay Nath Mishra  
*Georgia State University, amishra@gsu.edu*

Anandasivam Gopal  
*University of Maryland - College Park, agopal@rhsmith.umd.edu*

Tridas Mukhopadhyay  
*Carnegie Mellon University, tridas@cmu.edu*

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IT INFUSION AND ITS PERFORMANCE IMPACTS: AN EMPIRICAL ANALYSIS OF E-PROCUREMENT IN THE SERVICE INDUSTRY

Completed Research Paper

Seunghee Yu
HKUST Business School
Hong Kong University of Science & Technology, Kowloon, Hong Kong
shyu@ust.hk

Abhay Nath Mishra
J. Mack Robinson College of Business
Georgia State University, Atlanta
amishra@gsu.edu

Anandasivam Gopal
Robert H. Smith School of Business
University of Maryland, College Park
agopal@rhsmith.umd.edu

Tridas Mukhopadhyay
David A. Tepper School of Business
Carnegie Mellon University, Pittsburgh
tridas@cmu.edu

Abstract

This paper examines the infusion of e-procurement applications along two dimensions of usage – intensity and organizational acceptance – and tests the relationship between use and procurement performance. Drawing upon the resource-based view of the firm, this paper tests the relationship between select organizational resources and e-procurement infusion in the context of procurement of indirect materials and services. The research model is estimated with survey data obtained on 193 organizations from the service sector. Data are analyzed using structural equation modeling. The results suggest that while organizational integration and business knowledge of IT managers are significantly related to only organizational acceptance of e-procurement, procurement process readiness and organizational slack resources are related to both the dimensions of e-procurement infusion. Our results also show that both dimensions of e-procurement infusion are positively related to procurement performance while their interaction effect on performance is negative. Theoretical and practical implications of these results are discussed.

Keywords: Electronic procurement, IT infusion, intensity of use, organizational acceptance, partial least squares, resource-based view, service industry.
Introduction

Investments in information technology (IT), the usage of innovative IT applications and their impact on firm performance remain enduring research questions in the information systems (IS) literature (Zhu and Kraemer 2005, Rai et al. 2006, Aral and Weil 2007). A significant amount of prior research has attempted to unravel the relationship between IT investments, productivity and firm performance, and found broad evidence to support the claim that investments in IT are related to various measures of firm performance (Kohli and Devaraj 2003, Brynjolfsson and Hitt 2000). More recent research has also documented the impact of technology use on performance, emphasizing the importance of IT use, above and beyond investments in IT, on performance (Devaraj and Kohli 2003). While this work has contributed significantly to our understanding of the relationships between IT investments, IT usage and firm performance, and moved the discourse beyond resolving the “IT productivity paradox”, it can be further extended in two important ways.

First, previous studies have predominantly adopted aggregate levels of analysis, potentially obfuscating the impacts of IT investments measured in aggregate across different functions and processes. This makes it difficult to isolate the impact of individual technologies on specific functions and processes (Devaraj and Kohli 2003). While a number of researchers in recent years have recommended a more nuanced examination of the impact of IT at the business process level (Melville et al. 2004, Ray et al. 2004), such studies are still sparse in the literature. Second, while there is increasing realization among researchers that the extent and nature of IT use may impact performance outcomes, and that IT use has multiple dimensions and manifestations, limited research has examined these dimensions at a more fine-grained level. For instance, an innovative technology may be used heavily in terms of the volume of business activities processed through it, but be made available only to a limited number of members in an organization. Conversely, a technology could be available to and be used by a large number of organizational members, but it may cover only a small portion of the targeted business activities, and only a small volume of the business activities may be processed through it. Furthermore, the relationship between different dimensions of IT innovation use and the impact of such usage on performance have been studied somewhat narrowly; the literature typically links the extent of IT use to performance impacts, with only limited examination of the nuances inherent in the application of IT in organizations. As a result, frameworks to help managers decide if deep deployment in one unit or broader deployment across multiple units should be preferred and to make organizational investments accordingly are lacking in the literature.

In this paper, we extend the extant literature by examining the infusion of electronic procurement and its impact on the performance of the organizational procurement process using a more fine-grained approach than seen in the literature thus far. We conceptualize IT infusion – the extent to which IT is utilized in an intensive manner for performing the target business process (Cooper and Zmud 1990) – as inclusive of both the breadth and depth dimensions of IT use within the organization. Infusion is one of the advanced stages of the IT adoption and implementation process and focuses on significant use of the technology rather than mere adoption. Deeply infused IT applications provide extensive support for the business process they enable, thereby creating business value for firms. Yet infusion remains one of the least studied facets of IT innovation in the literature (Zmud and Apple 1992, Saga and Zmud 1994). In general, compared to the extent of literature on adoption, research on deep and integrative post adoption usage of IT applications is limited (Fichman and Kemerer 1997, Jasperson et al. 2005, Zhu and Kraemer 2005). In this paper, we add to the literature by examining the antecedents and consequences of infusion in the context of e-procurement.

E-procurement refers to the application of Internet technologies in the purchasing process within a firm. Purchasing is a complex process that consists of a series of activities and covers a wide range of areas within an organization. As depicted in Figure 1, a typical purchasing process can be categorized into different types of activities depending on where a certain activity is involved in the whole cycle of purchasing process: 1) Pre-order purchasing activities which take place prior to the actual placement of an order, 2) Preparation/transmission of purchase orders which are related to the actual placement of orders, and 3). Post-order purchasing activities which take place after the actual order placement (Zenz and Thompson 1994).
Offering opportunities to improve purchasing processes by automating and coordinating activities, to reduce costs and to increase productivity, e-procurement is considered one of the most promising Internet-based applications. Researchers have also found that the use of e-procurement applications is related to the streamlining of and improvements in the procurement process (Mishra et al. 2007). Despite the potential benefits of e-procurement, firms are faced with various challenges in their efforts to adopt and use these applications, which may impact their infusion and therefore the benefits firms derive from implementing them. The use of e-procurement systems is not routine in firms yet, and they still constitute an innovation in the procurement process several years after their introduction.

Cooper and Zmud suggest that the later stages can be better explained by taking into consideration organizational resources such as knowledge, learning and readiness. The rationale is that integrative and more encompassing use of IT necessitates significant monetary outlays, organizational changes and commitments; therefore, firms with a significant stock of resources and capabilities can draw upon their endowment to implement innovative technologies more effectively. In other words, even after adopting an involved and complex technology based upon rational calculations, firms that do not possess necessary resources may not be able to exploit or benefit from it.

We draw upon the resource-based view (RBV) of the firm – a theoretical framework that stresses the role of an organization’s resources and capabilities – to examine the infusion of e-procurement. Building upon prior research that has underscored the importance of resources and capabilities, we theorize that certain resources and capabilities enable firms to infuse e-procurement applications in their procurement process which, in turn, leads to better procurement performance. This study focuses on a particular type of purchasing, namely purchasing of indirect materials and services. Indirect materials and services include office supplies, computer equipment, and Maintenance, Repair and Operation (MRO) provisions, and can account for 30% to 60% of an organization’s expenditures (Zenz and Thompson 1994). The opportunity for improving an organization’s procurement process using Internet technologies is especially large in this type of purchasing because internal processing costs involved can be greatly decreased by streamlining the process. However, there is considerable heterogeneity in the preparedness and ability of firms to exploit technological solutions. We estimate our empirical model with survey data obtained from a large-scale survey of 193 organizations that have infused e-procurement applications to different levels.

This paper contributes to the IS literature in several ways. We examine an important post-adoption behavior - the infusion of electronic procurement - which has been less studied in the existing literature. In examining the infusion of electronic procurement, we also extend the nascent but emerging stream of literature that examines sophisticated application of a technology at the nuanced level of an organizational business process. Further, we also examine the relationship between e-procurement infusion and procurement performance; thereby avoiding potential confounding and obfuscation that may result when IT impacts are aggregated across different processes and functions and reported at the firm level. We study two dimensions inherent in the infusion of IT applications – the intensity (depth) of use and organizational acceptance (breadth of use). We theorize and empirically evaluate the relationship between different dimensions of infusion and performance. We further investigate the interaction effect of the two dimensions of e-procurement infusion on performance, illustrating that the nature of relationship between them is more fine-grained and deserves a more nuanced treatment.
Theoretical Background and Literature Review

**IT Infusion**

The infusion of an IT innovation constitutes an important aspect of the overall assimilation process (Swanson and Ramiller 2003). IT infusion has been variously defined as: “embedding an IT application deeply and comprehensively within an individual’s or organization’s work systems” (Saga and Zmud 1994); “using IT applications in a more comprehensive and integrated manner to support higher levels of organizational work” (Cooper and Zmud 1990); and as “the extent to which an innovation’s features are used in a complete and sophisticated way” (Fichman 2000). A careful examination of these definitions suggests that comprehensive, integrative and inclusive use are the defining features of IT infusion. However, while Zmud and colleagues (e.g., Cooper and Zmud 1990, Zmud and Apple 1992) have considered the depth aspect of innovation use in infusion, Swanson and Ramiller (2003) suggest that breadth, conceptualized as the extent of innovation’s use across individuals and subunits, is an important dimension of IT infusion. Accordingly, in this paper, we combine the conceptualizations of infusion developed by Zmud and colleagues and Swanson and Ramiller in examining both the extent of use of the application for conducting the target business activity (*depth*) and the availability of the application to members across the firm (*breadth*). Certain resources such as knowledge and readiness, which are heterogeneously distributed, may enable firms to infuse Internet technologies to different extents in the procurement process, and such differences may impact performance. Thus, RBV provides an appropriate theoretical framework to examine organizational infusion of e-procurement.

**Resource-based View of the Firm, Technology Usage and Firm Performance**

The resource-based view of the firm conceptualizes a firm as a bundle of resources that constitutes the foundation of its competitive position (Penrose 1959, Barney 1991). These resources are heterogeneously distributed, and firms differ in their ability to develop, combine and deploy them toward productive use, leading to large variations in performance (Mata et al. 1995). Performance advantages enjoyed by firms tend to be sustainable if the underlying resources resist imitation (Barney 1991, Bhardwaj 2000). Historically, while RBV has been used to examine the conditions that enable firms to gain and sustain a competitive advantage, recent research has argued that RBV can be applied to understand technology usage and the corresponding business value at the organizational process level (see Ray et al. 2004, Piccoli and Ives 2005). The rationale is that resources and capabilities are applied at the process level in firms and their first impact, as well as the impact of IT use, is experienced at the same level (Melville et al. 2004). Along these lines, researchers have suggested that system use is a critical construct that should be studied in depth, and that the extent of technology use within major organizational processes itself can be treated as a key measure of success (DeLone and McLean 1992, Doll and Torkzadeh 1998,). In other words, the successful use of IT represents an important dimension of performance in firms (Armstrong and Sambamurthy 1999).

The diversity in “performance” observed across firms can thus be attributed to significant differences in the stock of resources firms possess such as slack resources, managerial knowledge, technological infrastructure and prior experience with IT (Mishra et al. 2007). Further, firms also differ in their efforts to develop and their skills to deploy these resources productively. These differences result in diverse organizational abilities to leverage IT in business processes and value-chain activities (Armstrong and Sambamurthy 1999, Rai et al. 2006). It is in this context, we argue, that the RBV provides additional insight into how firms can gain value from their IT investments. Because the business value firms obtain from their IT investments is dependent upon the extent and manner in which they use the technology, advanced users of IT often out-maneuver their competitors, even though the technology *per se* is ubiquitous (Ray et al. 2004).

**Theoretical Model and Hypotheses**

Our research model, represented in Figure 2, is grounded in the extant research on IT infusion and RBV, as employed in the context of IT use and business value of IT. The model examines four key resources that may impact e-procurement infusion in organizations. Drawing upon prior research that suggests that readiness (Barua et
al. 2004, Bhardwaj 2000), integration (Sambamurthy and Zmud 1992, Grover 1993), organizational knowledge (Ray et al. 2004) and firm size (Armstrong and Sambamurthy 1999) are influential antecedents of IT use, we include these constructs in our model as the key resources that will likely impact e-procurement infusion in firms. Admittedly, organizations also possess and exploit other resources; however, our choice of constructs is grounded in the prior literature and our interviews with managers. Two dimensions of e-procurement infusion – the intensity of use and organizational acceptance – are included in the research model. The focal outcome of interest in our research model is procurement performance.

**Procurement Process Readiness**

Process readiness signifies the preparedness of an organization to adopt and implement an innovative technological solution. Successful assimilation of IT places significant demands on firms to understand technological and process nuances, and to make necessary adjustments for effective deployment (Brynjolfsson and Hitt 2000, Bresnahan et al. 2002, Zmud and Apple 1992). These adaptations take place during the entire innovation cycle, but the extent of adaptation made during earlier innovation stages lowers the burden of changes necessary during infusion; it also prepares the firm and its members to use the technology in a sophisticated and relatively seamless manner. Zmud and Apple (1992) found that the extent of adaptation made in earlier innovation stages was related to higher infusion of electronic scanners in supermarkets. By contrast, if the organization is not ready and needs to make substantial changes at the infusion stage, the extent of infusion will be low.

Procurement process readiness is a significant organization resource in the context of procurement. Prior structuring, standardization of process and content interfaces, and prior experience with similar existing applications and systems enhances the readiness of some firms while other firms are relegated to playing the “catch-up game” Due to different levels of experiences with technologies, organizational practices and culture. Further, such differences are not easy to overcome and it is likely that firms with higher readiness levels will enjoy advantages consistently over other firms that may not exhibit the same level of readiness.

Higher levels of readiness indicate that the technology is compatible with the firm’s requirements and practices, and that the firm will need to make fewer changes to use the technology effectively. For example, the adjustments necessary in the reporting relationships and workflow arrangements, as well as needs for training and incentive realignment are likely to be low for firms with high readiness. A firm’s prior experience with similar systems is also likely to expose it to the changes necessary for successful exploitation of the technology, and prepare the firm for the adjustments. The lower burden of change will lower employee resistance and inertia and motivate them to use the technology. Hence:

**H1a:** Procurement process readiness will be positively related to the intensity of e-procurement use.
**H1b**: Procurement process readiness will be positively related to the organizational acceptance of e-procurement.

**Business Knowledge of IT Managers**

Business knowledge in this context refers to IT managers’ knowledge about the business strategies, work processes, products and services of the organization. A keen knowledge of business requirements enables IT managers to work with the users or other business functions, to develop appropriate IT applications, and to coordinate IT activities in ways that support the users and business requirements. It also promotes better relationships between IT workforce and other functional departments. Organizational knowledge has been considered the most significant and strategic resource for organizations (Grant 1996). Knowledge acquisition and deployment is path-dependent and resistant to easy imitation. It is not straightforward for firms to imbue their IT managers with business knowledge and to create symbiotic relationship between business and IT managers. Thus, firms that possess knowledge can use it to exploit innovative technologies easily whereas firms that lack knowledge may face significant barriers in using innovative technologies, and hence the advantages enjoyed by such firms can be sustained. Hence:

**H2a**: Business knowledge of IT managers will be positively related to the intensity of e-procurement use.

**H2b**: Business knowledge of IT managers will be positively related to the organizational acceptance of e-procurement.

**Organizational Integration**

Organizational integration refers to practices, technologies, and systems that improve the diffusion of knowledge and information within the organization. Diffusion of a technological innovation such as e-procurement in a firm reflects a cross-functional activity where the extent to which information, decision-making and knowledge is shared across functions plays an important role in determining success. Implementation of any IT-based system in an organization requires a collaborative culture that encourages members to solve problems and share information regarding solutions. This integration of skills between stakeholders enhances the footprint of the innovation in the organization, thereby leading to greater intensity of adoption. In addition, organizational integration promotes a collective learning, especially how to coordinate diverse skills and integrate multiple streams of technologies, thereby affecting the organizational usage of the applications (Sambamurthy and Zmud 1992).

From a knowledge-based viewpoint, any implementation of a cross-functional IT application in a firm requires intense amounts of knowledge transfer, assimilation and integration (Kogut and Zander 1992). However, knowledge transfer and integration do not occur without existing processes that facilitate such integration. Therefore, a necessary condition for knowledge transfer and integration is the existence of processes wherein information is shared across functional boundaries (Kellogg et al 2006). Thus, from a knowledge-based viewpoint, the presence of integration is a critical resource in facilitating the knowledge sharing that is essential in the complete infusion of a technological innovation. Thus:

**H3a**: Organizational integration will be positively related to the intensity of e-procurement use.

**H3b**: Organizational integration will be positively related to the organizational acceptance of e-procurement.

**Organizational Slack Resources**

Organizational slack resources have been consistently found to be related to innovation (Rogers 1995). Firms with substantial slack resources can afford a sizable level of investment and the costs of implementing innovations. In addition, slack resources facilitate efforts by organizations to experiment with innovations, engage in risk taking and proactively search for opportunities to exploit technologies, and therefore, large firms are expected to have greater success with assimilating IT into their value-chain activities and business strategies (Armstrong and Sambamurthy 1999). Large organizations may also have more room for improvement, and thus may obtain greater benefits from implementing innovative technological applications. The use of e-procurement solutions necessitates their integration with the existing infrastructure in the firm, which may entail substantial resource commitments. Organizations with significant slack resources are better prepared to meet these requirements than small firms. Such firms are also better prepared to absorb initial setbacks (e.g., disruption of existing procedures and maintaining
multiple systems) and the failure of projects. In the context of purchasing, e-procurement applications allow firms to achieve bottom-line savings (e.g., reduction in purchase price) and cut cost in purchasing operations (e.g., reduced paperwork). Thus:

**H4a:** Organizational slack resources will be positively related to the intensity of e-procurement use.

**H4b:** Organizational slack resources will be positively related to organizational acceptance of e-procurement.

**Two Dimensions of Infusion and Firm Performance**

Higher levels of e-procurement intensity suggest that a firm is using Internet technologies efficiently and effectively in the procurement process. The high “performance” accomplished in technological exploitation is likely to be related to procurement performance through two key mechanisms: product/process cost savings, and cycle time reduction. Cost savings are achieved from the reductions in product costs (e.g., price discount and lower inventories carrying cost) and purchasing process costs (e.g., lower paper and communication costs). By enabling the automation of the purchasing process within the organization and streamlining the whole supply chain activities inside and outside the organization, e-procurement is expected to enable these cost savings. Cycle time is defined as the time taken from initiation to completion of the purchasing process. E-procurement can speed up key purchasing activities, such as product selection, requisition approval, purchase order transmission, invoice matching, etc., and therefore, is expected to shorten cycle time. Thus:

**H5:** The intensity of e-procurement use will be positively related to procurement performance.

Organizational acceptance of e-procurement is also likely to have a significant impact on procurement process performance. If a large proportion of an organization’s employees have access to and use e-procurement applications, they will be able to automate their individual procuring tasks and also coordinate their tasks, including tasks that may be interdependent, with one another electronically. There is consequently no need for the organization to maintain both electronic and manual systems, necessary when only a small proportion of employees have access to IT applications, which can lead to significant delays in the process and introduce inefficiencies in the system, resulting in higher costs. Such access will facilitate information visibility throughout the organization and enable employees to purchase from approved suppliers that may be offering price and volume discounts. It will also enable firms to locate competent suppliers with whom regular contracts can be established, and orders placed with them frequently, lowering overall costs. The automation of various post-order activities such as returns, logistics management, and contacting suppliers in case of problems results in faster cycle time. Hence:

**H6:** Organizational acceptance of e-procurement will be positively related to procurement performance.

We posit that the intensity of e-procurement use and organizational acceptance of e-procurement will reinforce each other and have a complementary impact on procurement process performance. Firms that employ e-procurement to a significant extent in different aspects of procurement will identify new and efficient ways to accomplish tasks. In fact, sustained use of IT applications has been posited to create new work flow linkages between independent tasks and facilitate performing new tasks, not previously considered possible. Firms that are able to diffuse such learning and efficient ways through rolling out e-procurement applications to a large proportion of the organizational members are likely to experience synergistic impacts. Conversely, as organizational acceptance of e-procurement applications increases, those organizations that are able to exploit the learning and knowledge that members acquire while using the system by intensifying the use of the application in a wide variety of procurement activities are able to exploit the learning. Hence:

**H7:** The interaction effect of the intensity of e-procurement use and organizational acceptance of e-procurement will be positive on procurement performance.
Research Methods

Data Collection

The data collection for the empirical investigation of the model was accomplished through a series of web-based surveys of purchasing directors or executives from the following two contact sources: a random sample of 3,533 organizations in service industries, and two major purchasing associations. Given that this study is focusing on e-procurement and its application to a particular kind of activities, namely purchasing of indirect materials and services, services industries were selected as the most suitable industry type. A random sample of 3,533 organizations was drawn from the Dun and Bradstreet’s Million Dollar Databases for organizations with more than 100 employees that have an identifiable purchasing structure in place. Two major purchasing associations, the National Institute for Government Purchasing (NIGP) and the National Association of Educational Buyers (NAEB), also provided their support for the survey. We were able to obtain contact information for 1869 and 1389 professionals respectively from NIGP and NAEB. Personalized email invitation letters along with the survey followed by two reminders in two or three week intervals were sent to all the potential respondents. We received a total of 671 usable responses for a response rate of 9.88%. In light of the fact that respondents were senior purchasing executives in their respective organization, it can be assumed that they had a significant knowledge about procurement operations, had collaborated with the IT department on technological implementations and were familiar with organizational strategy and structure. In other words, their response can be assumed to represent the organizational perspective.

Because the data for this study were collected through surveying managers from multiple sources, we conducted additional analyses, such as comparison of mean t-tests, to ensure that such data could be considered to be from the same population. Our analyses indicated that organizations in different sources – Dunn and Bradstreet, NAEB and NIGP – did not differ significantly on measures such as size, readiness, integration, and the use of e-procurement. We also conducted a comparison of mean t-tests on early versus late responses, and found that respondents did not differ significantly on any study variable. Hence, data from multiple sources and sampling rounds were merged. Because we conducted multiple t-tests, we also used the Bonferroni correction, again indicating non-significance across different sources and time-periods.

Among the 671 organizations, 193 have implemented e-procurement applications and only their responses are used in subsequent data analysis. This insures that only those organizations that have adopted e-procurement applications and are using it are included in the study. Because the data were obtained from one key respondent from every organization, we also conducted Harman’s one-factor test (Podsakoff and Organ 1986). The results indicated that one factor could not adequately account for the variance, providing support to the argument that common-method bias does not impact our analyses and results significantly. Following Podsakoff et al. (2003) and Liang et al. (2007), we also tested a PLS model with a method factor in the measurement model. The constructs explained considerably more variance in the dataset than the common method factor, further suggesting that common method bias is not likely to impact our results significantly.

Survey Design and Items

Survey questionnaire items were adapted from previous studies and refined through interviews with several purchasing managers and reviews by IS faculty members to assess face and content validity. In total, 67 purchasing managers completed a preliminary survey and provided detailed feedback. A careful revision was made based on the results from preliminary analysis of pretest responses and feedback from purchasing managers. The final survey questionnaire items and their sources are listed in the appendix. A brief explanation of the survey questionnaire items for e-procurement performance and two usage measures follows.

The dependent variable in our analysis is procurement performance (PFMC). It is measured by three questionnaire items that represent performance advantages that firms enjoy in cost savings and purchasing cycle reduction. Corresponding to the major categories in the purchasing process (in Figure 1), the first item captures performance in pre-order purchasing activities; the second, in preparation/transmission of purchase orders; and the third, in post-order purchasing activities.

Two key facets of usage are developed to measure e-procurement infusion: intensity of use measures the percentage (%) of the actual purchase conducted using e-procurement applications, and organizational acceptance measures the
percentage of the members in the organization who have access to and use e-procurement applications on a regular
basis. Pre-order purchasing activities, preparation/transmission of purchase orders and post-order purchasing
activities are considered for both these measures. In our actual survey, different activities were illustrated and a
definition of e-procurement was provided (see the appendix for the definition). Unlike other constructs in the
model, the two usage measures are operationalized as formative constructs, because the three items measuring usage
represent distinct activities and may not co-vary. Formative indicators are used to form a construct at a higher
abstract level and each indicator is assumed to cause the respective construct, rather than reflecting it. The
individual indicators are weighted according to their relative importance in forming the construct (Chin 1998). The
antecedent constructs have been adopted or adapted from the existing literature, as shown in the Appendix.

Model Estimation and Results

Given the nature of the conceptual model and the data, structural equation modeling (SEM) is used for model
estimation. In particular, the partial least square (PLS) approach is employed in this study for two reasons. First,
the estimation model includes two formative constructs, and PLS allows us to incorporate both formative and
reflective indicators (Chin 1998). Second, the conceptual model of this study includes an interaction effect, and PLS
is suggested to produce more accurate estimate of interaction effects than other SEM techniques. A product-
indicator approach in conjunction with PLS accounts for the measurement error that attenuates the estimated
relationship, revealing true effects in comparison to summated regression (Chin et al. 2003).

As a SEM technique, PLS comprises a measurement model and a structural model, and the two models are
estimated simultaneously. In contrast to a typical SEM tool, such as LISREL, the objective of PLS is to maximize
variance explained, rather than fit, and PLS provides no overall goodness-of-fit measures. Therefore, prediction-
oriented measures, such as R², are used to evaluate PLS estimation results (Chin 1998). In addition, since PLS
makes no distributional assumptions, non-parametric techniques, such as bootstrapping or jackknifing, are used to
test the statistical significance of estimation. In this study, the results for the PLS estimation are obtained from
SmartPLS Version 1.01 (License #20041116), and a bootstrapping procedure (Chin 1998) generating 500 random
samples to test the statistical significance of the estimates.

Measurement Model

The PLS measurement model provides statistics such as individual item loadings, composite reliability and average
variance extracted (AVE) that are used to assess the measurement properties. Table 1 provides some of the results
of analyses of the measurement properties of the reflective constructs in the model. The results obtained from the
measurement model display adequate measurement properties, including reliability and convergent and discriminant
validity.

| Table 1: Reflective Constructs: Reliability, Correlation and Square Root of Average Variance Extracted (AVE) |
|---------------------------------------------------------------|------|------|------|------|
|                                                                 | Composite Reliability | PFMC | READ | BIZ  |
| Performance (PFMC)                                            | 0.920 (0.870)         | 0.891 |      |      |
| Readiness (READ)                                              | 0.837 (0.717)         | 0.246 | 0.795|      |
| Knowledge (BIZ)                                               | 0.945 (0.913)         | 0.162 | 0.139| 0.923|
| Integration (INTG)                                            | 0.914 (0.864)         | 0.066 | 0.131| 0.346| 0.883|

The reliability of each construct is assessed by computing the Cronbach’s alpha and Fornell and Larcker’s (1981)
composite reliability. The Cronbach’s alpha and the composite reliability exhibited in Table 1 exceed the cutoff of
0.7, demonstrating adequate reliability. In addition, the item loadings represent the correlation between each item
and its construct, and it is suggested that the standardized loading of each item should be above 0.70 to show
adequate reliability of each item (Hulland 1999, Chin 1998). The loading of each item (not shown) is above 0.70
and significant.
Convergent and discriminant validities are assessed by using AVE. The AVE measures the “amount of variance that is captured by the construct in relation to the amount of variance due to measurement error”. Convergent validity is established if the AVE value for a construct is 0.5 or above (i.e., the square root of AVE > 0.707). In addition, a heuristic for assessing discriminant validity involves comparing the square root of AVE and the correlations among the latent variables. It is recommended that the square root of AVE be larger than the correlations between constructs to demonstrate adequate discriminant validity (Barclay et al. 1995, Chin 1998). In Table 2, the diagonal elements represent the square root of AVE, and it is apparent that the square root of AVE is greater than 0.707 (i.e., AVE is 0.5 or above), indicating adequate convergent validity. Table 1 also shows that the square roots of the AVEs are all larger than correlations between constructs, i.e., the off-diagonal elements in Table 1. All of our constructs thus meet the requirements for discriminant validity.

As discussed above, two usage measures, intensity and organizational acceptance, are operationalized as formative. Formative constructs, in contrast to reflective constructs, are associated with indicators that form or cause the constructs, resulting in the direction of causality being reversed. This reversion of causality suggests that reliability and validity can no longer be used to judge the quality of measurement model; instead, one needs to examine item weights for formative indicators (Bollen 1984, Chin 1998). Item weights of formative constructs can be interpreted as beta coefficient estimates from a multiple regression analysis. The weights and t-statistics for the formative constructs have been provided in Table 2.

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<th>Table 2: Formative Constructs: Weights and t-statistics</th>
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**Structural Model**

To test the structural model of the study, two different models, the main effect model and the interaction effect model, are estimated. The ‘main effects model’ tests the theoretical model without the interaction term, and the results are used to test the primary hypotheses to test the impact of organizational resources on e-procurement infusion, and the link between infusion and performance. The results are shown in Figure 3. As shown in Figure 3, the results of the PLS analysis of the main effects model largely support the primary hypotheses relating organizational resources and e-procurement infusion (Hypotheses 1 – 4). The model accounts for a modest amount of variance in the two infusion measures: $R^2$ is 0.160 for intensity of use and 0.176 for organizational acceptance. Readiness and organizational slack resources are positively related to the two usage measures with significance at $p<0.01$ level, fully supporting Hypotheses 1 and 4. Business knowledge of IT managers and organizational integration have positive and significant impact on organizational acceptance, at the $p<0.05$ and $p<0.1$ levels, respectively, but not on intensity of use, partially supporting Hypotheses 2 and 3. Additionally, both measures of e-procurement infusion are significantly related to procurement process performance ($p<0.01$ for both intensity of use and organizational acceptance). The two dimensions of e-procurement infusion account for a substantial variance in performance ($R^2 = 0.495$).
The ‘interaction model’ tests the theoretical model with the interaction construct between the two dimensions of infusion. Testing for interaction effects using PLS requires us to follow a hierarchical process similar to that used in multiple regression in which one compares the results of two models, one with the interaction construct and another without it (Chin et al. 2003, Jaccard and Turrisi 2003). The results of the interaction model, shown in Figure 4, are used to test the hypothesis pertaining to the interaction effects of two usage measures. Since the two usage measures are formative constructs, the interaction terms are constructed employing the two-stage technique suggested by Chin et al. (2003), and are added to the main effects model.

![Figure 3. Estimation Results of the Main Effects Model](image)

Figure 3. Estimation Results of the Main Effects Model

Note. Reported values are standardized coefficient estimates. ***: $p<0.01$; **: $p<0.05$; and *: $p<0.1$

The estimation results of the interaction model, shown in Figure 4, can be interpreted in the following way. The coefficient estimate of the interaction term is a measure of the number of units the effect of one infusion dimension (e.g., intensity of use) on the dependent variable (i.e., performance) is predicted to change given a one-unit change in the other (i.e., organizational acceptance). The overall effect size for the interaction can be assessed by...
comparing the squared multiple correlation \( R^2 \) for the interaction model with the squared multiple correlation for the main effects model. The standardized coefficient of the main variable is interpreted as the extent of effect of the main variable on the dependent variable when the moderator is at its mean value (Chin et al. 2003).

The estimation results provide a positive and significant standardized coefficient estimate of 0.392 for the path from intensity of use to performance, 0.499 for the path from organizational acceptance to performance, and -0.240 for the interaction term with a total \( R^2 \) of 0.533. Thus, these results indicate that intensity of use has a standardized effect of 0.392 on performance when organizational acceptance is at its mean (i.e., equals to zero). Also, the results imply that one standard deviation increase in organizational acceptance will not only impact performance directly by 0.499, but it would also decrease the impact of intensity of use on performance from 0.392 to 0.152. This is contrary to what we had hypothesized and constitutes a novel finding; we discuss these findings in some detail in the next section. The overall effect size \( f^2 \) is computed using the following formula: \( f^2 = [R^2(\text{interaction model}) - R^2(\text{main effects model})]/[1 - R^2(\text{main effects model})] \) (Chin et al. 2003). The interaction term, therefore, has an overall effect size \( f^2 \) of 0.075, which is suggested as between a small and medium effect (Cohen 1988), and is larger than found in most past IS studies (Chin et al. 2003).

**Discussion and Implications**

Our overall findings are consistent with the research model hypothesized. All the resources have a significant relationship with at least one dimension of e-procurement infusion while procurement process readiness and organizational slack resources are related to both the dimensions. The non-significant impact of business knowledge of IT managers and organizational integration on the intensity of e-procurement use suggests that these resources do not differentiate organizations that have infused e-procurement to carry out a significant proportion of their procurement activities from others that have not. Upon careful deliberation, one possible explanation emerges to explain the result. Both these resources are geared more toward shared understanding, and better coordination between involved parties, departments and divisions. These characteristics may be more likely to persuade organizational members to use the e-procurement application, thereby enhancing acceptance, and not to deep and integrative use of the application to carry out business transactions. The presence of knowledge sharing and managerial knowledge reflect the social aspect of an innovation’s diffusion and therefore appear to influence the acceptance of new technologies amongst diverse organizational members. However, these might be relatively less important in determining the system components that go into developing an e-procurement system which determines the intensity of infusion. More importantly, our analysis suggests that different resources need to be leveraged within the organization, depending on whether the goals are focused on enhancing intensity or acceptance.

Our results also indicate that organizational acceptance is a stronger predictor of performance than intensity of use. Our context may be at least partly responsible for this result. Unlike the purchasing of direct materials and services, the purchasing of indirect materials and services is distributed across different departments within most organizations. Therefore, the opportunity for improving the organization’s procurement process and exploiting the potential benefits of e-procurement is expected to be greater when the application is deployed organization-wide and are available to and widely accepted by more members within the organization. Nevertheless, the interesting insight that emerges from our study is that various dimensions of infusion can impact performance differently and such differences need to be examined in detail.

Finally, another critical insight that emerges from our study is that multiple dimensions of infusion can interact with one another and impact performance. In contrast to the hypothesized complementary impact (Hypothesis 8), we find evidence for substitutive impact. In order to analyze the interaction effect and its impact on performance, we graphed the interaction effects between intensity and high and low levels of acceptance as also between acceptance and high and low levels of intensity. Following existing literature, we chose two levels to represent high and low levels – mean ± 1*sd and mean ± 2*sd. Our analysis suggests that when the level of intensity is low, higher performance can be achieved when acceptance is high, but when intensity is high performance does not receive an additional benefit from acceptance (see Figure 5 and 6). In both, Figures 4 and 5, we notice that the slope is larger for lower levels of acceptance in comparison to the higher level. This suggests that as the level of intensity increases, the marginal effect of acceptance on performance decreases, demonstrating a substitutive impact. The explanation is identical for the results shown in Figures 7 and 8. Therefore, while each dimension of use individually is beneficial, together they exhibit a lack of synergy that may be driven by a multitude of reasons.
including transaction costs, political and power factors, managerial attention, organizational structuring as well as cultural norms within the organization. Additionally, it is plausible that the demand for resources, when firms attempt to intensify their use of the technology and make it available to a large number of users simultaneously, is too large to meet. We conjecture that in environments where firms have limited resources to leverage, an optimal level of infusion might entail limiting one facet while enhancing the other. However, future work is needed to examine these dynamics in some detail.

**Figures 5 and 6. Interaction between Intensity, and Low and High Levels of Acceptance**

**Figures 7 and 8. Interaction between Acceptance, and Low and High Levels of Intensity**

**Limitations of the Research**

This study has some limitations that provide avenues for future work. This study tests the theoretical model in the context of indirect materials and services in service industries. The focused setting of our data collection suggests caution in generalizing to other contexts. In generalizing to purchasing of direct materials, for instance, it is possible that intensity of use may be more relevant than organizational acceptance given the potential differences in the way direct purchasing is conducted in most organizations. With regard to the industry context, interviews with purchasing directors suggest that the nature of purchasing tasks and related organizational environments are quite
similar for indirect materials across different industries; thus, the findings of this study may have meaningful implications for other industries. Nonetheless, future work should extend our model and conduct empirical tests in other contexts.

We collected data from a single respondent within the organization. Given the nature of the survey items that ask about purchasing practices and related organizational aspects as well as purchasing performance, all respondents are purchasing directors or executives with comprehensive understanding of organization-wide purchasing rules and practices. The respondent characteristics suggest good data quality, minimizing the potential problem of single respondent bias. The tests conducted on our data also indicate that common method bias may not significantly affect our results. Nonetheless, there still exist concerns with analyses based on self-reported data collected from a single source.

The data collected in this study are cross-sectional in nature and thus unable to establish causality. The theory, nonetheless, suggests that the web of relationships tested in this study are causal in nature. Further research of a longitudinal nature is required to establish causality in a rigorous manner. Additionally, organizational slack resources have been measured using a single item. Our measure can be improved by implementing a multi-item latent variable. However, the use of single item measures has been accepted as being appropriate when the item is objective and unambiguous for respondents (Wanous et al., 1997). Through interviews and pre-tests, we had established that this item was unambiguous for respondents. Additionally, one item in each of the two formative use constructs did not load significantly. This may suggest that our respondents did not relate post-order purchasing activities with either intensity of use or acceptance. Future research may also strengthen these constructs by adding new, theoretically-grounded items.

Finally, in this research, we examined the relationship between four significant organizational resources and e-procurement infusion. It is possible that other organizational characteristics such as centralization or formalization, or other resources such as readiness of business partners may also impact infusion. Our attempt was to cautiously balance comprehensiveness and parsimony of the model.

Implications for Research

There has been a considerable amount of interest among researchers recently to examine deep and integrative use of IT in business processes, the relationships between such uses and their impact on performance. Consistent with some previous studies (e.g., Doll and Torkzadeh 1998, Devaraj and Kohli, 2003, Zhu and Kraemer 2005), our findings support the significant role of IT usage as a key antecedent of business process performance. However, our work goes beyond this; we model usage along two dimensions and more importantly, show that the two usage dimensions account for more than 49% of the variance in purchasing performance. This finding strongly suggests that future research on IT impact should address the role of IT usage at the process level in its theoretical development and empirical investigation. While linking IT usage to firm-level financial performance variables is definitely valuable, the latter are likely to aggregate the impact over several processes and make it difficult to understand process-level impacts. Research investigating antecedents to IT use in business processes, process-level impacts of such use and firm performance variables that are linked to such IT use are likely to be particularly useful.

Second, IT use comprises distinct facets that need to be examined systemically. This has two distinct implications for future research. First, it is important to understand the differential impact of resources and capabilities within the firm on enhancing different usage outcomes, as we show. In other words, in the world of limited resources and capabilities, “one size does not fit all” usage goals. Future research should take such differences into account while developing theoretical propositions. Second, the results of this study indicate that the nature of the effects of IT usage on performance differ depending on usage measures that reflect different facets of usage, and these different usage measures interact with each other in possibly counter-intuitive ways. The novel finding of a counter-intuitive interaction result, we argue, opens up the opportunity for new insights into the externalities that might result to an organization from pushing multiple aspects of IT usage simultaneously. While extant literature suggests that the IT implementation and process changes have synergistic impacts, our results suggest that IT implementation along multiple dimensions may not be needed beyond a certain point to achieve performance results as the dimensions are substitutive rather than complementary. However, this issue is open to further investigation and provides a fertile ground for further research.
Implications for Practice

The findings of this study also have implications for practice that mirror implications for research. First, our results indicate that value creation through use of the IT, beyond simple adoption, is key for realization of organizational performance; thus, after an organization has formally adopted an innovation, it needs to make continuing efforts to spread the use of the innovation to fully benefit. However, the organization would be well-advised to consider leveraging the right resources towards enhancing use, depending on what aspect of use is important.

Second, when an organization makes strategic decisions about the scope of e-procurement usage pertaining to indirect materials and services, it may need to focus more on the level of organizational acceptance rather than the level of intensity of use to better realize the potential benefits. Purchasing of indirect materials and services at most organizations is distributed across departments. Thus, the opportunity for improving the procurement process and exploiting the potential benefits of e-procurement may be greater when applications are deployed organization-wide and are available to and widely accepted by the members within the organization.

Finally, the negative interaction effect of the intensity of e-procurement use and organizational acceptance on procurement performance suggests that managers should not attempt to exploit the resources at their disposal toward both depth and breadth dimensions of infusion simultaneously. It is suggested that managers focus their efforts on one dimension at a time and upon successfully infusing e-procurement in that dimension, concentrate their endeavor on the other dimension, akin to the staged implementation approach that has been discussed in the systems analysis and design literature. While the reasons for the negative interaction coefficient cannot be unambiguously established from our work, it is clear that are significant externalities from focusing on both usage dimensions.

References


### Appendix: Constructs and Indicators

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Indicators</th>
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</thead>
<tbody>
<tr>
<td><strong>Performance (PFMC)</strong></td>
<td>Improvement on cost savings and purchasing cycle time: percentage (%) estimates</td>
</tr>
</tbody>
</table>
| (Based upon the work of Mukhopadhyay et al. 1995, Srinivasan et al. (1994) and Monczka et al. (2002)) | PFMC1 Product cost saving (0: below 6% – 10: over 50%)  
PFMC2 Purchasing process cost saving (0: below 6% – 10: over 50%)  
PFMC3 Reduction of purchasing cycle time (1: below1 time – 10: over 5.0 times) |
| **Intensity of Use (INTC)** | Percentage (%) estimate of actual purchasing conducted: 0: below 10% – 9: over 90% |
| (Based upon the work of Zenz and Thompson (1994) and Monczka et al. (2002)) | INTC1 Pre-order purchasing activities  
INTC2 Preparation/Transmission of purchase orders  
INTC3 Post-order purchasing activities |
| **Organizational Acceptance (ACCP)** | Percentage (%) estimate of the members in your organization who have access to these applications and use the applications on a regular basis: 0: below 10% – 9: over 90% |
| (Based upon the work of Zenz and Thompson (1994), Monczka et al. (2002) and Swanson and Ramiller (2003)) | ACCP1 Pre-order purchasing activities  
ACCP2 Preparation/Transmission of purchase orders  
ACCP3 Post-order purchasing activities |
| **Procurement Process Readiness (READ)** | [Likert scale from 1: absolutely disagree, to 4: indifferent, and to 7: completely agree] |
| (Adapted from Ramamurthy et al. (1999)) | READ1 Changes to operating practices to be introduced by e-Procurement would be compatible with the existing operating practices.  
READ2 Changes to work procedures to be introduced by e-Procurement would be compatible with the existing value/belief systems.  
READ3 E-Procurement would be compatible with our experience with similar systems. |
| **Business Knowledge of IT Managers (BIZ)** | Business understanding (IT managers)  
[Likert scale from 1: extremely poor, to 4: neither, and to 7: extremely excellent] |
| (Adapted from Mata et al. (1995)) | BIZ1 The ability of IT managers to understand and appreciate the business needs of members of your organization’s functional departments  
BIZ2 IT manager’s intimate knowledge of terms and language of members of your organization’s functional departments  
BIZ3 IT manager’s expert knowledge of how process and technology solutions can be leveraged to achieve significant business/operational results |
| **Organizational Integration (INTG)** | Integration among involved parties: knowledge transparency  
[Likert scale from 1: absolutely disagree, to 4: indifferent, and to 7: completely agree] |
| (Adopted from Grover (1993)) | INTG1 Joint development of project occurs frequently with other departments.  
INTG2 Applications and data are often shared between departments.  
INTG3 Our organization encourages exchange of ideas between departments. |
### Organizational Slack Resources (SLCK)

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>1: 100 or less</th>
<th>2: 100-199</th>
<th>3: 200-299</th>
<th>4: 300-399</th>
<th>5: 400-499</th>
<th>6: 500-749</th>
<th>7: 750-999</th>
<th>8: 1,000-1,249</th>
<th>9: 1,250-1,499</th>
<th>10: 1,500-1,999</th>
<th>11: 2,000-2,999</th>
<th>12: 3,000 or more</th>
</tr>
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**Definition of e-procurement:** E-procurement refers to the use of Internet technologies for the procurement process within an organization.