A Study of the Value and Impact of B2B E-Commerce: The Case of Web-Based Procurement

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ABSTRACT: Web-enabled business-to-business (B2B) e-commerce enhances interorganizational coordination, resulting in transaction cost savings and competitive sourcing opportunities for the buyer organization. However, organizations are uncertain whether this is an improvement over existing information technology, such as EDI. In particular, what is the value of B2B e-commerce to a buyer organization, and how can it be measured? What factors most affect the realization of the value of B2B e-commerce? Using the case of Web-based B2B procurement systems, a framework is proposed to quantify and measure the value of B2B e-commerce systems and identify the factors that determine it. The methodology is applied to help a major heavy-equipment manufacturer located in the midwestern United States evaluate the potential of its Web-based procurement system. The preliminary results indicate that, even though all stages of B2B procurement are affected by the Web, the value of Web-based procurement is most determined by the process characteristics, organization of business units, and the “extended enterprise.”

KEY WORDS AND PHRASES: Extended enterprise, interorganizational information systems, value measurement, Web-based procurement.

Web-enabled applications for business-to-business (B2B) electronic commerce are expected to enhance interorganizational coordination and improve relationships among business partners. Transaction cost savings and competitive sourcing opportunities are the potential benefits of B2B procurement. However, organizations are still unsure whether a Web-based B2B e-commerce system can deliver the promised benefits. For example, is the use of the Web an improvement over existing, and mature, information technology (IT) systems, such as electronic data interchange (EDI)? Organizations need to measure and determine the impact of Web-based systems on B2B processes and the value to the enterprise. Knowing the value of Web-based systems is a necessary first step in motivating users to adopt one.

In the current economic environment, organizations are critically evaluating their investments, and Web-based B2B systems are no exception. But as IT has evolved from a productivity tool to a more pervasive and strategic business tool, the measurement of its value to an organization has become more challenging. Most evidence of Web benefits on the organizational level is anecdotal, and there are very few systematic studies that look at the value from an organization’s perspective. Moreover, the nature of the Web creates impacts beyond traditional organizational boundaries, requiring the cooperation of business partners and, in some cases, even competitors within the industry. A better framework is needed that can determine the value of the Web for an organization and provide a clear understanding of what factors affect this value. The objective of the research summarized in this article is to fill this void by developing a comprehensive valuation framework for B2B e-commerce that can be used to evaluate and formulate B2B implemen-
Web-Based B2B Procurement Systems

A significant proportion of organizational resources is devoted to managing interorganizational processes, such as procurement of goods and services from other companies, collaboration for product development, and financial transactions between companies. Procurement of goods and services, called business-to-business procurement, involves the largest cost for an enterprise, with many organizations spending 50 to 60 percent of their revenue on goods and services [12]. Despite this, interorganizational information systems (IOS) and other information technology applications have focused on more structured processes, such as manufacturing, leaving most procurement processes inefficient and ineffective. Procurement usually covers two types of purchases—direct and indirect. Direct purchases involve the raw materials and components that go into the finished products sold to the customer. Indirect purchases, on the other hand, involve goods and services that are not part of the finished product but support internal business activities, such as computers, office equipment, operating supplies, and office supplies.

The use of the Internet for procurement has generated great excitement because of its potential to reduce procurement costs and improve strategic sourcing [6, 16]. The availability of electronic markets and industry-specific B2B exchanges has added to the choices available to organizations for managing their procurement [1]. From the point of view of B2B procurement, there are four models of Web-based procurement systems (see Figure 1). These reflect the different ways that a buyer or a supplier can execute a B2B transaction [13, 17, 22]. Each model creates value for buyers and sellers in unique ways, and organizations typically use more than one of the models, if not all of them. Table 1 summarizes the factors that create value and the factors that affect value in each form of B2B procurement system.

Although researchers have predicted a significant shift toward electronic market-based transactions [1, 18], every Web-based model has a different way of creating value, and B2B managers have to evaluate the role of each model in their enterprise. But it is clear that organizations, whether buyers or sellers, can derive competitive advantage from any of these systems in the form of economic benefits and increased business opportunities [9, 11, 29]. Interactions with the B2B managers of a large manufacturing organization during the course of the research described here showed that there are still doubts about the real benefits of the Web. Organizations that already have an IOS of some kind, such as electronic data interchange, have not yet decided whether the Web is an improvement over the existing system. Moreover, the different players in the B2B procurement process, such as users, business units, central procurement managers, and suppliers, all have their own, sometimes mutually conflicting, expectations from the system. As a
Figure 1. Framework for the Value of Web-Based Procurement
result, the players may not all perceive the same value from implementing a B2B system, and their perceptions are critical to successful adoption of the system [8].

To address these concerns in existing research and practice of B2B e-commerce, the following research questions were proposed:

1. What is the value of a B2B e-commerce system to an organization? How can this value be measured?
2. What factors affect the value of a B2B e-commerce system?
3. What are the implications of the value for B2B implementation strategies?

These questions were addressed by studying the value of a Web-based procurement system to a large buyer organization. The framework used for this research identified three levels of factors—process, organization of business units, and extended enterprise—and derived propositions on how these factors affect the value of Web-based procurement. Using preliminary data from an organization, the framework was subjected to a limited empirical test with the value as procurement cost savings and the effect of process-level characteristics on this value. In future, the research will be extended to collect more data for a comprehensive measurement of value and for empirical verification of the complete framework, including the effect of organizational and

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Table 1. Value Created by Different Forms of Web-Based Procurement.
supply-chain characteristics. The analysis and empirical results summarized below make it clear that B2B implementation is not a simple yes-or-no decision, but involves understanding the differences in the value of a B2B system for various users and business units. The framework provides a roadmap for successful implementation of B2B e-commerce systems.

A Review of Related Research

The impact of information technology on firm performance has long been a subject of intensive research, with the issues studied ranging from measurement of the impact to the conditions necessary to realize an impact. The realized impact in the form of actual improvement in firm performance represents the value of the IT system to the organization. However, researchers have pointed out the conflicting results yielded by these studies [7, 10, 21, 25]. Some of the issues relate to measurement, others to the complexity of isolating the effect of IT on firm performance [21]. The problem of relating IT investments to firm performance is complicated by the effect of confounding factors, such as other internal performance-improvement measures and external economic influences. Another issue is that some IT investments may provide benefits after a certain period but increase operating costs in the short run [14]. Researchers suggest a process-oriented approach to overcome these confounding problems. Kauffman and Weill hold that the locus of impact, that is, the business process, should be the primary level of value analysis for the benefits to become discernible for the investing firm [15]. Barua et al. utilize a multistage, process-oriented study to measure the first-order and higher-order impact of IT [5]. Mukhopadhyay uses such an approach to understand how EDI benefits an organization [19].

Research on the impact and value of interorganizational information systems, and particularly the use of electronic data exchange, has shown that they are largely positive in improving the efficiency of business processes and the overall performance of organizations [19, 26]. Electronic processing and communication of interorganizational data improve the timeliness and accuracy of the information, allowing trading organizations to better plan and manage their assets, such as inventory [4]. The use of IT improves the process quality, which in turn improves the level of output [20]. Impacts of this type occur mainly on the operational level and result in cost reduction, higher productivity, and improved quality [19]. IOS also increases the bargaining power of the buying organization, which now has a better information visibility of its business processes [23, 24]. At the same time, however, by having access to more information about the buyer, a supplier can better match the preferences of the buyer and extract a premium price. The close relationship built up between buyer and supplier may also enable the supplier to gradually increase its volume of business with the buyers.

These impacts, however, are neither guaranteed upon implementation of the system nor uniform across the organization [5, 7, 19, 27]. Realization of the value of the system is conditional upon internal and external factors, some of which are controllable by the organization [27]. These are called conversion
contingencies: “a spectrum of things that are likely to influence realized value from a system” [7]. For example, the contribution of an IT system depends on such resources as people and investments in associated processes [15]. In a study of EDI impacts, Mukhopadhyay found that the operational benefits of EDI increased with increased integration of the IOS with internal systems, but decreased with more parts variety and a greater number of trading partners [19]. Suppliers handling a larger proportion of their business electronically saw better performance than other suppliers. With respect to strategic impact, the size of the supplier determined what incentives were needed to join the system. The strategic benefits were better if the buyer initiated the system or if the system had been used for a longer time.

While some of the issues and critical variables of previous research are relevant for Web-based systems, other issues and variables assume increased importance. The capability of EDI to reduce communication and processing costs and errors is also found in Web-based systems. But in Web-based systems, the potential to reduce search costs is great and affects every B2B transaction. Thus, in the present research, for example, savings in search cost emerged as an important economic benefit. Coordination costs are reduced significantly by using the Web, and the present research quantified the economic impact of this reduction. The Web allows organizations to choose from different procurement models, an issue that did not arise with EDI systems. Many studies have looked at different pieces of the B2B puzzle, such as supplier selection [3] and the impact of electronic markets [1, 9]. B2B e-commerce is rapidly transforming how organizations structure and coordinate their business relationships, but there are very few systematic studies in this area that try to understand the impacts comprehensively from an organizational perspective.

Framework for Value of Web-Based Procurement

Our framework is based on a multistage impact model of information technology on enterprise processes [5, 10, 15, 19]. The principle is that certain features or capabilities of the Web are used to enable B2B operations, which in turn have an impact on a set of intermediate variables. The impact on intermediate variables leads to improvements in performance. Any improvement of a performance variable helps improve the effectiveness of the procurement process, which is the B2B goal of the enterprise. The framework is shown in Figure 1.

Impact on B2B Tasks

A Web-based procurement system provides enhanced search capabilities, faster and more accurate processing, real-time and rich-media information support, and low communication and coordination costs [6, 16]. From the buying enterprise’s point of view, the use of a Web-based system affects four major categories of B2B operations: search, order processing, monitoring and control, and coordination.
Search

Search costs are the costs incurred by a buyer in locating an appropriate seller and purchasing a product [2]. In procurement, search costs are incurred when a professional buyer looks for a supplier to contract purchases, and when an individual user in an organization looks for an appropriate product to order. In both cases, the Web and associated search engines considerably lower the search costs, which can be quite significant in large organizations. Web-enabled search engines help users to search using multiple methods to ensure that they can find the right product even with limited available information. The system’s “user-friendliness” reduces the “premium buys,” where the user goes around the procurement system and incurs higher processing and product costs [12].

Processing

A Web-based procurement system involves electronic document routing and information flow, thus reducing the labor costs entailed by manual processing. A Web-based system can automatically route product requests for the necessary approvals and order placements with suppliers. This reduces the transaction cycle time and gets the materials to the user faster. As the system requires only minimal data inputs during the information-processing cycle, many former sources of error are eliminated. Thus, Web-based procurement processing lessens cycle time, errors, and processing costs.

Monitoring and Control

Using a Web-based procurement system, organizations can achieve the twin objectives of responding effectively to user needs and leveraging their combined buying power. Users can search the catalog to identify the most cost-effective supplier and place their orders. Corporate B2B managers can aggregate the demand for a product so as to negotiate a more competitive price, and then make the product available to the various business units of the enterprise irrespective of their size or location. Centralized control, combined with the availability of an increased range of items on the electronic catalog, motivates more users to order through the e-procurement system, reducing the number of premium buys. Thus, Web-based monitoring and control reduce both the average product price and the incidence of premium buys.

Coordination

One of the major advances of a Web-based IOS over a traditional IOS is its ability to support increased and more complex coordination. When fulfilling an order, procurement personnel often need to communicate and exchange information with suppliers and users. A Web-based procurement system provides a real-time information flow and is less costly to coordinate with suppliers and users. This leads to faster resolution of problems and shortens order cycle time. The low communication costs of the Web and the shorter time
spent by the procurement staff for coordination result in lower transaction costs.

**Impact on Performance Measures**

The impact of the Web on B2B performance measures can be discussed in terms of the concept of first-order and higher-order impacts suggested in the literature on information technology [5, 15]. The first-order impact is on intermediate measures closer to the process, which in turn affect performance measures. One of the most visible performance impacts of Web-based procurement is the lower total procurement cost. The reduction in transaction cycle time resulting from the use of Web-based procurement reduces the labor time used in the process and the labor cost component of the transaction costs. Costs incurred due to electronic processing and coordination are several magnitudes lower than those involved in manual processing and coordination. The lower incidence of errors in a Web-based procurement system reduces the need for labor for error resolution, thereby reducing transaction costs. With less lead time for acquiring products, organizations can store less in inventory and increase inventory turns, leading to lower inventory costs. The lower average prices negotiated for contracted items also contribute to the reduction in total procurement costs.

**Quality of the Procurement Process**

The quality of the procurement process is an indicator of how well a system meets the procurement needs of the enterprise. Any error in the processing cycle decreases the chance that the product delivered to the user will fully meet expectations. The proportion of B2B orders rejected or returned by the user is a measure of process quality. So is the number of user complaints about the product. By reducing the probability of errors, a Web-based system can reduce the potential mismatch between user needs and the delivered product, thus reducing user complaints.

**User Satisfaction**

User satisfaction refers to the perception of users that the system effectively meets their business demands. This perception covers more than the receipt of a matching product. User satisfaction is affected by how well the system is perceived to meet user expectations. Higher cycle time and more errors in the process lead to lower user satisfaction. Access to required information with minimum effort, faster resolution of complaints, and ease of use of the system interface are some ways in which user satisfaction can be improved by a Web-based system.

**System Responsiveness**

System responsiveness is the ability of a B2B procurement system to respond to the needs of the user and the enterprise. It reflects not only the time taken to
get users what they need, but also the ability to locate alternative sources, within a reasonable time, if necessary. For example, a user or a business unit may require a critical item to prevent the idling of expensive production machinery. Delay in locating or procuring the item may cost more, though indirectly, than the cost of the item. In such situations, a responsive system will help search internal and external locations to find the item in the shortest time possible and the best way to get it to the business unit.

The effects of a Web-based B2B procurement system are summarized in the following list:

**Impact on Intermediate Measures**

1. Lower transaction costs
2. Lower inventory holding costs
3. Lower price for products purchased

**Impact on performance measures**

1. Higher process quality
2. Lower total procurement costs
3. Increased user satisfaction
4. Increased responsiveness of the system

The potential value of a Web-based procurement system to an organization depends on the extent to which it can derive benefits from the system, net of its investments, and other implementation costs. One way to estimate the value of a system is to quantify the improvements in the performance measures in economic terms. Measuring and quantifying the impact on the intermediate measures will provide a more precise estimate of the value of the system [15, 19], but requires more detailed data on the process level.

**Factors That Affect the Value of Web-Based Procurement**

Research on the value of information technology shows that implementing a system does not automatically guarantee realization of the potential value [5, 7, 19, 27]. The realized value depends on several conversion contingencies [7]. These conditions could be firm-level controllable conditions, such as training of users, or can be external influences, such as actions of competitors and technology [27]. For a B2B manager who understands the potential value of an e-procurement system, the next important task is to identify the conditions that determine the realized value. These vary for each organization and even, within an organization, for each business unit. When motivating a business unit to join Web-based procurement efforts, an understanding of these factors provides a framework for the B2B manager to precisely convey the value of Web-based procurement to a particular business unit.

The effect of these factors can be analyzed at several levels, ranging from
the internal process to external macroeconomic conditions. Davern and Kauffman identify five levels of analysis to study the value realized from IT: market, firm, workgroup, business process, and individual users [7]. The impact of a Web-based system is felt first on the procurement-process level. Although the use of the Web is expected to benefit transactions of every type, the fact is that all transactions do not have the same need for search, processing, and error resolution. Since process characteristics can be expected to influence the value, the first level of analysis is the B2B process.

All B2B transactions occur in the context of individual business units that use procurement systems to serve the needs of their internal customers. Depending on the organization, business units may have the freedom to use either a central procurement system or their own independent system. This is particularly so for most large manufacturing organizations. The extent of decentralization differs for different business units. Together with the volume of B2B transactions and the capability of the business unit to fully exploit the potential of the Web, it will determine the value of Web-based procurement. Hence, the next level of evaluation is the organization of the business unit within a firm. This corresponds to the firm level of analysis [7].

The scope of B2B operations goes beyond the buying enterprise. The Web breaks down the barriers between firms and helps in the virtual integration of all the steps in the process into a request-to-fulfillment-to-payment process. Web technology allows the integration of several levels of suppliers and distributors with the enterprise systems in order to form an “extended enterprise.” The success of a Web-based procurement system depends on the effective participation of this extended enterprise. Thus, the extended enterprise is the third level of evaluation. This corresponds to the market level of analysis [7]. This paper looks at how supply-chain fragmentation and other supplier characteristics affect the value.

**B2B Process Characteristics**

Business-to-businesses processes differ along several dimensions, such as specificity, structuredness, variation in demand, frequency of orders, value of product, amount of human intervention required, and complexity of the tasks involved. In this research, these dimensions are grouped by type and complexity. In addition to the differentiation of the processes based on these factors, the research also notes how the distribution of transaction volume in each category plays an important role in determining the value.

**Type of Process**

Transaction cost economics identify asset specificity, transaction frequency, and supply uncertainty as the principal dimensions on which the differences in transaction costs of procurement can be studied [28]. These characteristics essentially determine the level of transaction costs for the transactions in each process category and elicit organizational responses to manage the transaction costs in a non-Web environment. When an e-procurement solution is imple-
mented, one assumes that the procurement costs of using the Web are so low that they can be considered equal for all Web-based transactions. Thus, the benefits are differentiated by the costs that exist before the implementation of e-procurement. Accordingly, one can identify two types of procurement on two ends of a continuum—structured and unstructured—where existing systems and procedures determine the value of e-procurement.

On the one end, there are procurement processes that are highly automated in terms of need identification, ordering, and fulfillment. The customized needs, high demand volume, and potential uncertainties associated with supply can lead to high transaction costs for the buyer enterprise if each transaction has to undergo the supplier search, approvals, processing, and ordering. If the demand is regular and the product specifications do not change over time, organizations can reduce their transaction costs by negotiating a long-term contract with a supplier and designing an automated procurement process for reordering. This type of procurement is called structured procurement. Examples include tooling items, welding wires, and custom replacement parts.

On the other end of the continuum, there are products that are not suitable for any level of automated procedure. Organizations often allow end-users to take advantage of the best deals available at the time of ordering, and very little benefit will be derived from tying such procurement to product-specific purchasing steps with a particular supplier. These procurements tend to have very broad procurement rules that give users great freedom to choose suppliers. This type of procurement is called unstructured. Examples include office equipment and furniture.

Structured ordering procedures lessen the time users and procurement staff spend for search, input, and processing activities at the level of each transaction. The streamlined and repetitive nature of the orders reduces the scope for input and processing errors. The use of the Web is mainly to replace paper-based manual communication with electronic communication. On the other hand, it is difficult to set up meaningful automatic replenishment procedures for unstructured procurement needs, and every user request must be processed individually and the order placed with suppliers. More time is spent in search, input, and processing for each transaction, mostly in the form of labor. The greater variety of these requests and the higher human intervention increase the incidence of errors, and more staff time is spent in error resolution. Web-enabling unstructured procurement effects savings in the staff resources used for search, input, processing, and error resolution. Thus, the use of the Web for unstructured processes results in more value than its use for more structured processes.

**Proposition 1:** Use of Web-based procurement for unstructured procurement results in greater value than its use for structured procurement.

**Complexity of Process**

The complexity of a transaction refers to the need for additional efforts to process the transaction successfully. For example, a critical component may
have to undergo special inspection prior to any use, requiring an investment in testing equipment or inspection personnel. As a required item or ordering process becomes more complex, the transaction costs increase because of the greater search time, increased coordination requirements, need for more data processing, and the higher probability of errors. But if the transaction volume is insignificant, the organization cannot expect significant value from the use of the Web even for complex procurement. Thus the realized value depends not just on the complexity of the procurement process, but also on the transaction volume of this procurement category.

**Proposition 2:** The value of Web-based procurement increases with the complexity and transaction volume of the process.

**Organization of Business Units**

The effect of process-level factors conveys a sense of the effect on value from the transactional perspective. However, the procurement systems that handle these transactions serve different business units and user constituencies, and each unit perceives and realizes different values even from the same Web-based procurement system. The major factors that determine the different values are the volume of transactions, the distribution of the volume of different types of processes, and the degree of procurement centralization in the business unit.

**Size of Business Unit**

The use of the Web results in positive operational benefits (in terms of cost savings) on each transaction, irrespective of its type, even though the level of benefits may vary. More benefits accumulate when the volume of transactions of the business unit increases. Thus, between two business units with similar distributions of the different types of transactions, the larger unit can be expected to derive more value than a smaller business unit. In addition, there are more benefits from price reduction through centralization for a business unit with a larger volume of B2B purchases.

**Proposition 3:** Among business units with similar distributions of different types of B2B processes, larger business units realize higher values from the implementation of Web-based procurement.

**Dominant Type of B2B Process**

While the effects of the various types of processes were proposed above in isolation, a business unit deals with a mix of structured and unstructured processes. Some units, such as manufacturing facilities, can be expected to have a dominance (higher proportion) of structured processes, whereas other units, such as sales or administrative facilities, can be expected to have a dominance of unstructured processes. The potential value of Web-based procurement cannot be realized unless the dominant type of the process is Web-enabled.
Proposition 4: Business units can derive higher value from Web-based procurement only by Web-enabling the dominant type of procurement process.

Degree of Centralization

Web-based procurement systems enable organizations to centralize their purchase processes and at the same time give enough flexibility to local units to serve their local sourcing needs. Centralized procurement benefits a business unit in three ways. First, the administrative costs (part of the transaction costs) are spread over a larger volume of purchases, thus reducing the operational costs for each business unit. Second, the visibility of enterprise-wide procurement demand and preferences helps buyers to negotiate lower prices for goods and services. Third, centralized control and monitoring, combined with the user-friendly Web interface, motivate more users to order through the e-procurement system and reduce the volume of “off-contract” purchases. Since the benefits of the Web depend on how much centralization is achieved, it is proposed that the value depends on the increase in centralization rather than the level of centralization achieved.

Proposition 5: The value of a Web-based procurement system will be higher for a business unit that achieves a greater increase in centralization because of its use of the Web.

Extended Enterprise

While the characteristics of business units help to establish the value of implementing a Web-based procurement system in a particular business unit, the participation of external partners, such as suppliers, is necessary to realize the value of the Web across the supply chain. A supplier that is able to manage its production operations efficiently, based on timely and accurate information received from the buyer, as well as from its downstream suppliers, benefits the entire supply chain. The factors that are important in realizing the value of the Web relate to the organization of the supply chain and technology adoption, participation of the individual players, and the structure of the industry.

Integration of E-Procurement with Enterprise Systems

Electronic procurement systems interact with other information systems in the enterprise and the supply chain to enable the procurement process. For example, inventory, personnel data, and supplier data are accessed from the buyer’s ERP system. Design systems provide data for the product-development process. A supplier’s manufacturing information system is accessed for fulfillment information and order tracking. The full potential of an e-procurement system can be realized only when all the information exchange and sharing are done electronically, with minimum need for turnover of paper
documents. For example, even if the buyer side of a procurement process is fully automated and the purchase order is sent electronically to the supplier, if the supplier prints the purchase order and rekeys the data into its own system, the chances for errors and delays are increased, reducing the value of e-procurement.

Proposition 6a: Web-based procurement systems that have greater integration with existing enterprise systems yield higher value than procurement systems with lower integration.

Some of the information system applications in organizations are closely related, but others are disparate. For example, production planning and materials management may be closely connected, but not production planning and human resource management. As the existing information system applications are integrated into e-procurement, connecting to closely related systems helps leverage the synergy among the systems. An e-procurement system connected to production planning offers more benefits if it is also connected to materials management, but fewer benefits if connected to human resource management.

Proposition 6b: Web-based procurement systems that are integrated with closely related systems result in higher value.

Participation of Business Partners

From the enterprise point of view, business units and suppliers are the two most important participants in e-procurement systems. Business unit procurement managers are reluctant to reduce their control over procurement decisions and thus need strong incentives to motivate users to purchase through Web-based procurement systems. Suppliers are resistant to Web-based procurement because they anticipate fierce competition on-line and need strong incentives to Web-enable their catalog and ordering process. The potential value of the system cannot be realized unless both users and suppliers participate in the system.

Proposition 7a: The value realized from a Web-based procurement system is low when a small number of business units participates in the system, irrespective of the number of suppliers participating.

Proposition 7b: The value realized from a Web-based procurement system is low when a small number of suppliers participates in the system, irrespective of the number of business units participating.

As in the case of e-procurement integration, a synergy effect may be expected depending on who participates in e-procurement. In the “extended enterprise” supply chain, partners that have a close business relationship may add more value if they participate in the system together than will be yielded
by the participation of two unrelated partners. Suppose an MRO supplier and its suppliers participate in e-procurement—inefficiencies are reduced to a greater extent because information flow is optimized in the purchase process. But if an MRO supplier and an office products supplier participate in e-procurement, each purchase process needs to be optimized, which cannot be done without participation of the lower tiers of suppliers.

**Proposition 7c:** In Web-based procurement, participation by business partners that have closer business relationships in the same product supply chain results in higher value than participation by suppliers not related in the supply chain.

**Industry Fragmentation**

The characteristics of the industry play an important role in realizing the value of Web-based procurement. Industry fragmentation of demand or supply is an important factor that can be managed by using the Web. In an industry fragmented on the demand side, the supply side, or both, one expects high levels of search costs and inefficiencies in the traditional procurement. Intermediaries play an important role in reducing the transaction costs, but they are limited by technology. Such industries are greatly benefited by the Web, which allows the integration of demand and supply on a global scale. Enterprises that procure from a fragmented product supply chain can be expected to derive higher value from Web-based procurement.

**Proposition 8:** The value of Web-based procurement is greater if the existing product supply chain is more fragmented on the demand side, the supply side, or both.

The three levels of analysis, in the increasing order of scope of application, provide insights into the effect of the various factors on the value of Web-based procurement systems. An empirical case study will now be presented in which the framework is used to evaluate the Web-based procurement plans of an organization.

**Empirical Study**

The research site is a large manufacturer of heavy equipment located in the midwestern United States. This organization pioneered electronic commerce initiatives in its industry and is in the process of developing and implementing strategies. Since its indirect purchases account for nearly US$2–3 billion annually, the organization saw potential for significant cost reduction. The implementation of the Web-based procurement system has to move from the experimental stage to enterprise-wide adoption, and management wanted to validate the real benefits to motivate its internal users and suppliers. In addition, management also wanted to know what factors affect the reali-
Because of limited data availability at the time of writing this paper, procurement cost savings serve as the value of using a Web-based system, and the evaluation is limited to the effects of process type and complexity on this benefit. The research team used several data sources for the study. The first was a set of process-related data from internal procurement records that told of the distribution of process types and complexities. The second set of data was derived from interviews with users, purchasing analysts, and procurement managers at individual business units. These interviews helped the researchers to gather data on the benefits perceived by different types of users. The third set of data was a limited internal study conducted by the organization to measure the time saved for different types of procurement activities by using the Web-based system. Even these limited data provided very interesting insights into the need to consider the variations in processes and business units within the same organization instead of looking at the total impact on the organization of a Web-based system.

**Type of Process**

Structured procurement accounted for 55 percent of the organization’s total volume of procurement, and unstructured procurement accounted for 45 percent. The savings in processing, errors, and inventory were plotted for each of the two types of procurement, and the results are shown in Figure 2. The total cost savings from using the Web for unstructured procurement were significantly higher than for structured procurement, which is what had been expected. Interestingly, however, there were differences among the components of cost savings. While use of the Web for unstructured

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**Figure 2. Procurement Type and Value**

- Process savings
- Error savings
- Inventory savings
- Total savings

The chart shows the cost savings as a percentage of total savings for structured and unstructured procurement. Structured procurement accounts for 55% of the organization’s total volume of procurement, and unstructured procurement accounts for 45%. The savings in processing, errors, and inventory were plotted for each type, with unstructured procurement showing significantly higher total savings.
procurement resulted in higher process savings and higher error savings, the savings in inventory were significantly lower.

An important implication of the effect of process type on value is the question of which type to focus on when rolling out an e-procurement system. Although Web-enabling unstructured processes gives greater returns than structured, if a business unit has a dominance of structured procurement and high inventory levels, bringing structured processes into the system will result in higher savings, primarily because of inventory reduction, than bringing in unstructured processes. On the other hand, if the two types of procurement are evenly distributed or unstructured procurement dominates, there is more incentive to start the implementation with unstructured procurement.

**Complexity of Process**

Operational cost savings were plotted for the five types of unstructured procurement, organized in the increasing order of procurement complexity, and taking into account their volume in the organization. As shown in Figure 3, moderately complex items (i.e., MRO, office equipment, software, and services) had the potential to return higher benefits than simple or more complex items. As the “software & services” category did not involve the maintenance of a physical inventory, there were no inventory savings for this category of items. However, the total savings were significant because of the reduction in processing and error resolution costs.

Figure 3 shows that the volume of transactions in each category is an important factor to consider when implementing e-procurement. In motivating
internal users and business units to adopt a Web-based system, both the unit transaction benefit and the volume of purchases in each category of complexity should be taken into account. For example, a business unit with a dominance of complex purchases will not realize significant benefits unless it Web-enables its complex purchases. More complex purchases require more time and effort to be set up in an e-procurement system, and deciding which item to Web-enable at earlier stages depends on the distribution of transactions of different complexity.

Implications of the Value for Implementation Strategies

An important implication of the analysis and the empirical study is that the implementation of B2B e-commerce is not a simple yes-or-no decision, but involves understanding the differences in value of the system and the costs of implementation. An organization can implement Web-based procurement for the process or business unit that is expected to provide maximum value. While this approach may motivate other more hesitant business units to join the system, implementation of unstructured or complex procurement processes can be more difficult and time-consuming. Organizations have to consider the trade-off between realizing immediate benefits and lowering their risks for later benefits. However, as compared to traditional applications of information technology, the study found it is far easier and less complicated to design and implement a Web-based system. In consequence, the discussion that follows assumes that economic value is the prime motivating factor in developing implementation strategies.

Units with the highest decentralization of existing purchases should be chosen because they have the most potential for change through centralization (Proposition 5), and the resulting value will be higher. However, if the choice is between business units with similar distributions of purchase types, the larger the unit, the greater the value from Web-based procurement (Proposition 3). After a business unit has been chosen for implementation, the type of purchase to implement first is decided by the unit’s proportion of structured and unstructured procurement, and its inventory levels. If the business unit has a larger proportion of structured procurement combined with substantial inventories, Web-enabling structured procurement will yield the most value. Otherwise, Web-enabling unstructured procurement will yield the most value.

If the implementation strategy involves enterprise-wide adoption of the system, process type and complexity play a critical role in selecting which purchases to Web-enable first. Unstructured and complex purchases involve a high level of search and coordination. They also require stricter control in view of the possible noncompliance hazards. Purchases of this type require more human interaction. Thus, the firm should Web-enable the search process of unstructured and complex purchases in order to derive maximum value (Propositions 1, 2). However, if there is a very low proportion of unstructured and complex purchases as compared to other types of purchases, the most value will come from Web-enabling moderately complex purchases.
Once an implementation strategy is chosen, two critical factors influence the realization of maximum value: integration of Web-based procurement with current systems, and participation by suppliers. The procurement system should be designed to automatically retrieve and use data that are already available in the system instead of duplicating the input. Also, it should provide the necessary data required by other applications. The more integrated the organization and supplier systems are, the greater will be the value (Proposition 6a). In a manufacturing organization, purchasing is closely linked to engineering design and materials management because of the need for customized components. The implementation should integrate the Web-based procurement system with the design and materials management applications rather than with accounting or human resource applications (Proposition 6b). Thus, buyer organizations should not just integrate with other applications, but with applications whose functions are closely related to the procurement process.

Participation is the other critical factor. In order to encourage more use of a Web-based system, more suppliers have to be included in the procurement system and add their products to the electronic catalog (Propositions 7a, 7b). However, if the suppliers connected to the buyer-side system are themselves connected to their suppliers, there will be a further reduction in cycle time and errors, and coordination is improved. This leads to higher value than would result if two suppliers not related in the supply chain are added to the catalog (Proposition 7c). Thus buyer organizations should not simply seek to add more of their suppliers to the system, but should motivate the suppliers' suppliers to join the Web-based system.

Conclusion

The study described in this article was part of an ongoing research project represented by the overall framework in Figure 1. This phase has presented data related to B2B transactions and procurement cost savings in one organization. Further surveys will complete the collection of data to cover the business unit and extended enterprise factors, as well as other effectiveness measures (quality, user satisfaction, system responsiveness). The expanded research will help in developing an understanding of the impact beyond transactions. In particular, the coordination benefits of a Web-enabled B2B supply chain are expected to be significant and cannot be ignored by organizations.

The global scope of Web-based interorganizational information systems, and their enhanced capability for supply-chain coordination beyond immediate business partners, exemplifies the great leap they have taken beyond traditional IOS. Using the Web, organizations and their suppliers at all levels can integrate their supply chain across the extended enterprise in order to remove inefficiencies and to respond effectively to demand changes. Earlier generations of IOS were linear links between organizations, but with Web-based IOS a truly networked business system is possible. The economic contribution of each participant in this network, the benefits realized by the participants, the optimal incentives for increased participation, and the types of network ex-
ternalities created are very interesting issues for research and practice. The strategic impact of this network and its critical drivers are areas of research that will have tremendous value for organizations in the new economy.

Even as organizations are moving to Web-enable their B2B processes in the hope of improving their B2B supply chains and reaping economic benefits, there is a need to fully understand how this value is created and realized. Once researchers know how the value is created, it will be critical to identify the factors that explain the differences in the realization of Web potential across the entire B2B supply chain. This will help B2B managers to plan their adoption strategies such that the migration to e-procurement results in maximum benefit to the extended enterprise. This paper provides a start to this effort by developing a framework for understanding the value of Web-based procurement and the factors that affect the value. The effects of process-related factors, such as type and complexity, were established in determining the value of Web-based procurement to an enterprise, and the implications for implementation strategies. Future work in this line of research will use a comprehensive measurement of economic value and more empirical data to validate the framework both theoretically and empirically.

NOTES

1. In this paper “procurement” refers to the procurement of indirect materials.
2. “Extended enterprise” refers to an expanded scope of studying the impact of Web-based information systems beyond traditional organizational boundaries. As used in this paper, it refers to B2B processes and issues as seen from the perspective of a buying organization and covers the internal user, the procurement department, business units, immediate suppliers, and suppliers of the suppliers up to the last tier of supplier whose inputs are used by the buying organization.

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