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Antecedents and Consequences of Internet Use in Procurement: An Empirical Investigation of U.S. Manufacturing Firms

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This paper examines the antecedents and consequences of Internet use in the procurement process. Drawing upon the resource-based view (RBV) of the firm and the technology, organization, and environment framework, we develop an integrative model that examines the antecedents and consequences of Internet use in two stages—the search stage and the order initiation and completion (OIC) stage—of the procurement process. The model enables us to deconstruct both the usage and the performance aspects of information technology (IT) in business processes, and to provide insights into the enablers of use and business value. The model is estimated with survey data from 412 firms. Our results suggest that while some resources, such as procurement-process digitization, influence Internet use in both the procurement stages, other resources, such as the diversity of organizational procurement knowledge, impact Internet use in only one stage. We also find that Internet use in the OIC stage has a more significant impact on procurement-process performance than use in search. This study extends the digital capabilities and firm performance literature in the context of electronic procurement. This study also contributes to the small but emerging stream of literature that investigates antecedents, the extent, and implications of IT use holistically.

Key words: electronic procurement; business value of IT use; resource-based view; procurement-process digitization; B2B electronic commerce; IT adoption and use
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Introduction

The use of Internet-enabled procurement applications has emerged as an integral aspect of e-business efforts in contemporary firms (Swaminathan and Tayur 2003).[1] Firms have devoted considerable attention to understanding Internet use in the procurement process (Johnson and Whang 2003). Such interest stems from the potential of these applications to streamline the procurement process and to provide substantial economic payoff. Firms such as Dell, IBM, and Cisco Systems have obtained significant process efficiencies and cost savings from the use of Internet technologies in the procurement process. Concurrently, a number of firms have also grappled with the intricacies of using these technologies. Encouraged by the success of some firms in assimilating Internet technologies in their procurement process, and intrigued by the failure of others, firms are keen on understanding the antecedents of Internet use in procurement (IUP) and its performance impacts. In particular, insights regarding the determinants that impact Internet use in different stages of the procurement process and the differential impacts that such use engenders on firm performance are lacking in the literature.

The prior literature has identified search and ordering as two distinct and important stages of the procurement process (e.g., Zenz and Thompson 1994,

[1] In this paper, e-procurement and Internet-enabled procurement are used synonymously. Internet-enabled procurement solutions refer to all Internet-based applications (e.g., buyer-side e-procurement systems, business-to-business public markets, private exchanges) that facilitate electronic procurement using the Internet in organizations.

Monczka et al. 2002). These stages include activities that firms undertake to locate products and qualified suppliers and to order products and services, respectively. E-procurement applications enable firms to locate products and new sources of supply that can provide products and services at lower prices, and to streamline the ordering process to obtain significant efficiencies. Arguably, the ability of firms to use technological solutions, the actual usage of such solutions, and the impact of such usage in the two procurement stages may differ because the resources that firms can employ to leverage these technologies for procurement differ significantly. However, these differences have not been investigated in depth in the prior literature. Thus, insights regarding differences in organizational usage of Internet-based technologies in different procurement stages, and the antecedents and consequences of such differences will enable us to extend the literature on IT use and business value. Additionally, such insights may enable firms to channel resources for streamlining the procurement process and the value chain.

Considerable research has focused on investigating the adoption and use of IT and the implications of IT use. Although this research has made significant contributions to the literature in information systems (IS), it is limited in two important ways. First, research examining determinants of IT use, the extent of IT use, and firm performance in an integrative model is sparse (Devaraj and Kohli 2003). Thus, a nuanced understanding of the process of IT use and its implications is lacking in the literature (Zhu and Kraemer 2005). Second, academic research focused on investigating the use of Internet technologies in the procurement process and its consequences is relatively sparse. Attempts to generalize findings from studies investigating the use of earlier procurement technologies such as electronic data interchange (EDI) are likely to overlook the technological and economic differences that impact both antecedents and consequences of Internet use in procurement (Zhu and Kraemer 2005). Because usage characteristics and implications of the use of new technologies are not completely representative of prior technologies, generalizations of empirical findings from prior research conducted on older technologies may be problematic, and are cautioned against by scholars (Huber 1990).

In this study, we examine the antecedents and consequences of Internet use in both search and order initiation and completion (OIC) stages.[2] We posit that certain heterogeneously distributed resources, such as procurement-process digitization and organizational procurement knowledge, enable firms to use the Internet to different extents in two procurement stages, and such differences impact performance. Our research model draws upon the recent work that stresses the importance of digitization for technology use and firm performance (Barua et al. 2004, Rai et al. 2006, Ray et al. 2005, Sambamurthy et al. 2003). We estimate our model with data obtained from 412 manufacturing firms in the context of procurement of production goods.

This paper makes several contributions to the IS literature. First, we develop a detailed model examining the antecedents of Internet use in procurement, the extent of usage and its impact on organizational performance. Such a model examining the entire chain enables researchers to test the complete nomological net and leads to theoretical extensions and enhancements (Devaraj and Kohli 2003, Zhu and Kraemer 2005). Prior research has examined the relationship between information technology (IT) investments and firm performance (Bhardwaj et al. 1999), IT use and firm performance (Mukhopadhyay et al. 1995), and determinants that impact IT use (Cooper and Zmud 1990, Chwelos et al. 2001). However, the IT payoff literature has generally not considered IT usage, whereas the usage literature has largely overlooked firm performance. Second, we theorize about and test for the differences in the impact of antecedent resources on Internet use in two different stages of the procurement process. The extant research in IS suggests that antecedents may have different, and sometimes opposite, impacts on innovation adoption and infusion (Cooper and Zmud 1990); however, the impact of antecedents on different aspects of an organizational process has not been studied extensively. Third, we empirically extend the IS literature that theorizes the impact of firm digitization on performance in the new context of procurement (Rai et al. 2006, Barua et al. 2004). Finally, within the resource-based

[2] We use OIC, ordering, and order initiation and completion interchangeably in this paper.

view (RBV) framework, we examine the role of organizational perceptions of environmental uncertainty on e-procurement. The potential role of the external environment has been frequently alluded to in the literature, but rarely examined by scholars relying on RBV (Aragon-Correa and Sharma 2003, Wade and Hulland 2004). Our integrative approach attempts to address these limitations.

Background Literature

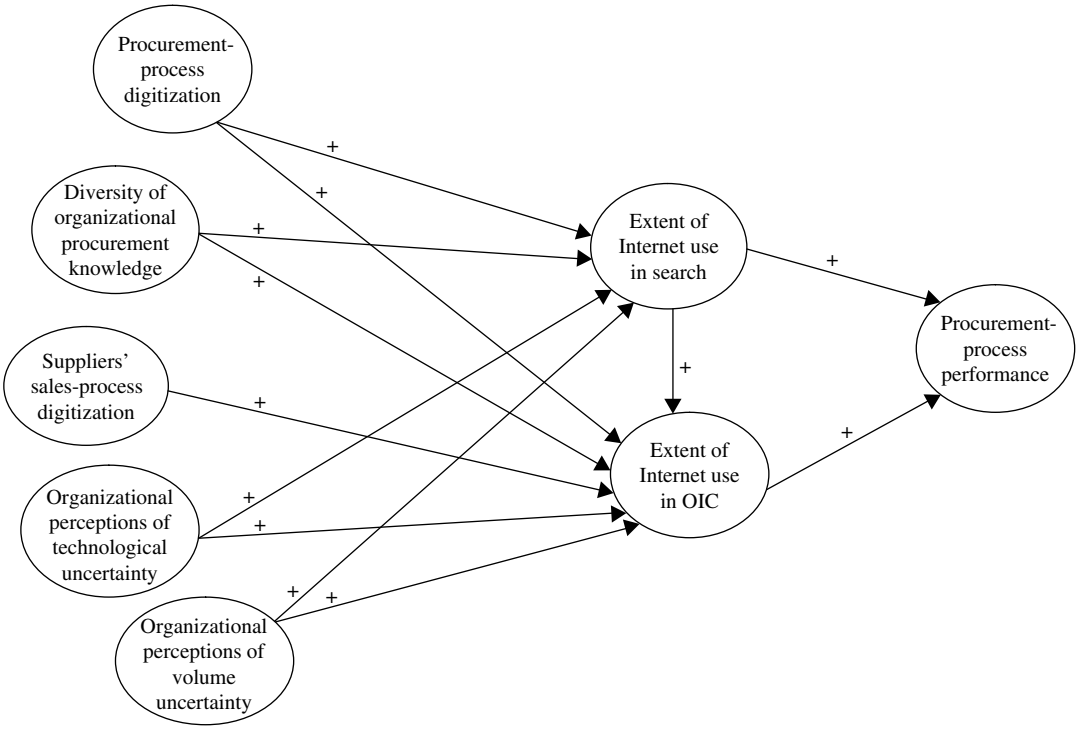
Considerable prior research has focused on examining the use of technological innovations in firms. Due to the need to examine innovation use in a wide variety of theoretically interesting contexts, several theories have been used in the prior work, resulting in a large set of antecedents that can impact innovation use. DePietro et al. (1990) developed a framework that succinctly categorizes these antecedents into three different contexts—technology, organization, and environment (TOE). It posits that in addition to the qualities of an innovation, there exist broader contexts that significantly impact innovation adoption and use. The TOE framework has been used widely in the extant IS research (Chau and Tam 1997, Zhu and Kraemer 2005, Chwelos et al. 2001). However, the TOE framework does not represent a well-developed theory, and hence does not provide the theoretical rationale to establish causal relationships. By contrast, individual theories lack the breadth of variables in the TOE framework, and its simple yet elegant classification. Thus, the recent literature in IS has attempted to combine the best attributes of the TOE framework with other theories (Zhu and Kraemer 2005).

We draw upon RBV to investigate Internet use in procurement and its performance implications. RBV conceptualizes a firm as a bundle of resources that constitutes the foundation of its competitive position (Penrose 1959, Wernerfelt 1984, Barney 1991). The basic tenet of RBV is that the possession, development, and unique deployments of heterogeneously distributed resources create performance advantages for firms. These advantages tend to be sustainable if the underlying resources resist imitation facilitated by time compression diseconomies, historical uniqueness, and causal ambiguity (Barney 1991, Bhardwaj 2000). The concept of sustained competitive advantage at the firm level has been difficult to operationalize (Wiggins and Ruefli 2002). This is because the prior research provides no clear guidelines on the length of time to which an advantage should persist (Piccoli and Ives 2005). The more recent work has attempted to address this limitation by acknowledging that sustained competitive advantages occur when competitors "face significant barriers in acquiring, developing, and using" the resources used to create the advantage (Mata et al. 1995, Piccoli and Ives 2005). This conceptualization obviates the need for examining competitive advantage in an infinite time horizon. Thus researchers have used RBV to understand performance differentials in business processes among competitors using cross-sectional data (Schroeder et al. 2002; Ray et al. 2004, 2005).

IS scholars have drawn upon RBV extensively to study both the usage of IT applications (e.g., Armstrong and Sambamurthy 1999, Yu et al. 2003), and the business value of IT-related resources (Bhardwaj 2000). The first stream of research suggests that the successful use of IT represents an important outcome in firms (Armstrong and Sambamurthy 1999). There is an implicit assumption in these studies that IT assimilation signifies a dimension of performance—firms that are able to use IT effectively and efficiently are assumed to have better performance than other firms. The diversity in performance is attributed to significant differences in the resources firms possess, such as managerial knowledge, technological infrastructure, and prior experience with IT. Further, firms also differ in their efforts to develop these resources 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, Yu et al. 2003).

The second stream of literature suggests that the value firms obtain from IT is contingent on their skills to leverage IT (Mata et al. 1995, Bhardwaj 2000). Zhu and Kraemer (2005) suggest that IT business value depends on the extent to which IT is used in the key activities in the firm's value chain. The greater the usage, the more likely the firm is to develop unique capabilities from its core IT infrastructure. Resources such as managerial knowledge and prior IT experience enable firms to utilize IT more effectively than their competitors (Mata et al. 1995, Bhardwaj 2000). Barua et al. (2004) have combined both streams of

Figure 1 The Research Model



work, and examined the use of e-business technologies and the business-value implications of such use.

There is growing consensus among IS researchers that firms derive benefits from IT through its impact on intermediate business processes (Mooney et al. 1995, Ray et al. 2004, Melville et al. 2004). Thus, researchers recommend that the impact of IT be studied at intermediate processes, the same level in which IT is deployed (Mooney et al. 1995). This enables moving beyond correlational evidence between IT and the business value, and prevents potential cancellation and obfuscation when the impacts of IT are aggregated across processes. Researchers applying RBV to examine IT use and its impact have adopted this approach. For instance, Yu et al. (2003) have used RBV to examine e-procurement. Armstrong and Sambamurthy (1999) have used RBV to investigate the use of IT in business strategy and value-chain processes. Ray et al. (2005) have used RBV to examine the impact of IT in the customer-service process. Following this tradition, we use RBV to study the impact of Internet use in different procurement stages on procurement-process performance.

The TOE framework and RBV provide good theoretical foundations for examining the antecedents and consequences of IUP. The former helps the categorization of resources, whereas the latter provides the theoretical rationale for linking them to Internet use in search and ordering and to procurement-process performance. Despite uniformly high investments in technology, resources and skills tend to differ widely across firms; therefore, deep usage of e-procurement applications and the business value firms derive from them may be inextricably linked to a firm's resources and its skills to leverage those resources.

Research Model and Hypotheses

Our research model is illustrated in Figure 1. The model draws upon prior work in RBV and the TOE framework.[3] It proposes three categories of antecedent resources that impact the extent of Internet use

[3] Following prior research, we conducted several field interviews as an additional measure to validate our research model (Kirsch and Beath 1996). Constructs used in the paper are grounded in the prior literature and interviews with managers.

in the procurement process—technological resources, organizational resources, and external resources.

Following the tradition in IS research (Wade and Hulland 2004, Piccoli and Ives 2005), we define resources to encompass both assets and capabilities. Assets represent anything tangible or intangible the firm can use in its processes for creating, producing, and/or offering its products. Capabilities represent a complex bundle of a firm's abilities, skills, and accumulated knowledge that enable it to create value (Day 1994, Grant 1996). The above definition draws upon the conceptualization of resources proposed by Wernerfelt (1984) as assets and capabilities organizations can use to develop and implement strategies.

Procurement-process digitization is a technological resource. It accounts for the technological infrastructure and prior experience of a firm with IT use in procurement. Supplier digitization is an external resource. The diversity of organizational procurement knowledge and firm perceptions about technological and volume uncertainties are organizational resources.

The dependent variable—procurement-process performance—represents the performance advantages due to Internet use in the procurement process. It takes into consideration measures of process efficiencies and cost savings in the procurement process. Firm performance is examined at the process level. The two use variables in the model—the extents of Internet use in search and OIC—refer to the level to which the Internet is used in the two procurement stages. We develop specific hypotheses below.

Internet Use in Search and OIC and Firm Performance

The recent research suggests that the relationship between innovations and their consequences has been understudied and needs to be studied explicitly (Rogers 1995). The IS success model also suggests that for a nuanced understanding, technologies and their impacts should be examined together (DeLone and McLean 1992). The rationale is that the consequences of innovations are contingent on the context and the manner in which they are used. Only when firms use these innovations to conduct value-chain activities, they can experience performance improvements (Devaraj and Kohli 2003, Zhu and Kraemer 2005). Firms differ widely in their skills to leverage IT, leading to differences in the scope and extent of use. The effective use of IT can provide support for business processes through several mutually reinforcing impacts. Mooney et al. (1995) propose three impacts. Automational impacts result in efficiency and cost-reduction benefits. Informational impacts emerge from IT's ability to process information efficiently and result in better quality. Transformational impacts refer to IT's ability to transform processes and result in reduced cycle times to conduct business.

Internet use in both search and order initiation and completion are expected to result in performance improvements in the procurement process. Effective use of the Internet in search lowers search costs and enables firms to find products of better quality at lower prices that suit the requirements of the firm better. It also allows firms to locate competent suppliers who can manufacture good quality products and ship them in a timely manner. Effective use of the Internet in ordering enables firms to share information with suppliers electronically and to wring inefficiencies out of the procurement process by automating different activities. It also enables firms to create more efficient processes that lower the cycle times. Thus,

Hypothesis 1A (H1A). *The extent of Internet use in the search stage will be positively related to the performance of the procurement process in a firm.*

Hypothesis 1B (H1B). *The extent of Internet use in the OIC stage will be positively related to the performance of the procurement process in a firm.*

Internet Use in Search and OIC

The process of technological innovation is evolutionary in nature (Nelson and Winter 1996). Innovations take place in a cumulative manner wherein accumulated knowledge and skills determine their fruitful use in entirety (Arrow 1962). When an innovation needs to be implemented in contexts that are related but vary in skills needed for the effective use of the innovation firms are likely to begin with the less demanding context. This enables them to develop the capabilities necessary for assimilating the innovation in the more involved context. This progression makes it more likely that the innovation will be implemented successfully in both contexts. We posit that Internet

use in search is a simpler innovation context than that in ordering. The skills and capabilities required for the effective use of the Internet in search can be developed more easily than those required for the effective use in order initiation and completion. Further, the skills developed for Internet use in search can be also exploited for use in ordering. Hence, the extents of Internet use in search and ordering are likely to be related and the use in search is likely to precede the use in ordering.

Hypothesis 2 (H2). *The extent of Internet use in the search stage will be positively related to the extent of Internet use in the OIC stage.*

Procurement-Process Digitization

Procurement-process digitization refers to the availability and prior utilization of IT infrastructure and applications to support efficient procurement in firms. It is a significant organizational resource that enables firms to build on pre-existing assets and develop the necessary skills to implement IT applications effectively in the procurement process (Rai et al. 2006). Due to the significant differences in the technological infrastructure available to firms and their prior experience with using IT, procurement-process digitization differs significantly in firms. Further, due to the considerable knowledge barriers associated, it may not be possible for firms with lower digitization levels to quickly acquire or develop the skills and knowledge necessary to exploit IT solutions in business processes. In other words, due to path and history dependence, firms with higher digitization levels may enjoy advantages consistently over other firms in using innovative information technologies.

The adoption and implementation of IT places significant demands on firms to understand technical details and deploy it productively. The prior use of related technologies enhances their ability to combine, coordinate, and exploit IT resources in innovative ways (Barua et al. 2004, Rai et al. 2006). Such firms benefit from the ease of learning and lower barriers to IT use, and incur lower costs in adopting technologies (Attewell 1992). Further, such firms can leverage their infrastructure and experience and develop higher levels of technical knowledge, which aids innovation assimilation (Damanpour 1992). Thus, contingent on the existing infrastructure and IT applications already deployed, firms may have different innovation opportunities, differ vastly in the efforts required to use innovative IT products, and achieve varying levels of new technology use.

Firms with high procurement-process digitization can leverage their infrastructure, experience, and knowledge to readily implement e-procurement solutions. The availability of infrastructure, which encompasses hardware, software, and networking, enables such firms to locate products and competent suppliers online, besides providing a robust foundation for the implementation of e-procurement solutions. Skills developed through the prior use of procurement solutions enables firms to customize transactional features of the e-procurement applications and to replace time-consuming and error-prone manual processes by efficient electronic processes that facilitate transmitting orders, completing transactions, and paying. These firms also have the ability to integrate Internet-enabled solutions with the existing infrastructure and tailor the search and ordering features to suit firm requirements (Barua et al. 2004). In sum, firms with high procurement-process digitization are better equipped to leverage the Internet in the two stages of the procurement process. Thus,

Hypothesis 3A (H3A). *The extent of procurement-process digitization will be positively related to the extent of Internet use in the search stage in a firm.*

Hypothesis 3B (H3B). *The extent of procurement-process digitization will be positively related to the extent of Internet use in the OIC stage in a firm.*

The Diversity of Organizational Procurement Knowledge

Organizational knowledge is widely recognized as a valuable resource that impacts innovation significantly (Attewell 1992, Grant 1996, Fichman and Kemerer 1997). Organizational knowledge development is a path-dependent and socially complex process that is resistant to easy imitation. Thus, due to the heterogeneity and inimitability of organizational knowledge, firms that possess knowledge can use it to exploit new and innovative technologies easily whereas other firms may face significant barriers in using innovative technologies.

A firm's ability to innovate is largely a function of prior related knowledge. Such knowledge enables

firms to easily acquire and retain new knowledge, which is necessary for innovation whereas the need to acquire such knowledge presents considerable challenges to firms that lack it (Cohen and Levinthal 1990, Attewell 1992). Two prominent dimensions of knowledge have been discussed in the literature—the depth of knowledge and the breadth or the diversity of knowledge. Although both dimensions impact innovations in firms, recent studies have found that the breadth of knowledge has a more significant impact than the depth (Prabhu et al. 2005). Therefore, in this study, we focus on the diversity of procurement knowledge possessed by a firm.

Cohen and Levinthal (1990) argue that the diversity of knowledge contributes to absorptive capacity—the ability to recognize the value of new information, assimilate it, and apply it to commercial ends. The diversity of knowledge enhances the likelihood that new information will be related to what is already known, and facilitates the innovation process by enabling novel associations and linkages (Zahra and George 2002). The diversity also facilitates easier acquisition of new knowledge essential for using the innovation effectively, and enables more creative and complex combinations of knowledge (Prabhu et al. 2005).

The diversity of procurement knowledge refers to the range of procurement situations over which a firm has knowledge. It reflects the variety of requests that may be placed on the procurement process and the consequent knowledge a firm gathers through such opportunities. The broader a firm's experience with search and ordering requirements, the more extensive its insights are into the procurement process and the greater its ability to exploit this knowledge to use an innovative procurement solution.

Firms that have diverse procurement knowledge are able to analyze, process, and comprehend the functional features of the innovation—e-procurement technologies—in a more efficient way and innovate more effectively than firms with low diversity of procurement knowledge. Their experiences with and the knowledge obtained from different procurement scenarios in the past enable them to create associations with different procurement requirements and the features offered by e-procurement solutions. Such firms are more likely to recognize that Internet technologies enable them to locate products and suppliers effectively and efficiently. Further, these firms are also more likely to comprehend the transactional features of e-procurement solutions and the efficiencies offered by them. By contrast, the lack of such knowledge creates assimilation barriers for firms, thereby having a deleterious impact on their innovation (Fichman and Kemerer 1997). Hence,

Hypothesis 4A (H4A). *The diversity of organizational procurement knowledge will be positively related to the extent of Internet use in the search stage.*

Hypothesis 4B (H4B). *The diversity of organizational procurement knowledge will be positively related to the extent of Internet use in the OIC stage.*

Suppliers' Sales-Process Digitization

Suppliers' sales-process digitization refers to the availability and prior use of IT infrastructure and solutions among a firm's suppliers to support efficient sales to the firm. In the context of interorganizational processes, the availability of IT infrastructure and applications among partners constitutes an important source of technologies that impact innovation opportunities for firms. The ability of firms to use IT in interorganizational processes is dependent on their partners' ability to use IT to support these processes (Chwelos et al. 2001). High digitization levels in partners enable firms to leverage IT resources in the entire process, whereas low digitization levels can reduce connectivity and impede firms' efforts to digitize boundary-spanning processes (Barua et al. 2004). Due to the significant differences in the IT infrastructure available to the suppliers and their prior experiences with IT solutions, the digitization levels differ significantly among the suppliers of different firms. Such deficiencies among suppliers may be difficult to "fix" easily or quickly and the difference in digitization levels may persist, thus providing firms with different abilities to exploit innovative IT applications.

In the context of procurement, digitized suppliers help firms enhance the efficiency of the procurement process, and become a valuable external resource for the firm. Such suppliers have the capability to electronically exchange and process information, to automate routine tasks such as order management and

customer service, to conduct transactions, and to collaborate with buyer firms. These capabilities in suppliers enable firms to use e-procurement solutions to exchange information and initiate and complete transactions online. Barua et al. (2004) have found that supplier readiness significantly impacts e-business use in firms. Thus,

HYPOTHESIS 5 (H5). *The extent of suppliers' sales-process digitization will be positively related to the extent of Internet use in the OIC stage in a firm.*

Organizational Perceptions of Environmental Uncertainty

Organizational researchers have suggested that environmental uncertainty can be construed as a perceived construct as well as an objective reality (Downey et al. 1975, Gerloff et al. 1991). They argue that managerial perceptions about environmental uncertainty differ significantly from its objective measures. Because the environment is enacted through managerial perceptions, such perceptions may be more effectively related to strategies, actions, and performance than the objective attributes of the environment (Sharma 2000). The rationale is that perceptions influence the way firms observe, interpret and learn about the environment, make strategic choices, and take actions. As firm perceptions about environmental uncertainty differ widely, and can influence strategies and actions, it is imperative that researchers examine their impact on innovation.

The extent and pace of activities and technological opportunities in an industry depend on the rapidity with which new technological breakthroughs take place. However, the recognition of opportunities is affected by firm perceptions of environmental volatility (Teece et al. 1997). In other words, the existence of opportunities can be different for firms in the same industry, which arguably experience the same objective uncertainty. Firms that perceive higher uncertainties in the environment tend to sense more opportunities, are proactive, and innovate more than other firms (Sharma 2000). Thus, such perceptions can be construed as significant intangible assets that enable firms to be more innovative than competitors on an ongoing basis.

The support for these arguments comes from the pioneering work of Penrose (1959) whose research laid the foundation for RBV. She argued that managers' perceptions and knowledge shape a firm's opportunity set and are key to economic performance. These perceptions may enable firms to notice opportunities and act on them, whereas other firms may not be able to identify the opportunities. Because managerial perceptions regarding the environment differ, there exist a large number of possibilities for actions, which produce different economic outcomes. Such perceptions are closely tied to firms and are not easily transferable. We posit that organizational perceptions about environmental uncertainty will impact their use of innovative IT solutions.

Uncertainty has multiple dimensions including technological changes, volume unpredictability, cost fluctuations, and market variability. As the impacts of different facets of uncertainty may differ, we focus on the managerial perceptions about technological and volume uncertainties faced by a firm. A firm perceives high technological uncertainty if it believes that the specifications of goods it buys are likely to change frequently and/or the probability of future improvements in goods is high. A firm perceives high volume uncertainty if it believes that the volume requirements of goods it procures cannot be predicted accurately and reliably.

Organizational Perceptions of Technological Uncertainty

Perceptions of high technological uncertainty are likely to be associated with expectations of frequent changes in product design and specifications, and regular product innovations. Such perceptions lead to environmental scanning and interpretation, and consequent actions by firms (Milliken 1987, Sharma 2000). Thus, firms with perceptions of high technological uncertainty are likely to engage in search for input goods on a regular basis, to exchange technical information with new and existing suppliers regularly, to enter into new contracts with suppliers, to negotiate prices and delivery schedules, and to purchase goods frequently. Further, researchers argue that managers facing uncertain environments tend to be more proactive and use more innovative strategies than managers in less-turbulent environments (Milliken 1987, Aragon-Correa and Sharma 2003). They attempt to anticipate events and implement preventive actions

rather than merely respond to prior events. They seek to identify and adopt new products and processes proactively. Miller and Shamsie (1999) found that the environmental uncertainty was directly related to a firm's product variety and innovativeness.

Firms perceiving high technological uncertainty are likely to be proactive about identifying and exploiting innovative technologies such as e-procurement solutions that enable easier product and supplier search, and provide the foundation on which increased information search and processing can take place. In addition, such firms are also likely to exploit transactional capabilities of these solutions to negotiate prices, delivery, and other terms, and complete the purchasing transaction efficiently. In contrast, firms that do not perceive high levels of technological uncertainties are likely to adopt a passive approach. Thus,

Hypothesis 6A (H6A). *Organizational perceptions of technological uncertainty will be positively related to the extent of Internet use in the search stage.*

Hypothesis 6B (H6B). *Organizational perceptions of technological uncertainty will be positively related to the extent of Internet use in the OIC stage.*

Organizational Perceptions of Volume Uncertainty

Perceptions of high volume uncertainty are likely to be associated with unreliable and inaccurate volume requirements of input goods. Firms with such perceptions are likely to conjure two adverse scenarios: If they underestimate the volume requirements, they must fulfill the demand at a short notice. In contrast, if they overproduce, they need to sell products within a short notice to avoid incurring inventory holding costs. These firms may expect to draw new contracts, to negotiate the terms of contracts, to transact frequently, and to exchange a large amount of technical and design information with partners. They also expect to increase the search efforts to obtain needed products or close substitutes and to locate partners if the existing ones are unable to fulfill the requirements. As argued earlier, firms perceiving high levels of volume uncertainty will be proactive about identifying and leveraging solutions that enable them to manage the uncertainty efficiently. Hence,

Hypothesis 7A (H7A). *Organizational perceptions of volume uncertainty will be positively related to the extent of Internet use in the search stage.*

Hypothesis 7B (H7B). *Organizational perceptions of volume uncertainty will be positively related to the extent of Internet use in the OIC stage.*

Research Methods

The data for this study were collected through a mail survey. Firms within four U.S. industries that manufacture industrial machinery, electrical and electronic machinery, transportation equipment, and measuring and controlling instruments were chosen to test the model. The survey instrument was developed after a thorough literature search and interviews with several procurement managers. The preliminary survey was reviewed by two faculty members and five doctoral students actively involved in electronic commerce research, and by procurement managers in a large southwest city in the United States. These steps ensured face and content validity of the items. The modified questionnaire was pilot-tested and improved iteratively three more times, the last iteration being national in scope generating 43 usable responses, before being used in the actual survey.

The sampling frame was drawn from a mailing list obtained from the Institute for Supply Management (ISM).[4] From this list, a stratified random sample of 2,000 firms was selected. Sample sizes for different industries were based roughly on their population size in the ISM database. Two waves of mailing yielded a total of 424 usable responses, for a response rate of 21.2%. The appendix contains the final set of items used, Table 1 provides sample characteristics, and Table 2 reports the descriptive statistics and correlations between constructs.

We took several steps to lower potential impacts of biases on our results. To minimize the key informant bias, we sent surveys to professionals who were directly involved in procuring production goods in their firm. The respondents had an average tenure of 11.3 years in their firm, and hence were considered competent to answer survey questions. Our tests indicated that there was no systematic bias between "early" (first wave) and "late" (second wave)

[4] ISM (www.ism.ws) is the largest supply management association in the world. Its membership base includes more than 40,000 supply professionals. It is headquartered in Tempe, Arizona, and has chapters all across the United States.

Table 1 Sample Characteristics

Classification	(%) Respondents
1. Firm's size—Revenues in million $	
Less than 100 million	44.7
100–499 million	32.7
500–4,999 million	14.6
Above 5,000 million	8.0
2. Firm's size—Number of employees	
Less than 100	9.7
100–499	40.0
500–999	14.9
1,000–4,999	20.8
Above 5,000	14.6
3. Industry	
SIC code 35. Industrial and commercial machinery computer equipment	30.6
SIC code 36. Electronic and other electrical equipment and components except computer equipments	28.4
SIC code 37. Transportation equipment	22.6
SIC code 38. Measuring, analyzing and controlling instruments; photographic, medical and optical goods; watches and clocks	18.4

responses, and among responses from different industries. Hence we merged samples across different sampling rounds and industries.

Operationalization of Constructs

To the extent possible, we used existing measures and adapted them to the context of e-procurement. In the absence of existing scales, theoretically grounded new scales were developed. The appendix contains the sources of all construct items. Most constructs were measured with multiple indicators coded on a seven-point Likert scale. The measurement of two constructs deserves special attention.

The extents of Internet use in search and OIC were measured based on use in the following activities: product search, identification of suppliers, negotiation, ordering, document exchange, and financial settlement. These activities were chosen based on a review of the procurement literature (e.g., Zenz and Thompson 1994, Monczka et al. 2002). The extent of use in the first two activities was conceptualized as use in search and the extent of use in other activities was conceptualized as use in ordering. This conceptualization is intuitive, builds on existing measures (e.g., Massetti and Zmud 1996), and extends them by enhancing the scope of activities and participants considered. The percentage scale was employed to measure use. Respondents were asked to indicate the percentage of a specific activity conducted on the Internet. To assess the conceptual distinctness of Internet use in two stages, principal component analysis (PCA) was conducted on items that measure use. We obtained a two-component solution with items loading on different components as predicted.

Procurement-process performance was measured as the total number of performance indicators that are impacted positively by e-procurement solutions. In the absence of an existing scale, these metrics were chosen based on a review of the prior literature on procurement and the impact of IT use on procurement (e.g., Zenz and Thompson 1994, Mooney et al. 1995, Mukhopadhyay et al. 1995). Five indicators measuring procurement-process performance were parceled (added) together. Item parceling is a common practice used when the data to be analyzed are coarsely categorized and/or nonnormally distributed (Bandalos 2002).

Pursuant to the recommendation of scholars in IS who use RBV to explain IT use and the business value from IT use (e.g., Armstrong and Sambamurthy 1999, Piccoli and Ives 2005), we analyzed Internet

Table 2 Descriptive Statistics and Correlations Among Constructs

Constructs	Mean	S.D.	V1	V2	V3	V4	V5	V6	V7	V8
Procurement-process digitization (V1)	19.4	4.9	1.0							
Diversity of org. proc. knowledge (V2)	8.0	3.4	0.13	1.0						
Suppliers' sales-process digitization (V3)	16.7	5.4	0.32	−0.09	1.0					
Org. perceptions of technological uncertainty (V4)	16.5	5.0	0.22	0.41	0.25	1.0				
Org. perceptions of volume uncertainty (V5)	21.8	6.4	−0.23	−0.05	−0.10	0.02	1.0			
Internet use in search (V6)	0.28	0.24	0.21	0.10	0.18	0.13	0.06	1.0		
Internet use in OIC (V7)	0.11	0.14	0.31	0.11	0.26	0.25	−0.05	0.54	1.0	
Procurement-process performance (V8)	1.04	1.38	0.24	0.07	0.12	0.11	−0.008	0.21	0.42	1.0

Note. Correlations above 0.08 and 0.11 are significant at 5% and 1%, respectively.

Table 3 Establishing Discriminant Validity

Constructs	Procurement-process digitization	Diversity of org. proc. knowledge	Suppliers' sales-process digitization	Org. perceptions of tech. uncertainty	Org. perceptions of volume uncertainty	Internet use in search	Internet use in OIC
Procurement-process digitization	**0.33**						
Diversity of org. proc. knowledge	0.017	**0.42**					
Suppliers' sales-process digitization	0.11	0.008	**0.59**				
Org. perceptions of technological uncertainty	0.05	0.16	0.06	**0.60**			
Org. perceptions of volume uncertainty	0.05	0.002	0.009	0.000	**0.58**		
Internet use in search	0.05	0.01	0.03	0.02	0.004	**0.75**	
Internet use in OIC	0.09	0.01	0.06	0.06	0.003	0.29	**0.57**

Note. Variance-extracted estimates are on the diagonal; squared correlations are off-diagonal.

use in procurement and procurement-process performance of firms relative to other firms in their industry. We divided individual responses for Internet use in search and ordering and procurement-process performance by the respective industry average. This approach enables a competitive assessment of firm performance.

Prior research has suggested that firm size is an important determinant of innovation, technology use, and firm performance (Bhardwaj et al. 1999, Rai et al. 2006, Rogers 1995), thus we control for the impact of firm size. Firm size is operationalized as the log of the number of employees working in the firm.

Instrument Validation

Exploratory factor analysis was performed to validate the proposed factor structures. The results suggest that the factor structures proposed are consistent with the data. The reliability of constructs, as measured by Cronbach's alpha, varied from 0.68 to 0.86. These values suggest that the instrument has adequate reliability (Nunnally 1978). The psychometric properties of the scale were evaluated within the confirmatory approach using AMOS 4.0. Convergent validity was assessed by reviewing indicator loadings. The loadings varied from 0.34 to 0.96 and were significant ($p < 0.001$), establishing convergent validity (Anderson and Gerbing 1988). Discriminant validity was assessed by conducting the variance-extracted test. This test involves comparing the variance extracted for a construct to the square correlations between that construct and every other construct. Discriminant validity is demonstrated if the variance-extracted estimate is higher than squared correlations. The discriminant validity is supported for all the constructs (see Table 3).

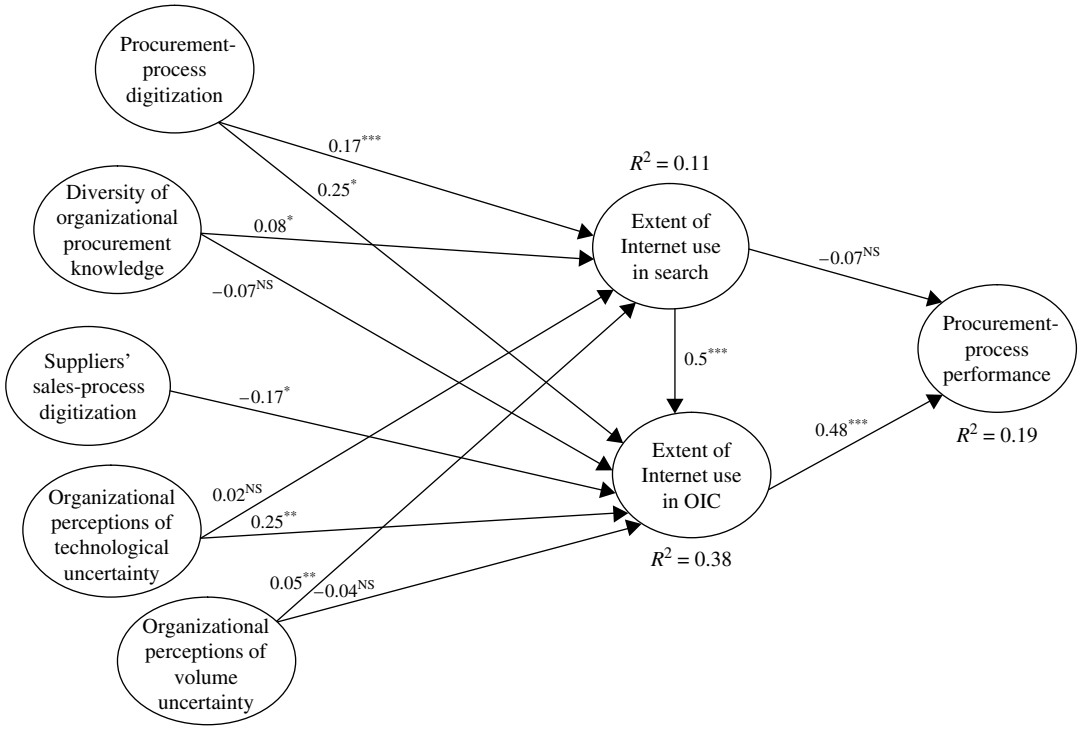
Because data were collected from a single key respondent, we also checked for common-method bias. As suggested by Podsakoff and Organ (1986), we conducted Harman's one-factor test. PCA resulted in five components. Principal components accounted for 64.0% of the total variance and the first component accounted for only 20.96% of the variance; hence there was no general factor accounting for over 50% of the variation. These results indicate that common-method bias is not a significant problem in our study.

Model Estimation and Results

Prior to estimating the models, data were tested for nonnormality and outliers. Skew and kurtosis values were used to assess nonnormality. These values indicated that all our variables can be assumed to be from a normal population. To identify outliers in the sample, Mahalanobis distance was estimated and the most influential outliers were eliminated, leaving us with 412 observations.

As recommended by Anderson and Gerbing (1988), we employed the two-step process to analyze the data. In the first step, we estimated the measurement model using AMOS 4.0. Overall, the model provided a good fit (Relative chi square = 1.50, Tucker-Lewis index = 0.99, Comparative fit index = 0.99, RMSEA = 0.035). The relative chi square index was 1.50, below 3.0, which is the acceptable limit. The goodness of fit indices, the Tucker-Lewis index and the Comparative fit index, were above 0.9, which is the acceptable limit. At 0.035, RMSEA was below 0.08, the acceptable

Figure 2 The Estimated Model



$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. NS: Nonsignificant.

limit in the literature. Based on all these values, we concluded that the measurement model provides an adequate fit to the data. In the next step, we estimated the structural model. Figure 2 shows the estimated model. Full results are also reported in Tables 4 and 5. The structural model provided a good fit (Relative chi square = 1.56, Tucker-Lewis index = 0.99, Comparative fit index = 0.99, RMSEA = 0.037). The R^2 values for Internet use in search and OIC and procurement-process performance are 0.11, 0.38, and 0.19, respectively. These values indicate that the model fits the data well.[5]

Results

H1A and H1B predicted that Internet use in search and order initiation and completion, respectively, will impact procurement-process performance. Our results support H1B, but not H1A. As hypothesized in H2, the extent of Internet use in search is significantly related to the extent of use in ordering.

H3A and H3B predicted the impact of a technological resource on the extent of Internet use in search and ordering. The results support both H3A and H3B, demonstrating the significance of organizational IT infrastructure and the prior use of IT on the use of new and innovative IT applications.

H4A and H4B posited the influence of an organizational resource on the extent of Internet use. We find that the diversity of procurement knowledge influences Internet use in search positively and has an insignificant impact on Internet use in ordering. Thus, although H4A is supported, H4B is not supported.

We hypothesized the impact of an external resource in H5. We find that suppliers' sales-process digitization is positively related to the extent of Internet use in order initiation and completion—supporting H5.

Organizational perceptions of environmental uncertainties reveal an intriguing pattern on the extent of Internet use. Whereas organizational perceptions of

[5] In order to alleviate concerns that suppliers' sales-process digitization may also impact Internet use in search, the empirical model accounted for their impact. Models were also estimated after deleting the link and the results stayed the same qualitatively.

Table 4 Antecedents of Internet Use in Different Stages of the Procurement Process

	Search		OIC	
Parameter	Estimate	*P*-value	Estimate	*P*-value
Procurement-process digitization	0.17	0.005***	0.25	0.065*
Diversity of organizational procurement knowledge	0.08	0.071*	−0.07	0.569
Suppliers' sales-process digitization			0.17	0.09*
Organizational perceptions of technological uncertainty	0.02	0.671	0.25	0.04**
Organizational perceptions of volume uncertainty	0.05	0.071**	−0.04	0.586
The extent of Internet use in search			0.50	0.000***

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

technological uncertainty have a significant impact on the extent of use in order initiation and completion (H6B) and an insignificant impact on the extent of use in search (H6A), organizational perceptions of volume uncertainty show an opposite pattern. These results indicate that firm perceptions about different uncertainties have different impacts on IT innovation.

Discussion

IT use in firms and the business value of such use are enduring questions in IS research. Despite a significant body of research, insights regarding the antecedents of IT use in different stages of business processes, the interrelationship between such use, and the performance implications of use are lacking in the literature. Our goal in this study was to understand organizational use of Internet technologies in two stages of procurement and the antecedents and implications of such use in an integrative framework. Our research model, estimated with survey data from 412 firms, finds good overall support. The results indicate that firms distinguish between Internet use in search and ordering, and although some antecedents impact use in both stages, others influence use in only one stage. Further, performance impacts of Internet use in the two procurement stages differ significantly. Theoretically, this study provides three insights that significantly contribute to the IS literature.

Table 5 Consequences of Internet Use in Search and OIC

	Procurement-process performance	
Parameter	Estimate	*P*-value
Extent of Internet use in search	−0.07	0.544
Extent of Internet use in OIC	0.48	0.000***

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

This study synthesizes separate literature streams that investigate IT usage and business value largely in isolation. IT use and value creation constitute two separate but related aspects of the same nomological net used to examine IT innovations. By examining the entire nomological net that contains the antecedents, the extent, and implications of IT use, this study shows that antecedent resources significantly influence IT use in firms, and that the differential use of IT, in effect, impacts performance. Independent investigations of either the usage aspects or the business-value aspects are unlikely to generate such insights.

The prior research in IS does not deconstruct IT use in business processes. Thus, the differential impacts that antecedents can have on IT use in different aspects of business processes have been largely ignored in the literature. Our results suggest that firms perceive Internet use in search and ordering differently. Further, firm resources impact Internet use in the two stages differently. Whereas some resources impact Internet use in both the stages, others influence use in only one stage. Additionally, our results suggest that Internet use in search and ordering are related. In fact, we find that Internet use in search is a strong predictor and enabler of use in ordering. This indicates a "virtuous" cycle of IT innovation. As firms become progressively more sophisticated in their use and application of IT, the "next" related innovation becomes easier to use.

An interesting insight emerging from our study is that IT usage in different aspects of the procurement process can have differential impacts on performance. We find that Internet use in search has an insignificant impact on procurement-process performance, whereas Internet use in order initiation and completion has a significant positive impact. One plausible

explanation for this result is that Internet use in ordering entails integrating e-procurement solutions to the back-end systems available in firms; such integration is more firm-specific, tailored to its strategic context, and less transparent to outside competitors. Internet use in search, although valuable in locating products and suppliers, is less firm specific and may not entail integration with existing back-end systems, thereby not differentiating between high and low performing firms. Alternatively, it is also possible that the impact of Internet use in search on performance is experienced indirectly through its impact on use in order initiation and completion. In other words, Internet use in order initiation and completion mediates the relationship between Internet use in search and procurement-process performance. Because much of the prior research in IS has examined the impact of IT use in a business process on firm performance at the aggregate level, such insights could not be obtained earlier.

We find that procurement-process digitization is related to Internet use in both search and OIC. Our results are consistent with the findings and arguments of prior research which has suggested that the availability of IT infrastructure and the prior use of IT are among the most robust predictors of new IT use in organizations (Chwelos et al. 2001, Rai et al. 2006, Zhu and Kraemer 2005). Further, the significant effect of suppliers' sales-process digitization on Internet use in ordering clearly indicates that firms can leverage the experience, skills, and knowledge of these suppliers to exchange information and use the Internet to automate procurement tasks electronically (Barua et al. 2004). This suggests that suppliers' technological resources and their prior experience with IT can serve as valuable external resources for firms.

We find that the knowledge gathered through the organizational experience in a wide variety of procurement situations is positively related to Internet use in search but has no significant impact on the use in ordering. Zahra and George (2002) suggest that the ability of firms to create and use knowledge in innovative situations depends on their capacity for knowledge acquisition, assimilation, transformation, and exploitation. These capacities progressively build on one another. Whereas the first two capacities enable a firm to gather and comprehend new knowledge, the latter two capacities facilitate the combination of new and existing knowledge and the leveraging of this knowledge. Firms cannot exploit knowledge without first gathering it; however, they may not be able to exploit the breadth of knowledge acquired through experiences in different situations for Internet use in ordering. The integration of a wide variety of knowledge may be less straightforward for an involved innovation context such as Internet use in OIC.

Despite a significant amount of theorizing about and empirical examination of the role of uncertainty on innovation, insights regarding the impact of organizational perceptions of environmental uncertainties on IT use in different stages of a business processes are not available in the IS literature. Our results indicate that such perceptions have different impacts on Internet use in the two procurement stages. Whereas organizational perceptions of high volume uncertainty impact Internet use in search, perceptions of high technological uncertainty impact use in order initiation and completion. This difference suggests that perceptions of uncertainty in different dimensions impact awareness of innovation opportunities, proactiveness, and strategic action in different procurement stages differently. This is a significant insight from our research.

Limitations of the Study

This study has three limitations. First, the data used in the paper were collected from one key respondent in each firm. This could potentially lead to the percept-percept inflation problem (Crampton and Wagner 1994). However, this problem is at least partly mitigated in our context for several reasons including the long tenure of the respondents and their direct involvement in the procurement of production goods. Further, the questions pertain to facts and organizational perceptions, and not to psychological states and attitudes. The results from Harman's one-factor test suggest that common-method bias does not influence our results. In fact, Crampton and Wagner suggest that inflationary effects are a less likely result of the use of self-reported measures and that percept-percept inflation may be more the exception than the rule in organizational research. In summary, managers' perceptions of performance may not

be much different from the actual performance. Nevertheless, we recommend that the future research circumvent this issue by surveying more than one key respondent. In addition, researchers can supplement primary data collection with data from secondary sources.

Our study presents a cross-sectional analysis of Internet use in procurement. Therefore, we cannot establish the causality of arguments. A more rigorous test of our model will involve longitudinal data collection. Future research can undertake a longitudinal study and examine e-procurement and its performance impacts over a long period of time. Such studies can help support notions of causality and also provide insights into the process of Internet use and value creation, an important aspect that cannot be captured in cross-sectional surveys. Nonetheless, theory suggests that the relationships tested in this research are causal in nature.

The measures used for procurement-process performance in this study are coarsely categorized. The future research can develop fine-grained and continuous measures of procurement-process performance. Future research can also link this performance to the objective financial performance measures.

Implications for Research

This paper has two important implications for research. First, IT use in business processes should be deconstructed and studied at a more granular level. Our results indicate clearly that firms distinguish between Internet use in different aspects of procurement and that antecedents of usage differ significantly in these aspects. When examined at an aggregate level, these differences and antecedents that impact the differences are likely to be ignored. Any potential relationship between IT use in different aspects of the business process is also likely to be overlooked. For theoretical advancement, future research should acknowledge these differences and explicitly hypothesize the relationship between antecedents and IT use in different aspects. Further, IT use in different aspects of the business process should be explicitly tied to their implications. Finally, to bridge the gap between IT business value and usage literature, it is essential that researchers examine antecedents, the extent, and the consequences of IT use in a holistic model.

Implications for Practice

This study has significant implications for managers. We provide a framework for managers to understand which resources influence Internet use in different stages of procurement and how such usage impacts performance. We emphasize the usage part to illustrate that firms need to *use* e-procurement technologies to obtain value. Our results indicate that it is imperative for firms to focus on digitization to improve Internet use in both search and ordering. The integration of e-procurement technologies in a firm entails addressing several technological challenges and higher levels of digitization allow it to leverage the extant infrastructure and prior knowledge to manage those challenges. This sends a signal to firms that lack internal computerization to allocate more resources and digitize their processes before attempting e-procurement. Further, our results reinforce the importance of supplier selection. Firms keen on enhancing Internet use in ordering must involve suppliers that have digitized their sales process. If a large majority of a firm's suppliers lacks digitization, the firm must anticipate problems in using e-procurement for ordering, and actively encourage its suppliers to digitize. Firms must realize that such deficiencies in suppliers may be difficult to overcome in the short run.

Arguably, a firm may have little or no control over the objective environmental uncertainty, but it can impact innovation through managerial perceptions of it. Our research suggests that through their impact on Internet use in OIC, perceptions of technological uncertainty can influence procurement-process performance more significantly than those of volume uncertainty. Thus, opportunities that firms discover through such perceptions and the actions these engender are more valuable for firms. It follows then that firms should attempt to create an atmosphere that fosters perceptions of high technological uncertainty in the environment.

Our findings should motivate firms to carefully manage Internet use in ordering because it has a higher impact on procurement-process performance than use in search. Firms that use the Internet in just search are not leveraging the potential of e-procurement applications and are likely to receive lower benefits than firms that also carry out the OIC

stage online. However, firms that are just beginning their e-procurement endeavors will be well advised to acquire some knowledge and skills by searching online and then attempting ordering.

Conclusion

As firms explore the potential of Internet to streamline the procurement process and the value chain, it has become increasingly critical to understand the antecedents and consequences of Internet use in procurement. Drawing upon RBV and the TOE frameworks, and grounding our research in practice through interviews, we developed an integrative model, which examined both antecedents and consequences of IUP and extended the nomological net of constructs that examine IT use and business value separately. Due to the theoretical and empirical challenges associated with such endeavor, this study is among the few that have accomplished such an investigation. Our research model and results suggest that although some resources impact Internet use in both search and ordering, other resources impact use in only one stage—indicating that determinants of organizational use of the Internet in search and OIC are different. We also find that Internet use in ordering has a higher impact on procurement-process performance than use in search. These results contribute to an emerging stream of research that examines the phenomena of IT use and its performance impacts holistically.

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Appendix

1. The extent of Internet use in search and OIC

All the items were measured using percentage scale.

Stage	Activities	Use of the Internet (%)
Search	Product search on the Internet	
Search	Identification of new suppliers on the Internet	
OIC	Negotiations of terms with suppliers on the Internet	
OIC	Completion of procurement transactions on the Internet	
OIC	Payment and financial settlement on the Internet	
OIC	Document exchange on the Internet	

Source of items: Zenz and Thompson (1994), Monczka et al. (2002).

2. Antecedent constructs

Scale range: 1 = Strongly disagree; 7 = Strongly agree

(a) Procurement-process digitization (Cronbach's alpha = 0.68, composite reliability = 0.68).

1. We share procurement-related information electronically within our firm.

2. Our firm has automated the ordering process for production goods (raw materials).

3. We depend heavily on paper documents during the entire procurement process. **(R)**[6]

4. Our procurement application is highly integrated with other applications (e.g., inventory, logistics, manufacturing).

Source of items: Items developed for this study.

(b) Suppliers' sales-process digitization (Cronbach's alpha = 0.81, composite reliability = 0.81).

1. Our suppliers have computer systems in place to quickly respond to our product inquiries.

2. Our suppliers can electronically process business documents (e.g., invoices, designs, POs).

3. Our suppliers have computerized their order-management process.

Source of items: Items developed for this study.

(c) Diversity of managerial procurement knowledge (Cronbach's alpha = 0.68, composite reliability = 0.68).

1. Our production goods (raw materials) have a complex electronic or mechanical assembly of raw materials.

2. Overall specifications for the production goods we procure are simple. **(R)**

3. A large number of our production goods are custom designed to our specifications.

Source of items: Items developed for this study.

[6] Reverse-coded item.

(d) Organizational perceptions of technological uncertainty (Cronbach's alpha = 0.85, composite reliability = 0.86).

1. Functionality improvements are very likely in our production goods.

2. Major product innovations are very likely in the production goods we procure.

3. Major manufacturing innovations are very likely in our production goods.

4. Major price/performance ratio improvements are very likely in our production goods.

Source of items: Bensaou and Anderson (1999).

(e) Organizational perceptions of volume uncertainty (Cronbach's alpha = 0.72, composite reliability = 0.78).

1. Volume requirements for our production goods are predictable. **(R)**

2. Our volume estimates for production goods are reliable. **(R)**

3. Our firm experiences frequent over-stocking or under-stocking of production goods.

Source of items: Bensaou and Anderson (1999).

3. Metrics of procurement-process performance

(i) Reduction in production-goods procurement costs
(ii) Reduction in lead time
(iii) Reduction in administrative expenses
(iv) Reduction in the reject rates of goods procured
(v) Reduction in the time to transmit change orders

Source of items: Items based on the work of Mukhopadhyay et al. (1995), Zenz and Thompson (1994), Mooney et al. (1995), and Monczka et al. (2002), as well as our interviews with procurement managers.

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