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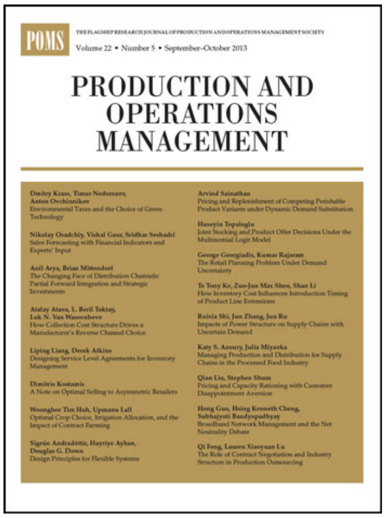

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E-Procurement Infusion and Operational Process Impacts in MRO Procurement: Complementary or Substitutive Effects?

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E-Procurement Infusion and Operational Process Impacts in MRO Procurement: Complementary or Substitutive Effects?

Abstract

The procurement of maintenance, repair and operating (MRO) goods has remained a relatively understudied topic in the literature. Though vital cost efficiencies can be extracted from procurement processes through investments in e-procurement systems, there is little empirical work that addresses how such systems should be deployed within organizations. In this paper, we focus on the role of e-procurement systems in MRO procurement and study two critical aspects of infusion. The first dimension captures the depth of e-procurement use within the procurement function while the second dimension depicts the breadth of use. We argue that these two dimensions of e-procurement use, and their interaction, will be related to the performance of the MRO procurement process. Using survey data from 193 service organizations and structural equation modeling techniques, we show that the two infusion dimensions are significantly associated with improved process performance. Additionally, we show a substantial *substitutive* effect between the two use dimensions on performance. Our work has significant implications for managers who seek to gain efficiencies by the deployment of Internet-based technologies within operational processes. Our conceptualization of e-

Professor Sandra Slaughter passed away unexpectedly on November 3, 2014. This paper couldn't have come to fruition without her support and guidance. We dedicate this paper to her.

procurement infusion along two dimensions provides a more fine-grained analysis of performance benefits accruing from the infusion of information technologies within organizations.

Keywords: Electronic Procurement Infusion, Intensity of Use, MRO, Organizational Acceptance, Procurement Performance.

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Introduction

The procurement of maintenance, repair and operating (MRO) goods endures as an important concern among procurement and supply chain managers and researchers due to its significance and prevalence in operations management and organizations (Gunasekaran and Ngai 2008; Van Weele 2005). MRO items include low-value, non-critical, high-volume goods (e.g., office supplies), costly and specialized goods (e.g., electronic items, including printers and photocopiers), and services (e.g., security and cleaning). Despite not being integral to the products manufactured or services created, MRO items, often numbering in thousands, must be available for use by employees throughout an organization for its effective functioning. According to Subramanian and Shaw (2004), firms spend 14-30 % of their revenues on the procurement of MRO items. In a recent study, AT Kearney reported that ninety four large multinational companies spent approximately $134 billion globally on MRO goods and services (Van den Bosch et al. 2010). In fact, MRO spending can account for more than 60% of third-party spending among firms in the non-manufacturing industries. Equally importantly, MRO items typically account for 80% of the procurement transaction volume in an organization, while representing only 20% of its purchasing dollars (Van Weele 2005). For efficient and cost-effective operations, it is thus critical for organizations worldwide to streamline the MRO procurement process.

Because MRO items are consumed internally by organizations and add little or no value to the final products made or services provided to customers, their procurement has received relatively less attention from top management. Further, the procurement of MRO goods continues to be uncoordinated because their demand arises from employees dispersed throughout the organization, and is often managed locally rather than through corporate procurement contracts. As a result, MRO items are usually purchased in an *ad hoc* manner from a large number of suppliers outside the formal purchasing agreements. Researchers have indicated that inefficient buying practices, including *maverick buying*, and paper-based, labor-intensive, redundant and disconnected processes for MRO procurement cause large inefficiencies (Puschmann and Alt 2005; Subramanian and Shaw 2004). According to an Aberdeen Group study in 2006, 86% of MRO orders are not transacted online; and 84% of payments are processed by paper (Foroughi 2007). Thus, while the procurement of MRO goods and services presents a significant potential for process improvement, cost savings and efficiencies, organizations have not fully exploited these opportunities.

Given these characteristics, the procurement of MRO items is ripe for efficiency improvements. Internet-based applications are an important vehicle for process efficiency improvements in firms (Croom 2005; Gupta et al. 2009; Schoenherr and Mabert 2011; Rosenzweig 2009; Sanders 2008). C-level executives have begun to recognize the importance of these applications in procurement and supply chain management (Croom 2005; Presutti 2003), leading to the development and use of several types of e-procurement systems, such as catalog systems, virtual marketplaces, online auctions, desktop purchasing systems, seller-side systems and buyer-side systems. While these technologies can be used in the operational enhancement of both direct and indirect procurement, the procurement of indirect goods has received relatively less attention (Gunasekaran et al. 2009; Van den Bosch et al. 2010).

Realizing the potential of MRO goods to control administrative, product and process costs and to enhance service levels, procurement managers have focused their attention on how to streamline the procurement of such products. The use of e-procurement, defined as the application of Internet technologies in the purchasing process within an organization, has emerged as a prominent means to transform the procurement process. Among modern firms, a variety of usage patterns of these technologies have been noted (Gunasekaran et al. 2009; Gupta et al. 2009; Rai and Tang 2010; Sahin and Robinson 2005). However, the mechanisms through which e-procurement impacts performance, and the manner in which processes change after the implementation of e-procurement, are not well-understood (Croom 2005; Schoenherr and Mabert 2011). Additionally, while there is increasing realization among researchers that information technology (IT) innovation use in operational processes has multiple dimensions, thus far, limited research has examined these facets in detail (Schoenherr and Mabert 2011; Swaminathan and Tayur 2003; Zhu et al. 2006). This is particularly true of MRO procurement, which has been less studied by researchers.

To address these gaps in the literature, this paper focuses on the use of e-procurement systems for MRO procurement in the service industry. We specifically answer two questions: 1) How can the use of electronic procurement technology among organizations to acquire MRO items be conceptualized? 2) How does the use of e-procurement technology to acquire MRO items impact operational performance, conceptualized here as comprising product cost savings, process cost savings and cycle time reduction? We believe that these questions are critical to address for two reasons. First, an innovative IT application, such as e-procurement, may be used heavily in terms of the volume of business activities processed, but be made available only to a limited number of employees. Conversely, it could be made available to a large number of employees, but may process only a small volume of business activities. Understanding these use dimensions is necessary for a granular understanding and application of e-procurement. Second, different dimensions of IT use in operational processes and their impact on performance have been studied in relative isolation without considering their inter-relationships. Specifically, the potentially complementary and substitutive ways in which various dimensions of technology use can impact performance have not been examined in the literature. Addressing this question also provides guidance to managers on the specific aspects of use they should choose to emphasize in their attempt to improve processes and thereby manage costs within the firm.

In this paper, we conceptualize e-procurement *infusion* – the extent to which Internet technologies are utilized in performing the procurement process within the organization – as comprising the *breadth* and *depth* dimensions of technology use in the organizational procurement process. The two dimensions of e-procurement infusion – *acceptance* (or breadth) and *intensity* (or depth) – capture different, but inter-connected facets of technology usage. Acceptance refers to the extent to which the e-procurement application is available to, and used by, qualified procurement professionals within the organization, while intensity refers to the extent to which the application is used in carrying out the business process. Taken together, the two dimensions of infusion indicate whether the e-procurement application is used extensively and intensively in procurement operations, thereby providing a more nuanced view of the infusion process. We evaluate our research model using survey data from 193 organizations in the service sector.

This paper makes two significant contributions to the operations management (OM) literature. First, within the OM literature, while there are many approaches proposed to improving the efficiency of the procurement process through the levers of contracts, supply chain management and pricing, there is little that explicitly tackles the role of technology within the procurement process of MRO items. Some of these processes are studied within the information systems (IS) literature, but the role of infusion, which is multi-dimensional by nature and pertains to the breadth and depth of application use, has been less studied. Therefore, our first contribution is to meld these two streams of research by considering how Internet-based procurement technologies can be used to improve the efficiency of the MRO purchasing process. Our primary contribution to the OM literature is, therefore, to provide a model of technology-enabled processes that drive outcomes of the firm's procurement function, traditionally an important component of service operations (Swaminathan and Tayur 2003). Second, we study the infusion of e-procurement within organizations along two vital dimensions that have been largely ignored in the literature – acceptance and intensity. Studying only one aspect and ignoring the other misses the way organizations use e-procurement (and potentially other) technologies and therefore leads operations managers to wrongly attribute value (or lack thereof) to newer Internet-based technologies. In addition, we study how these two dimensions interact to further affect performance of the procurement process. To our knowledge, this is among the first investigations at the intersection of operations management and information systems research to conceptualize and test for the interactions between intensity and acceptance on procurement process performance.

Infusion of e–Procurement and Operational Process Impacts

E-procurement applications constitute a significant innovation in the procurement process (Yoo et al. 2007). In contrast to other technologies firms use in the procurement function, the technological and economic characteristics of such applications differ significantly (Geoffrion and Krishnan 2003; Swaminathan and Tayur 2003). The prominent advances incorporated in e-procurement applications include support for all operational aspects of procurement (e.g., search, negotiations, information sharing, ordering, and payment) and near real-time exchange of rich information with existing and new suppliers using universal connectivity and uniform standards (Malhotra et al. 2007). Researchers suggest that the tasks of developing e-procurement solutions and assimilating them continue even today and such innovations have yet to become a routinized part of organizational procurement (Yoo et al. 2007; Mishra and Agarwal 2010). Furthermore, a study conducted by Forrester Research found that 23% of North American large enterprises (1,000 to 4,999 employees), 29% of North American very large enterprises (5,000 to 19,999 employees), and 36% of North American Global 2000 enterprises (20,000 and more employees) were not using e-procurement (Mishra and Agarwal 2010).

Many challenges still remain for e-procurement infusion. However, organizations that have surmounted these challenges can gain control over and simplify the process of purchasing indirect goods and services. The infusion of e-procurement allows organizations to consolidate supplier information within a single e-platform; facilitates online contract negotiation and easy data access for supplier analysis; and gives purchasing managers the ability to better manage their suppliers as well as the approval and transaction processes. The Internet has opened up opportunities to integrate backend processes, share information and efficiently coordinate activities with others in the value-chain (Swaminathan and Tayur 2003). Because the phenomenon of e-procurement, by definition, is at the intersection of the OM and IS disciplines, we draw upon both domains to support our investigation.

Within the OM literature, both analytical (e.g., Elmaghraby 2007; Johnson and Whang 2002; Peleg et al. 2002; Yoo et al. 2007; Zhu 2004) and empirical (e.g., Devaraj et al. 2007; Hill et al. 2009; Mukhopadhyay and Kekre 2002; Yao et al. 2009) approaches have been used to study e-procurement. Analytical modeling in this context has examined the impact of information sharing under various inventory policies, demand characteristics, degree of information exchange, layers in the supply-chain, reverse auction designs and capacity restrictions. Scholars here have proposed many mechanisms by which efficient and effective e-procurement processes can be devised. In a complementary fashion, the basic thesis of the empirical stream of research on e-procurement is that by enabling better information sharing, procurement technologies can help eliminate inefficiencies from the procurement and value-chain process. Specific improvements suggested and demonstrated in the literature include shorter lead-time, on-time delivery, improved quality of products, lower inventory, faster order fulfillment and improved order accuracy (e.g., Dutta et al. 2007; Geoffrion and Krishnan 2003; Gupta et al. 2009; Sahin and Robinson 2005; Swaminathan and Tayur 2003).

Concurrently, researchers in IS have examined the adoption and post-adoption use of various information technologies in a wide variety of application contexts. Our interest here is in *infusion* of an innovation within an organization's operational processes, which constitutes an important aspect of the overall innovation assimilation (Swanson and Ramiller 2003; Zhu et al. 2006). Scholars have variously defined infusion 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). These definitions emphasize the intensive and integrative uses of technology. Additionally, Swanson and Ramiller (2003) suggest that breadth, conceptualized as the extent of innovation's use across individuals and subunits, is an important dimension of technology infusion. Researchers argue that it is important to consider how *widely* the application is used within a given functional or process area because the depth of IT use does not completely capture the context of technology use in firms (Subramani 2004). While the earlier conceptualization of infusion included only the depth of innovation use, the latter conceptualizations explicitly indicated the importance of the breadth aspect. Thus, in order to be consistent with recent literature, we examine both the dimensions of depth and breadth, which refer to the extent of use of the application for conducting the target business activity and the availability of the application to members across the organization, respectively.

Limited empirical research in OM and IS to-date has focused on examining IT infusion in operational processes and its organizational impact (Fichman 2000; Saga and Zmud 1994; Zhu et al. 2006). While some IS studies have examined the factors that determine innovation infusion (Saga and Zmud 1994; Zmud and Apple

1992), research on operational implications of the infused innovation is lacking in the literature. Empirical research on comprehensive and integrative use of technological innovations in organizational processes is sparse in the operations literature. Organizational researchers have suggested that innovations should be linked explicitly to an outcome variable (Rogers 1995; Tornatzky and Fleischer 1990). These scholars argue that innovation is not an end in itself, and the ultimate measure that should be used is the utility of an innovation to achieve a certain purpose for the organization (Tornatzky and Fleischer 1990). Because achieving better procurement process performance is an important outcome for effective procurement and value-chain management (Devaraj et al. 2007; Power and Singh 2007), the approach we adopt here follows directly from the critical suggestions made by scholars in extending this literature.

The Procurement Process and e-Procurement

Procurement, i.e., the purchasing of goods and services, is an involved 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 three types of activities (Zenz and Thompson 1994): (1) **Pre-order purchasing activities**: These activities take place prior to the actual placement of an order. Example activities include vendor/product search and selection, price negotiation, and creation of an RFQ. The key decisions here are related to the goods and service to buy, suppliers to choose, and prices to pay. (2) **Preparation/transmission of purchase orders**: These activities are related to the actual placement of orders. Example activities include requisition entry, internal approval, and transmission of purchase orders. The key decision in this stage pertains to whether to approve the intended order. In other words, the approving authority can check for purchase quantity, supplier and price, decide to approve the order and then actually place the order with the selected vendor. (3) **Post-order purchasing activities**: These activities take place after the actual order placement. Example activities include invoice matching and processing, and managing the accounts payable interface. The key decision here involves whether to pay the amount that the suppliers have invoiced, or to invest in procedures to manage discrepancies. Additionally, if there are any discrepancies, the organization may decide to contact the supplies to get the issues resolved.

Organizations can use e-procurement technologies differently in each of the three stages, and consequently, may experience different performance impacts. For instance, some organizations may use the Internet to search for MRO items, negotiate on the phone and use an e-procurement system to complete the transaction. Others may use the search capabilities of the e-procurement system to find qualified suppliers for specific items, find pre-negotiated prices and then complete the transaction using fax. Yet others may perform search, negotiation and payment using the e-procurement system. The examination of these differential impacts arising from the form and structure of e-procurement infusion forms the central research model in this paper.

Research Model and Hypotheses

Our research model is represented in Figure 2. Based on extant literature on electronic procurement, innovation adoption and diffusion and systems use, this paper examines the impact of e-procurement infusion on MRO procurement performance. Two dimensions of e-procurement infusion – the intensity of use (depth) and organizational acceptance (breadth) – as well as their interaction are included in the research model. In addition, five constructs representing factors that prior research has found to influence IT use and impact in operational processes have also been included in the model as control variables. We note that our goal in this research is not to explain how organizations achieve high levels of e-procurement infusion, but rather to examine the specific impacts of two dimensions of infusion and their inter-relationships on operational performance in MRO procurement.

Intensity of E-procurement Use and MRO Procurement Performance

Higher levels of e-procurement intensity suggest that a firm is using Internet technologies in the procurement process deeply in the various procurement activities, as reflected in the use of the technologies for actual purchasing activities. This use epitomizes an important organization capability in the context of procurement. The infusion of e-procurement places significant demands on firms to understand technological and process nuances, and to make necessary adjustments for effective deployment (Chung and Swink 2009; Rai et al. 2006).

Such changes, also known as adjustment costs, act as significant deterrents of technology use. Procurement practices, rooted deeply in existing organizational culture and structure, are difficult to change, and prepare firms heterogeneously for e-procurement. Prior structuring, standardization of process and content interfaces, and prior experience with similar applications enhance the proficiency of some firms while other firms are relegated to playing the "catch-up game." These differences are non-trivial to overcome, and hence advantages and disadvantages associated with e-procurement intensity tend to persist among firms.

E-procurement systems can pervade all aspects of procurement, including sourcing, negotiations, ordering, receipt and post-purchase review (Croom and Brandon-Jones 2007; Presutti 2003). Organizations that use e-procurement systems intensively can improve their entire procurement process as the different activities are automated and transformed. For example, e-procurement can enable the consolidation of multiple supplier catalogs and creation of one catalog, which facilitates easy and timely access throughout an organization and reduces the complexity in the requisition process (Gunasekaran et al. 2009). The availability of consolidated information through this catalog enables organizations to conduct vendor, product and price searches easily. The ordering capabilities of the e-procurement systems allow procurement professionals to order items at contract or negotiated rates, route the order to the appropriate authority to approve it, and complete the order electronically. The payment processing modules of the e-procurement systems facilitate electronic disbursement of funds. Firms that use e-procurement more intensively are likely to benefit from all these features. For instance, SunTrust Bank has been able to control maverick buying and lower its product and process costs through the use of the Ariba e-procurement system.

The intensity of e-procurement use is likely to be related to procurement performance through two key mechanisms: cost savings, and cycle time reduction. Cost savings are achieved from reductions in product costs (e.g., price discounts and lower inventory carrying costs) and purchasing process costs (e.g., lower administration, communication and coordination costs). By enabling the automation of the purchasing process and streamlining supply chain activities inside and outside the firm, and also by enabling better control, e-procurement is expected to facilitate these cost savings (Subramanian and Shaw 2004). Cycle time is defined as the time taken from initiation to completion of the purchasing process (Hult et al. 2000) and is viewed as an important performance indicator in purchasing (Handfield and Nichols 1999). E-procurement can expedite key purchasing activities, such as product selection, supplier search, requisition approval, purchase order transmission and invoice matching, and can also improve coordination and collaboration; therefore, it is expected to shorten cycle time. Further, automating a range of post-order activities such as returns, logistics management, and contacting suppliers in case of problems results in faster cycle time to process post-order transactions. These benefits are likely to accrue more to organizations that use e-procurement intensively to carry out a large proportion of their purchasing activities online. Thus:

H1: *The intensity of e-procurement use will be positively related to procurement performance.*

Organizational Acceptance of E-procurement and MRO Procurement Performance

Higher levels of organizational acceptance of e-procurement suggest that a firm is using Internet technologies widely in the procurement process as reflected in the proportion of qualified purchasing professionals using the technologies on a regular basis. It is challenging for firms to migrate a large number of procurement professionals to the e-procurement platform quickly or easily. The technology needs to be compatible with the firm's requirements and practices such that the professionals will need to make fewer workflow changes to use the technology effectively (Gupta et al. 2009). Reporting relationships and workflows often change upon the implementation of a process-based technology, causing resistance and necessitating training and incentive realignment (Bresnahan et al. 2002). A firm's prior experience with similar systems may expose it to the necessary changes and prepare it for adjustments (Chung and Swink 2009; Mishra and Agarwal 2010). Further, prior studies stress the importance of knowledge sharing integration and coordination between members across the organization (Armstrong and Sambamurthy 1999; Malhotra et al. 2007). In particular, in the context of e-business, collaboration and coordination across managers in areas such as procurement, design and logistics is vital for success in IT infusion (Chatterjee et al. 2002). Thus, organizations pushing to diffuse e-procurement applications to a large number of qualified purchasing professionals are likely to retain advantages associated with e-procurement acceptance.

Organizational acceptance of e-procurement is also likely to have a significant impact on procurement process performance. High levels of e-procurement acceptance will allow professionals to automate their tasks and also coordinate with one another electronically. Thus, organizations will not need 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. Electronic access will facilitate information visibility throughout the organization and enable professionals to purchase from approved suppliers that may be offering price and volume discounts. It will also enable procurement professionals to easily locate competent suppliers with whom regular contracts have been, and can be, established, thereby lowering search and negotiation costs. Higher acceptance of e-procurement by an organization's purchasing professionals will facilitate extensive electronic order placement within the organization, lowering overall costs, because in comparison to paper-based, manual order placement, electronic order placement costs are up to 10 times lower (Bozarth and Handfield 2008; Trkman and McCormack 2010). According to a study conducted by the Aberdeen group, Hewlett-Packard benefitted handsomely from making e-procurement available to its purchasing professionals. The company was able to negotiate better prices and realize process savings from the implementation of the system. Hence:

H2: *Organizational acceptance of e-procurement will be positively related to procurement performance.*

Complementary Effects of Intensity and Organizational Acceptance

While the two dimensions of e-procurement infusion are expected to contribute independently to procurement process performance, we also posit an interaction effect. We suggest that the intensity of e-procurement and organizational acceptance of e-procurement will have a complementary impact on procurement process performance. Theoretical justification for such a proposition is implicit in research that suggests that technology use has multiple dimensions and these dimensions interact with one another (Subramani 2004; Zhu et al. 2006).

Researchers suggest that the development and deployment of certain organizational assets can increase or decrease the value of other assets. The reinforcing impacts are particularly prominent and measurable when they are geared toward accomplishing the same business activities. In fact, inputs that exploit the same knowledge can provide long-term performance advantages to firms because the knowledge base exploited by the inputs facilitates further identification of additional applications of the knowledge.

The two dimensions of e-procurement infusion are aimed at accomplishing procurement tasks and exploiting the knowledge base that the firm has on IT and procurement. It follows then that firms that have a high level of e-procurement intensity (acceptance) will benefit more from having a high level of acceptance (intensity) (Milgrom and Roberts 1995). 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 innovative technology applications has been posited to create new workflow linkages between independent tasks and facilitate performing new tasks, not previously considered possible. Firms that are able to diffuse such learning and efficient processes 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, firms 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, will be able to exploit the learning, enhancing performance benefits even further. Thus:

H3: *The interaction effect of the intensity and organizational acceptance of e-procurement will be positive on procurement performance, such that at higher levels of intensity of use, higher levels of acceptance will be associated with even better procurement performance.*

Our research model controls for process readiness, perceived benefits, business knowledge of IT managers, organizational integration and firm size. Our rationale for these controls follows: (1) Process readiness: Innovative IT applications create disruptions, ranging from minor adjustments to radical restructuring of work processes, governance arrangements and reward systems (Brynjolfsson and Hitt 2000; Chung and Swink 2009). If firms have already made efforts to change processes and structures, the burden of adaptation is likely to be lower (Zmud and Apple 1992). (2) Perceived benefits provide motivation and impetus to use the technology, and increase the possibility of allocation of managerial, financial and technological resources necessary for technology use (Premkumar et al. 1994). (3) Business knowledge: A keen knowledge of business requirements enables technology managers to work with users and other business functions, to develop appropriate applications, and to coordinate technology activities in ways that support the users and business requirements, impacting performance (Bassellier and Benbasat 2004). (4) Organizational integration: using an enterprise-wide technological innovation such as e-procurement reflects a cross-functional activity where the extent to which information, decision-making and knowledge is integrated and shared across functions plays an important role in determining success (Chatterjee et al. 2002; Elmaghraby 2007). (5) Slack resources, represented by firm size, facilitate efforts by organizations to experiment with innovations, engage in risk taking and proactively search for opportunities to exploit technologies (Hendricks et al. 2007). Following prior literature, which consistently uses firm size as a proxy for financial slack under the assumption that firm size adequately reflects the financial strength of the organization and has a direct relationship with technology use and impact, we include it as a control variable.

Research Methods

Data Collection

We collected data through web-based surveys of purchasing professionals in service industries. Surveys have been used extensively in the OM literature in contexts where data are needed from multiple organizations; specific firm-level data are not available through secondary sources; and the research questions involve understanding of broad trends rather than estimating specific firm-level effects (Gupta et al. 2006). The context and research questions we study here are thus well suited for the survey methodology (Bendoly et al. 2012; Menor et al. 2007). Given the focus of the study (MRO procurement), services industries were thought to be the most suitable, as a majority of purchases by organizations in the service industry comprise indirect materials and services. A random sample of 3,533 organizations with more than 100 employees and identifiable purchasing structure in place was drawn from Dun and Bradstreet's (D&B) Million Dollar Databases. Two major associations – the National Institute for Government Purchasing (NIGP) and the National Association of

Educational Buyers (NAEB) – also provided contact information for 1,869 and 1,389 professionals, respectively. Personalized email invitations along with the survey, followed by two reminders, were sent to all the potential respondents, who were all designated procurement professionals in their respective organizations. We received usable responses from a total of 671 organizations, of which 193 were from organizations that had implemented a formal e-procurement system. Thus, the effective response rate for the analysis presented here is 9.88%. However, the overall response rate to the request for participation, after deleting bounced emails and faulty email addresses, was approximately 20%.

Because the data for this study were collected from multiple sources, we conducted comparison of mean t-tests to ensure no systematic differences existed between the sub-samples. Our analyses indicated that data from D&B, NAEB and NIGP did not differ significantly on measures such as organizational size, readiness, integration, and procurement use. We also conducted a comparison of mean t-tests on early versus late responses and found no significant differences on any study variable ($p>0.1$). Finally, we performed a difference of means t-test between the non-respondents and the organizations that did respond ($n=671$) on organizational size (other variables are available from non-respondents) and found no significant differences ($p>0.1$). On the basis of these tests, we conclude that non-response bias is not a serious concern in our study; we therefore merged data from multiple sources and sampling rounds. Our final sample size is 193.

Survey Questionnaire Construction, Administration and Operationalization

Survey questionnaire items were adapted from previous studies and refined through interviews with purchasing managers and reviews by faculty members to assess face and content validity. Additionally, 67 purchasing managers completed a preliminary survey and provided detailed feedback in a pilot test, which was incorporated into the revised questionnaire used in final data collection. In addition, NIGP and NAEB officials provided extensive feedback on the substance and form of questions before the survey was finalized. Their input into the form and composition of the final questions was critical in establishing face validity for many constructs we measure. The final survey questionnaire items are shown in the Online Appendix.

Selecting the right respondent is a critical part of the survey methodology. Therefore, for our purposes, we identified respondents as the senior procurement professionals who had considerable (>10 years on average) experience in their respective organizations. Our pilot and pre-tests strongly indicated that respondents were likely to be familiar with the overall structure of the procurement function and technology use within their organization. Our respondents reported no problems with the domain of these questions or with difficulty in answering these questions. Indeed, there is a considerable body of work that supports the approach adopted in this study (Kumar et al. 1993).

The two infusion dimensions are implemented as formative constructs as follows: *intensity of use* measures the percentage of the purchase activities conducted using e-procurement applications and *organizational acceptance* measures the percentage of the procurement professionals in the organization who have access to and use e-procurement applications on a regular basis. We collected the extent of electronic procurement applications use across all three purchasing stages on both dimensions of infusion, as shown in the Online Appendix. This was done to ensure that the e-procurement infusion measure indeed covers the procurement process in its entirety. As per guidelines in the literature (Petter et al. 2007), we chose appropriate indicators – technology use in the three stages of procurement – based on prior work that has divided procurement activities into these three stages. Procurement professionals who worked with us on pilot-testing the survey as well as officials from the two organizations under whose sponsorship the survey was conducted agreed with these indicators. These measures helped establish content validity (Petter et al. 2007) since in the case of formative constructs, content validity is vitally linked to understanding the context in which measurement is undertaken.

To assess construct validity, we analyzed the loadings of each item in the two formative constructs on the respective constructs. We found that INTC1 and INTC2 loaded highly on the latent construct INTC, but the loading for INTC3 was low. The pattern of item loading for ACCP was identical, with ACCP1 and ACCP2 loading highly and a lower loading for ACCP3. At this stage, the literature provides conflicting guidelines. Diamontopoulos and Winklhofer (2001) recommend deleting the insignificant indicator while Bollen and Lennox (1991) suggest retaining it in order to preserve content and face validity. To preserve content and face validity, we retained both INTC3 and ACCP3. We thus have a more fine-grained measure of infusion in the procurement process than typically seen in the literature. Finally, in order to evaluate reliability of the formative constructs, we examined the multicollinearity statistics to determine if the variance inflation factors for the independent regression weights that form the latent construct were less than 3.3, as recommended by Petter et al. (2007). For both of our formative constructs, the estimated VIFs are less than 3.3. On the basis of these tests, we concluded that our formative constructs displayed adequate reliability in their measurement.

Our dependent variable is procurement performance, measured by three items that represent performance advantages firms enjoy in product/process cost savings and purchasing cycle reduction. It is modeled as a reflective construct, consistent with the literature (Mishra et al. 2007). There is an established tradition in the OM literature of using survey data to measure theoretical constructs, including operational performance, and we follow in that tradition (Bendoly et al. 2012; Menor et al. 2007). The control variables are adapted or adopted from existing scales. Table 1 reports descriptive statistics and correlations.

Since we collect our data using a single respondent, there is a possibility of common method bias affecting our analysis. This bias can render coefficient estimates inconsistent. To evaluate the extent to which it may be a problem, we first conducted Harman's one-factor test (Podsakoff and Organ 1986). Principal component analysis found that one factor accounts for only 25.6% of the variance, suggesting that it cannot adequately account for the variance in the data. To further examine the bias, following the procedure in Podsakoff et al. (2003) and Liang et al. (2007), we estimated a measurement model with a method factor. As summarized in the table in the Online Appendix, the average variances of each indicator explained by its substantive construct and the method factor are 0.6663 and 0.0099, respectively, showing that the constructs explain substantially greater variance in the data set than the common method factor. While these tests do not completely rule out common method bias, the results suggest that bias in the data is unlikely to be a serious concern.

Model Estimation and Results

Structural equation modeling (SEM), as employed in the partial least squares (PLS) approach, was used for model estimation. PLS allows the estimation of both formative and reflective constructs (Chin 1998; Malhotra et al. 2007). Further, our conceptual model includes an interaction effect, and PLS produces more accurate estimates of interaction effects than other SEM techniques (Chin et al. 2003). 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). We estimated the measurement and structural models using SmartPLS 2.0 M3, and a bootstrapping procedure (Chin 1998) generated 500 random samples to test the statistical significance of estimates. In robustness tests described below, alternative regression techniques were also used to estimate the research model, with largely consistent results.

Measurement Model

Tables 2 and 3 show results from analyses of the measurement properties of the reflective constructs in the model. The results indicate adequate measurement properties, including reliability and convergent and discriminant validity, for all constructs. The reliability of each construct is assessed by computing Cronbach's alpha and composite reliability (Fornell and Larcker 1981). Cronbach's alpha and the composite reliability exhibited in Table 2 exceed the cutoff of 0.7, demonstrating adequate reliability. In addition, our item loadings shown in Table 3 all exceed 0.70, as recommended in the literature, indicating adequate reliability (Chin 1998; Hulland 1999).

Convergent and discriminant validity in PLS analysis are typically assessed by using the AVE value. Convergent validity is established if the AVE value for a construct is 0.5 or above. Discriminant validity is established if the square root of AVE is larger than the correlations between constructs (Chin 1998; Fornell and Larcker 1981). In Table 2, the diagonal elements represent the square root of AVE, all of which are above 0.707, indicating convergent validity. Table 2 also shows that the square roots of all AVEs are larger than correlations between constructs. All of our constructs thus meet the requirements for discriminant validity. In addition, as shown in Table 4, all indicators have high loadings on their respective constructs and relatively low loadings on other constructs, demonstrating discriminant validity. Note that the two formative constructs (intensity and acceptance) are not included in Table 4; the validity of formative constructs is assessed differently, as described below.

Our two usage measures, acceptance and intensity, are operationalized as formative constructs, which are associated with indicators that form or cause the constructs, resulting in the direction of causality being reversed. This reversion suggests that reliability and validity can no longer be used to judge the quality of the measurement model; instead, the researcher needs to examine item weights for formative indicators (Chin 1998; MacKenzie et al. 2005). The weights and t-statistics for the formative indicators are provided in Table 5. Further, unlike reflective constructs where orthogonality of the underlying dimensions is assumed, formative constructs can be correlated. In our sample, the two formative constructs (intensity and acceptance) are moderately correlated. Note that while this correlation does not bias the coefficients that are obtained in the estimation of the structural model, it may affect the standard errors (Belsley et al. 1980) and therefore, we perform tests to evaluate the effects of these correlations on the hypothesized results later in this section.

Structural Model

To test our structural model, a main effects model and an interaction effects model were estimated. The results are presented in Table 6. The 'main effects model' omits the interaction term, and the results are used to test the link between infusion and procurement performance. Testing for the interaction of the two infusion constructs 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 and the other without it (Chin et al. 2003; Jaccard and Turrisi 2003). The results of the interaction model are used to test the interaction of acceptance and intensity (Hypothesis 3).

As shown in Table 6, the results of the PLS analysis of the main effects model support Hypotheses 1 and 2. Both measures of e-procurement infusion are significantly related to procurement process performance. The two dimensions of e-procurement infusion account for a substantial variance in performance ($R^2 = 0.513$). We also test the impact of interaction of the two usage measures.

Since the usage measures are formative constructs, the interaction terms are constructed by employing the two-stage technique described by Chin et al. (2003) and added to the main effects model. The coefficient estimate of the interaction term indicates how much the effect of one infusion dimension (e.g., intensity of use) on the dependent variable (i.e., performance) will change given a one-unit change in the other dimension (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 that for the main effects model. The standardized coefficient of the main variable is interpreted as the effect of the main variable on the dependent variable when the moderator is at its mean (Jaccard and Turrisi 2003).

The estimation results provide positive and significant standardized coefficient estimates of 0.405 and 0.498, respectively, for the paths from intensity of use and organizational acceptance to performance, and 0.280 for the interaction term, with a total R^2 of 0.56. The results indicate that intensity of use has a standardized effect of 0.405 on performance when organizational acceptance is at its mean. Also, the results imply that one standard deviation increase in organizational acceptance will not only impact performance directly (proportional to the beta of 0.498), but also decrease the impact of intensity of use on performance from 0.405 to 0.125. This is *contrary* to our hypothesis and constitutes a novel finding, which we discuss in some detail in the next section. The overall effect size f^2 is computed as follows: $f^2 = [R^2(\textit{interaction model}) - R^2(\textit{main effects model})] / [1 - R^2(\textit{main effects model})]$ (Chin et al. 2003). The interaction term has an overall effect size of 0.097, which is between a small and medium effect (Cohen 1988) but is larger than found in most past studies (Chin et al. 2003).

We also conduct several robustness checks to evaluate the stability of our results. First, it is possible that the control variables we include influence not only the performance construct directly but also the two usage variables. To evaluate this possibility, we re-estimated our structural model, including the paths from the control variables to the two usage variables. Despite including these additional paths, the results for H1, H2 and H3 are fully consistent with those shown in Table 6. Alternatively, it is possible that the usage variables fully mediate the relationship between the control variables and performance. We evaluated this model and found that the estimated coefficients of intensity and acceptance on performance are fully consistent with those shown in Table 6, while the individual coefficients of the control variables on the two usage variables vary slightly from those shown in Table 6. More importantly, model fit and R^2 in this mediated model is significantly lower than in our baseline model, suggesting that our baseline model fits the data better.

Recall that multicollinearity may pose a problem in the context of our formative constructs. The literature suggests that the extent to which multicollinearity affects the standard errors of regression coefficients can be assessed by studying the VIFs and condition indices that are associated with the correlated variables in an OLS regression (Belsley et al. 1980). VIFs and condition indices are not provided as part of PLS estimation and therefore, we estimate simple OLS models for our baseline specification shown in Table 6. We first estimate an OLS model without the interaction term and subsequently, the full model with the interaction term. In the first model, the highest VIF is 2.9, which is below the cut-off value of 10.0 typically used in the literature (Kutner et al. 2004). In the interaction model, the VIF for the interaction term rises to 7.6 while the condition index for this variable exceeds 20, indicating that collinearity may affect the standard error of this variable. However, note that collinearity biases the standard errors upwards, rendering coefficients insignificant (Belsley et al. 1980). In our analysis, across all specifications, the interaction term remains significant, implying that multicollinearity does not affect the estimated statistical effects.

Discussion and Conclusion

Our goal in this study was to examine how the operational performance of MRO procurement is impacted by multiple dimensions of e-procurement infusion in various stages of the procurement process. We investigated e-procurement infusion along two dimensions: organizational acceptance and intensity of use. Our work makes a significant contribution to the recent stream of research in OM that has examined the role of IT use in procurement and supply chain management (Devaraj et al. 2007; Khazanchi et al. 2007; 2007; Mukhopadhyay and Kekre 2002). Specifically, we add a rigorous analysis of e-procurement infusion along two dimensions and their interaction effects on process performance. We believe that the interaction effects enable us to disentangle the real impact of the two infusion dimensions on procurement performance.

Statistical tests conducted on coefficients indicate that organizational acceptance is likely to be a stronger predictor of performance than intensity of use. This result may reflect our context. Unlike the purchasing of direct materials and services, the purchasing of indirect materials and services is distributed across different departments and groups 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. Nevertheless, an interesting insight that emerges is that various dimensions of infusion can impact performance differently and such differences need to be examined in detail.

A 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, we find evidence for a substitutive impact. To obtain a deeper understanding into the interaction effect and its impact on performance, we graphed the effects between intensity and low, medium and high levels of acceptance. Symmetrically, we graphed the interaction effects between acceptance and low, medium and high levels of intensity. Our analysis suggests that when the level of intensity is low, higher performance can be achieved through higher acceptance. However, when intensity is high, performance does not receive an additional benefit from higher acceptance (see Figure 3). In other words, as the level of intensity increases, the marginal effect of acceptance on performance decreases, demonstrating a substitutive impact. A similar effect is depicted in Figure 4, which shows that the marginal effect of intensity on performance decreases as the level of acceptance increases. Additional calculations show that at very high levels of acceptance (e.g., greater than or equal to mean + 2 x standard deviation), the marginal impact of acceptance on the relationship between intensity and performance is negative, as evidenced by the negative effect size. Similarly, at high levels of intensity, the marginal impact of intensity on the relationship between acceptance and performance is negative. While each dimension of use is individually beneficial to performance, together they exhibit a lack of synergy; firms experience diminishing returns to increasing usage on both dimensions.

To better understand the reasons for the negative interaction between the use dimensions, we conducted some exploratory *post-hoc* analyses. We first divided the sample along the mean of the performance variable and created two sub-samples, representing high and low-performance firms. We estimated the relationship between intensity, acceptance and their interaction on performance for both subsamples. The results show that the coefficient of the interaction term is positive ($p<0.10$) in the high-performance subsample but remains negative ($p<0.05$) in the other subsample. This suggests that for firms that cross a threshold of performance, the two dimensions are complementary. Thus, high performing firms may have the ability to continually improve their e-procurement performance as long as these firms can keep increasing the two dimensions of usage. In contrast, firms that do not reach this performance threshold experience only substitutive effects from the two dimensions. We conjecture that high performing firms may have the capabilities to leverage both dimensions of infusion effectively, whereas low performing firms may not have such capabilities, and hence an optimal level of infusion for the latter might entail limiting one facet while enhancing the other. While the interpretation of this result is not definitive, it suggests the need for more nuanced research on dimensions of technology use and the performance implications of their interactions.

Note that our formative constructs of usage allow us to evaluate how impactful each item is in forming the underlying variable. We find that applications for pre-order purchasing activities (TYPE 1) are the most salient to intensity and acceptance and hence to purchasing performance, followed by those for preparation/transmission of purchase orders activities (TYPE 2). Combining item weights with the construct path coefficients, 0.269 and 0.461 for intensity of use and organizational acceptance, respectively, as shown in Table 6, it could be suggested that the level of organizational acceptance of TYPE 1 applications is the most important factor contributing to procurement performance, followed by intensity of use of TYPE 1 applications, organizational acceptance of TYPE 2 applications, and intensity of use of TYPE 2. This result suggests that usage of technology applications as well as the *locus of deployment* within the organization have significant effects on performance; this is clearly an avenue for further empirical investigation.

This study has some limitations that provide opportunities for future research. We test our theoretical model of e-procurement intensity and acceptance 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 may be more consequential than acceptance given the potential differences in the way direct purchasing is conducted in most firms. With regard to the industry context, *ex post* 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 also 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 in each organization. Respondent characteristics suggest good data quality, minimizing the potential problem of single respondent bias. Further, our analyses suggest that common method bias is not likely to significantly affect our results. Nonetheless, there still exist concerns regarding bias with analyses based on self-reported data collected from a single source. Our methodology restricted the number and variety of questions we could ask respondents. Potentially significant antecedents, such as how dispersed the three phases of procurement were in organizations, and e-procurement use constructs, such as frequency of use, were not included in the study. A prolonged interaction with multiple key respondents would have allowed us to examine usage and performance issues in more depth. Future research using a field study can complement our findings by studying further dimensions of e-procurement infusion, organizational heterogeneity and its impact at the level of the transaction; such granularity is not available to the survey researcher. Establishing face validity is a recurring concern in survey research. It is possible that despite pilot and pre-testing our instruments, and significant feedback from senior procurement managers in two professional bodies, some uncertainty may exist about the measurement of our constructs.

This research focused on examining two infusion dimensions of e-procurement and their impact on an intermediate, process-level, performance outcome and not an organizational-level financial performance measure. Several reasons account for this. Our sample includes several types of organizations that do not report performance data, such as academic institutions, federal, state, municipal and country level organizations and private organizations. Given such diversity, finding an objective performance variable that is relevant for all organizations is challenging. Finally, recent research has suggested that many technologies are applied at the level of an operational process, and hence their impacts need to be studied at the same level (Menor et al. 2007;

Mishra et al. 2007; Ray et al. 2004; Schroeder et al. 2002). Nonetheless, we recommend that future research links the two dimensions of infusion and procurement process performance to organizational level financial performance.

Our study does not entertain the possibility that e-procurement infusion in the three stages of procurement can adversely impact procurement performance, i.e. we do not allow for negative performance reporting in our surveys. While open-ended comments on the survey allowed respondents to provide further input, we received no comments suggesting that there may have been negative implications from the rollout of e-procurement applications. However, there is a potential censoring effect in our instrument since negative responses were not an option, which is a limitation.

Despite its potential limitations, this study has important implications for research. We find that the two dimensions of e-procurement infusion account for a significant amount of the variance in procurement performance. This finding strongly suggests that technology infusion in an operational process is not a unidimensional variable but rather comprises distinct facets. The novel finding of a counter-intuitive negative 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 technology usage simultaneously in a business process. Finally, researchers may wish to analyze the impact of technology at different stages of an operational process and investigate whether the impact of technology is complementary or substitutive in each stage of the procurement or other operational process.

The findings of this study also have useful implications for practice. First, 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. The purchasing of MRO items 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 procurement professionals. Procurement managers will be well-advised to provide e-procurement solutions to a large number of buyers and associates in their organization and to encourage them to use the technology on a regular basis. The greater point here, we believe, is that different aspects of usage have differing implications for performance; managers should establish, in their context, which dimension of usage has a higher marginal contribution to performance and invest in that particular dimension.

Second, the negative interaction between the intensity and acceptance in low-performing firms suggests that procurement managers in these firms should not attempt to exploit the resources at their disposal toward *both* depth and breadth dimensions of e-procurement infusion simultaneously. It may be more advantageous for these managers to focus their efforts on improving one usage dimension at a time to successfully infuse e-procurement in that dimension, before turning attention to the other dimension, akin to a staged implementation approach such as has been discussed in the operations management and information systems literatures. This may be true for all firms below a threshold level of procurement performance. However, above that threshold level, firms benefit from complementary impacts. As organizations explore the potential of Internet technologies to streamline the procurement process and the value-chain, and researchers and managers desire to better understand the process and consequences of electronic procurement, we believe that results of this paper will be helpful to them.

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Table 1: Summary Statistics and Correlations

	PFMC1	*PFMC2*	*PFMC3*	*INTC1*	*INTC2*	*INTC3*	*ACCP1*	*ACCP2*	*ACCP3*	*READ1*	*READ2*	*READ3*	*BNF1*	*BNF2*	*BNF3*	*BNF4*	*BIZ1*	*BIZ2*	*BIZ3*	*INTG1*	*INTG2*	*INTG3*	*SIZE*
PFMC1	1.84 (2.20)																						
PFMC2	.75***	2.72 (3.17)																					
PFMC3	.63***	.67***	2.86 (3.02)																				
INTC1	.49***	.61***	.48***	2.45 (3.40)																			
INTC2	.32***	.40***	.44***	.41***	3.52 (4.14)																		
INTC3	.28***	.35***	.24***	.36***	.49***	1.93 (3.56)																	
ACCP1	.56***	.59***	.51***	.77***	.32***	.30***	2.95 (4.03)																
ACCP2	.40***	.44***	.51***	.37***	.84***	.43***	.50***	3.83 (4.3															

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ACCP3	.39***	.41***	.33***	.34***	.38***	.81***	.46***	.50***	2.13 (3.76)													
READ1	.16**	.18**	.11	.12	.11	.05	.09	.11	.09	4.84 (1.35)												
READ2	.17**	.17**	.10	.18**	.15**	.04	.15**	.10	.01	.51***	5.12 (1.30)											
READ3	.18**	.24***	.18**	.21***	.28***	.12*	.22***	.26***	.14*	.54***	.36***	4.57 (1.32)										
BNF1	.27***	.10	.14*	.18**	.03	.06	.13*	.07	.12*	.13*	.19***	.02	5.12 (1.23)									
BNF2	.22***	.25***	.19***	.22***	.03	.13*	.14**	.01	.12*	.18**	.26***	.04	.49***	5.50 (1.26)								
BNF3	.16**	.13*	.08	.12*	-.04	-.003	.13*	.02	.09	.08	.19***	.02	.42***	.50***	4.97 (1.39)							
BNF4	.19**	.18**	.32***	.16**	.06	-.008	.16**	.10	.08	.12*	.27***	.09	.46***	.55***	.51***	5.72 (1.04)						
BIZ1	.18**	.17**	.14*	.19***	.03	.12*	.25***	.14**	.18**	.14**	.17**	.15**	.16**	.26***	.42***	.14*	4.91 (1.51)					
BIZ2	.18**	.16**	.09	.14**	-.04	.13*	.22***	.08	.19***	.04	.06	.07	.03	.12	.29***	.02	.79***	4.87 (1.40)				
BIZ3	.06	.11	.07	.13*	.06	.18**	.15**	.14*	.19***	.08	.11	.10	.06	.16**	.27***	.006	.81***	.71***	4.94 (1.42)			
INTG1	.09	.08	.07	.16**	.12*	.24***	.145*	.20***	.24***	.01	.09	.13*	-.01	-.10	.05	-.04	.26***	.30***	.36***	4.78 (1.22)		
INTG2	.04	.06	.01	.12*	.12*	.23***	.12*	.19***	.25***	-.01	.03	.11	.001	-.09	.03	-.01	.22***	.25***	.25***	.67***	4.91 (1.28)	
INTG3	.01	.04	-.02	.07	.04	.17**	.08	.12*	.18**	.12*	.15**	.22***	.03	-.04	.06	-.007	.32***	.33***	.36***	.68***	.70***	5.10 (1.19)

SIZE	.003	.11	.25***	.22***	.28***	.02	.21***	.31***	.10	.04	-.003	.10	.08	.13*	.15**	.22***	.07	-.04	.009	-.02	.03	-0.03	7.57 (3.81)

Note. Diagonal elements are the average (standard deviation) of each variable. Off-diagonal elements are correlations between variables.

*** significant at p<0.01, **significant at p<0.05, and * significant at p<0.1

Table 2: Reflective Constructs: Reliability, Correlation and Validity (AVE) (N = 193)

	Composite Reliability *(Cronbach's α)*	PFMC	READ	BNF	BIZ	INTG
Performance (PFMC)	0.918 *(0.866)*	**0.889**				
Readiness (READ)	0.840 *(0.726)*	0.244	**0.798**			
Perceived Benefits (BNF)	0.861 *(0.788)*	0.272	0.196	**0.780**		
Knowledge (BIZ)	0.943 *(0.910)*	0.163	0.147	0.205	**0.920**	
Integration (INTG)	0.915 *(0.866)*	0.064	0.132	-0.033	0.344	**0.884**

Note. Diagonal elements (bold) are the square roots of average variance extracted (AVE) by latent constructs from their indicators. Off-diagonal elements are correlations between latent constructs.

Table 3: Reflective Constructs: Loadings and t-statistics (N = 193)

Construct	Indicators	Loadings	t-stat
Performance (PFMC)	PFMC1	0.892	47.161***
	PFMC2	0.915	60.725***
	PFMC3	0.858	36.506***
Readiness (READ)	READ1	0.800	9.287***
	READ2	0.728	7.075***
	READ3	0.863	16.561***
Perceived Benefits (BNF)	BNF1	0.742	10.031***
	BNF2	0.827	9.422***
	BNF3	0.712	7.864***
	BNF4	0.830	14.648***

Knowledge (BIZ)	BIZ1	0.955	88.476***
	BIZ2	0.905	36.726***
	BIZ3	0.899	26.907***
Integration (INTG)	INTG1	0.911	11.395***
	INTG2	0.894	8.532***
	INTG3	0.846	7.354***

***significant at p<0.01

Table 4: Reflective Constructs: Factor Structure Matrix of Cross Loadings (N = 193)

	(1)	(2)	(3)	(4)	(5)
(1) Performance (PFMC):					
(a) PFMC1	**0.892**	0.216	0.262	0.161	0.063
(b) PFMC2	**0.915**	0.259	0.215	0.159	0.073
(c) PFMC3	**0.858**	0.171	0.249	0.111	0.033
(2) Readiness (READ):					
(a) READ1	0.171	**0.800**	0.169	0.103	0.029
(b) READ2	0.166	**0.728**	0.301	0.129	0.092
(c) READ3	0.231	**0.863**	0.059	0.120	0.158
(3) Perceived Benefits (BNF):					
(a) BNF1	0.182	0.121	**0.742**	0.101	0.003
(b) BNF2	0.242	0.174	**0.827**	0.200	-0.092
(c) BNF3	0.135	0.104	**0.712**	0.351	0.049
(d) BNF4	0.257	0.190	**0.830**	0.070	-0.028
(4) Knowledge (BIZ):					
(a) BIZ1	0.183	0.192	0.282	**0.955**	0.288
(b) BIZ2	0.162	0.076	0.120	**0.905**	0.322
(c) BIZ3	0.088	0.122	0.133	**0.899**	0.358

(5) Integration (INTG):					
(a) INTG1	0.090	0.109	-0.045	0.323	**0.911**
(b) INTG2	0.046	0.071	-0.031	0.256	**0.894**
(c) INTG3	0.010	0.217	0.006	0.362	**0.846**

Table 5: Formative Constructs: Weights and t-statistics (N = 193)

	Main Effect Model		Interaction Model	
	Weights	t-stat	Weights	t-stat
Intensity of Use (INTC):				
INTC1	0.779	9.572***	0.777	8.797***
INTC2	0.329	2.830***	0.334	3.130***
INTC3	0.077	0.406	0.074	0.990
Organizational Acceptance (ACCP):				
ACCP1	0.695	6.227***	0.692	6.411***
ACCP2	0.338	2.600***	0.343	2.610***
ACCP3	0.147	1.483	0.144	1.488

**significant at p<0.05 ***significant at p<0.01

Table 6: Results of PLS Structural Model: Path Coefficients and R^2 (N= 193)

Constructs	Main Effects Model	Interaction Model
INTC	0.269 *(3.206)* ***	0.405 *(4.036)* ***
ACCP	0.461 *(5.963)* ***	0.498 *(5.912)* ***
INTC*ACCP		-0.280 *(4.609)* ***
Readiness (READ)	0.053 *(0.995)*	<0.001 *(0.246)*
Perceived Benefits (BNF)	0.147 *(3.080)* ***	0.181 *(3.951)* ***
Knowledge (BIZ)	0.007 *(0.105)*	0.017 *(0.059)*
Integration (INTG)	-0.072 *(1.016)*	-0.054 *(0.849)*

Size (SIZE)	-0.091 *(1.793)* *	-0.086 *(1.467)*
R^2	0.513	0.560

Note. Reported values are standardized coefficient estimates. *t*-statistics are within parenthesis.

*** significant at p<0.01, ** significant at p<0.05, and * significant at p<0.1

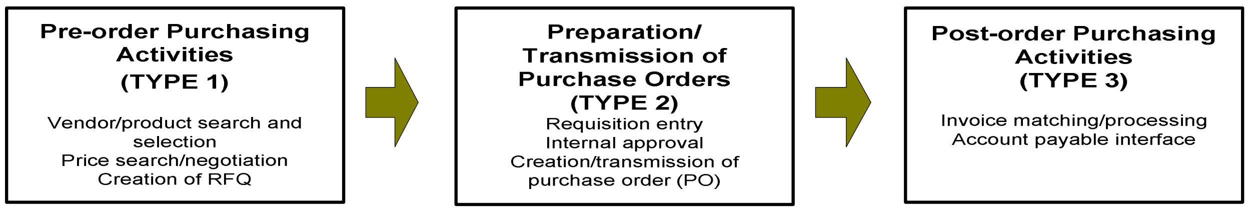

Figure 1: Procurement Process

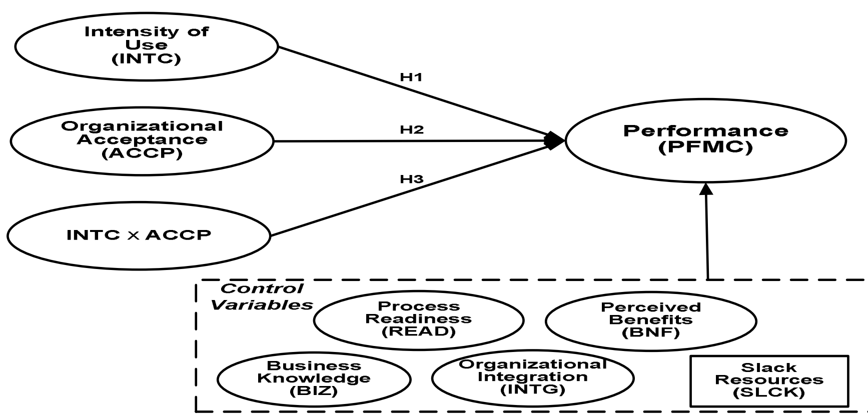

Figure 2: Conceptual Model of E-procurement Infusions and Procurement Process Performance

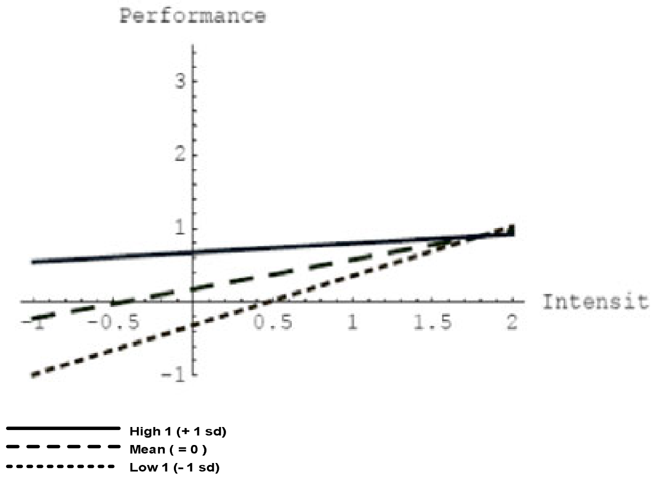

Figure 3: Interaction between Intensity, and Low, Medium and High Levels of Acceptance

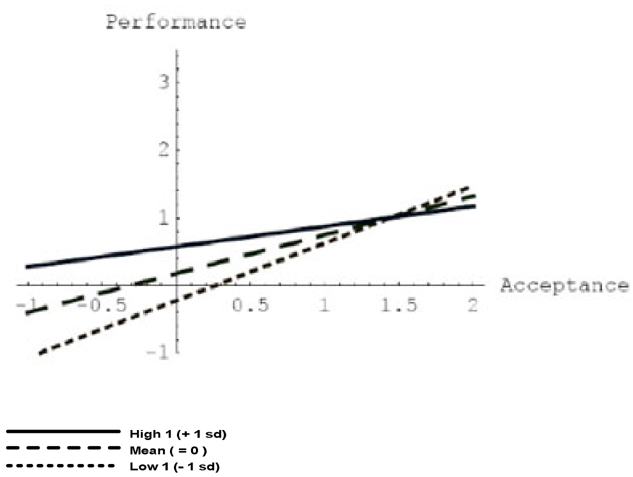

Figure 4: Interaction between Acceptance, and Low, Medium and High Levels of Intensity